Mother & Fetus

The start of a relationship

Janneke Maas

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General introduction

Infant-mother attachment and mother-infant attachment

Over the past thirty years, developmental research has demonstrated the importance of the early relationship between an infant and his or her mother for the child's later development. Research in this area is primarily based on attachment theory perspectives and has mainly focused on infant-mother attachment relationships, thus from the child's perspective. Bowlby (1969/1982) –the founder of the attachment theory- conceptualized attachment as "the propensity of human beings to make strong affectional bonds to particular others". According to Bowlby, every infant needs attachment behavior to seek the proximity and safety of a caregiver in order to survive. In stressful situations, for example when the infant is tired, scared, or ill, the infant will either show adaptive (secure attachment) or maladaptive (insecure attachment) emotion regulation strategies towards the caregiver. These early attachment patterns affect the way the infant will react to future stressful situations and shape the infant's social relationship patterns later in life (Sroufe, 2005; Weinfield, Sroufe, Egeland, & Carlson, 2008). Many studies have confirmed the significance of the infant-mother attachment relationship by showing that optimal and securely attached children are more capable of developing and maintaining successful close relationships, exhibit greater emotional understanding, and demonstrate more social problem-solving skills (for a review see Thompson, 2008). In contrast, non-optimal or insecure attachment relationships in children have been related to poor peer relations, higher levels of anger, and more behavioral problems in the child's later life (DeKleyn & Greenberg, 2008; Sroufe, 2005; Sroufe, Egeland, Carlson, & Collins, 2005). More recently, three meta-analyses concerning the role of insecure attachment on children's internalizing (e.g., depression, anxiety, social withdrawal, and somatic complaints) and externalizing behavior (e.g., aggression, oppositional problems, conduct problem, or hostility) were conducted (Fearon, Bakermans-Kranenburg, van IJzendoorn, Lapsley, & Roisman, 2010; Groh, Roisman, van IJzendoorn, Bakermans-Kranenburg, & Fearon, 2012; Madigan, Atkinson, Laurin, & Benoit, 2013). These meta-analyses demonstrated that early attachment insecurity modestly increases risks for internalizing symptoms, whereas large effects of early attachment insecurity on children's externalizing behavior were found.

Mother-infant attachment -referring to the maternal side of the mother-infant relationship- on the other hand, has until now received much less attention in research. This lack of research is rather surprising, since it has been shown that a disturbed relationship between mother and infant, for example as a result of maternal mental health problems, is associated with negative infant development (Brockington, Aucamp, & Fraser, 2006). Mother-infant attachment has often been described as the emotional bond or tie of affection experienced by the mother towards the infant (Condon & Corkindale, 1998). The rationale behind this construct is that this

emotional bond motivates and shapes a mother's response to her infant's behavior. These reciprocal behaviors within the mother-infant dyad subsequently result in the development of a long-standing complex relationship, frequently referred to as an attachment relationship (Müller, 1994). Some investigators consider the use of the term 'attachment' to describe the mother to infant relationship as at least controversial, since the relationship between mother and infant is not an attachment relationship in the sense as Bowlby (1969/1982) first defined it. According to Bowlby, the term attachment should be restricted to the security seeking behavior of the child towards the caregiver and should not be used to describe the corresponding behavior of the caregiver (Bowlby, 1969/1982; Walsh, 2010). The behavior of a mother or caregiver is not primarily motivated by seeking security but rather by providing security. Some researchers argue that it is more appropriate to consider the relationship between a mother and her infant –thus from the mother's perspective- as an emotional bond, at best similar but certainly not identical to attachment (Jansen, Weerth, & Riksen-Walraven, 2008; Pollock & Percy, 1999). Nevertheless, the term attachment is often used in studies examining the mother-infant relationship (Condon & Corkindale, 1998; Condon, Corkindale, & Boyce, 2008; Feldstein, Hane, Morrison, & Huang, 2004; Mercer & Ferketich, 1994; Müller, 1994, 1996). In line with the aforementioned studies and based on the fact that mothers themselves also use the term 'attachment' to describe their feelings towards their infants, the studies described in this thesis will use the term 'attachment' to describe the relationship between mother and her (unborn) infant from the mother's perspective.

Maternal fetal attachment

Based on studies in the past decades there is sufficient evidence that the development of the mother-infant relationship starts before the infant is born, while the infant is still a fetus (Brandon, Pitts, Denton, Stringer, & Evans, 2009; Condon, 1993; Cranley, 1993). The relationship a mother forms with her fetus is referred to as *maternal fetal attachment* (MFA) or *prenatal attachment* and is generally defined as the emotional tie or bond which normally develops between a pregnant woman and her unborn baby (Condon, 1993; Cranley, 1981; Müller & Mercer, 1993). These feelings of attachment generally begin as early as 10 weeks of gestation and become more intense during the course of pregnancy (Caccia, Johnson, Robinson, & Barna, 1991; Laxton-Kane & Slade, 2002). Developing a relationship with the fetus is critical for a successful physical and psychological adjustment to pregnancy and parenthood (Raphael-Leff, 2005; Van den Bergh & Simons, 2009). Stronger feelings of attachment towards the fetus have been associated with positive health practices of the mother during pregnancy. Mothers who reported higher levels of MFA, more likely abstain from alcohol and tobacco, follow prenatal classes, and are eager to learn about the pregnancy (Lindgren, 2001). These

actions may positively affect maternal and fetal health and may prevent poor birth outcomes. In contrast, poor prenatal attachment, reported as having fewer thoughts about the fetus and being less involved with the pregnancy, has been associated with more symptoms of anxiety, mood instability, depression, and feelings of irritation towards the fetus (Brandon et al., 2009; Condon & Corkindale, 1997; Pollock & Percy, 1999; Van Bussel, Spitz, & Demyttenaere, 2010a). These factors may lead to negative pregnancy and poor birth outcomes. These findings strongly support the importance of MFA for pregnancy, health, and birth outcomes of both mother and infant.

Etiology of maternal fetal attachment

Several studies have addressed the question which factors are involved in the etiology of individual differences in MFA. Findings however, were often inconclusive and inconsistent, with some studies confirming and other rejecting significant associations (Alhusen, 2008; Cannella, 2005; Van den Bergh & Simons, 2009; Yarcheski, Mahon, Yarcheski, Hanks, & Cannella, 2009). In general, adequate family support, more psychological well-being of the mother, and progressed gestational age seem to promote the development of MFA. In contrast, maternal depression, maternal anxiety, and substance abuse are more likely to hinder the development of attachment towards the unborn child (see reviews by Alhusen, 2008; Cannella, 2005). In the meta-analysis of Yarcheski et al. (2009), moderate positive effect sizes were found for social support and prenatal testing. Low effect sizes were found for a planned pregnancy, maternal age, ethnicity, marital status, income, education, maternal anxiety, depression, and self-esteem (Yarcheski et al., 2009). Mothers who were more satisfied with the amount of support they received both within and outside their partner relationship, reported higher levels of attachment towards the fetus. The support they receive from their social environment enables these mothers to fully focus on the current pregnancy and their fetus, resulting in higher levels of MFA (Condon & Corkindale, 1997). Nowadays, prenatal testing using fetal ultrasound screening has become routine practice in prenatal care in many countries (Righetti, Dell'Avanzo, Grigio, & Nicolini, 2005). Also in the Netherlands it is common practice to have an ultrasound screening at 20 weeks gestational age. Viewing the fetus on the ultrasound provides visual evidence of fetal viability and facilitates mother's recognition of the fetus as an independent human being, both enhancing mother's attachment feelings (Yarcheski et al., 2009). The majority of the studies described in the reviews of Alhusen (2008), Cannella (2005), and Yarcheski et al. (2009) had small sample sizes with a maximum of 100 participants, were exploratory in nature instead of theory-driven, and failed to apply appropriate multivariate analyses. There is a strong need of high quality research on identifying factors influencing MFA. In this thesis, the focus is a process model in which multiple determinants in predicting MFA are studied concurrently.

Associations of maternal fetal attachment with postnatal outcomes

Several short-term longitudinal studies have been conducted to examine the association between MFA and the mother-infant relationship after birth. In these studies, the concept of MFA is seen as part of a continuum of feelings and behaviors that develop during pregnancy and extend into the postnatal relationship between mother and infant (Cranley, 1993). Findings have confirmed the association between the pre- and postnatal relationship by demonstrating that mothers with more positive and stronger feelings towards their fetus also report more positive feelings towards their infant in the postnatal period (Mercer & Ferketich, 1994; Müller, 1996; Reading, Cox, Sledmere, & Campbell, 1984; Van Bussel, Spitz, & Demyttenaere, 2010b). Research has further shown that more and stronger feelings of MFA are associated with less depressive symptoms of the mother (Goecke et al., 2012), more overall maternal competence (Mercer & Ferketich, 1994), and an enhanced ability to feed and take care of her infant in the postnatal period (Fowles, 1996). However, only a few studies have focused on the association between MFA and postnatal maternal interactive behavior. Fuller (1990) for example demonstrated a strong relationship between MFA in the third trimester of pregnancy and mothers' sensitive behavior during feeding the first three days after birth. Mothers with stronger feelings of MFA were more sensitive to their infants' cues, held their infants closer, made more eye contact, and verbally stimulated their infants more often. Moreover, research has shown that the effect of MFA on maternal interactive behavior is not limited to the period directly after birth but even extends into the first months postpartum. Mothers with stronger MFA, reported on a self-report questionnaire that they felt more sensitive 6 weeks postpartum (Shin, Park, & Kim, 2006). Finally, Siddiqui, and Hägglöf (2000) showed that mothers who reported higher levels of MFA during the third trimester of pregnancy, were more involved and stimulated their infants more during observed mother-infant interaction 12 weeks postpartum. Whether associations between MFA and mother-infant interaction exist beyond the third month postpartum has currently not been examined and will be one of the aims of the present thesis. Additional knowledge of factors that influence MFA and the effects of MFA on postnatal mother-infant relationships could stimulate the development of interventions aiming to enhance mothers' feelings towards their fetus during pregnancy and to prevent the development of sub-optimal mother-infant relationships.

Measuring maternal fetal attachment

MFA is generally measured with self-report questionnaires. The Maternal Foetal Attachment Scale (MFAS; Cranley, 1981), the Prenatal Attachment Interview (PAI; Müller & Mercer, 1993), and the Maternal Antenatal Attachment Scale (MAAS; Condon, 1993) are the most commonly used. The items in these questionnaires refer

to concepts based on the idea that the mother-fetus relationship is manifested in her behaviors, attitudes, thoughts, and feelings about the fetus (Brandon et al., 2009; Van den Bergh & Simons, 2009). In the current thesis, the MAAS has been used, because this measure focuses exclusively on thoughts and feelings about the fetus (e.g., "Over the past two weeks I have thought about, or been preoccupied with the baby inside me") and does not capture attitudes towards the state of pregnancy and motherhood (e.g., "I feel my body is ugly", MFAS). Condon conceptualized MFA into five different core experiences: 'To know' (information seeking behavior about the development of the baby), 'to be with' (desire to interact with the baby), 'to avoid separation or loss' (behaviors aimed at prolonging or maximizing contact), 'to protect' (taking precautions to make the pregnancy period as optimal as possible for the baby), and 'to identify and gratify the needs of the baby' (desire to be sensitive to the needs of the baby) (Condon, 1993). By measuring these core experiences as reflected in behaviors and thoughts about the fetus, the quality of affective feelings towards the fetus and the intensity of concern for the fetus could be evaluated.

Maternal sensitivity

Previous research distinguished two sides of the mother-infant relationship; mother's (experiences of) feelings towards her infant and her behaviors associated with these feelings (Sluckin, Herbert, & Sluckin, 1983). Therefore, in addition to evaluating mothers' cognitive and emotional aspects of the relationship using self-report questionnaires, maternal interactive behaviors have to be evaluated as well to get more insight into the quality of the mother-infant relationship. The quality of maternal interactive behavior is often assessed by observing maternal sensitivity during mother-infant interactions. Maternal sensitivity is defined as the ability to accurately perceive and interpret the infant's behavioral signals and communications, and to respond appropriately to them (Ainsworth, Bell, & Stayton, 1974). A mother who is sensitive to the infant's signals and needs, gives her infant the confidence that she is available when the infant is in need. Previous research has stressed the importance of maternal sensitivity for the relationship between mother and infant by identifying maternal sensitivity as a major predictor for secure attachment behavior in infants in the first year postpartum (De Wolff & van IJzendoorn, 1997; NICHD Early Child Care Research Network [ECCRN] et al., 1997). Research has also shown long term associations between maternal sensitivity, infant's attachment security, and the emotional and cognitive development during infancy, the preschool years, and later childhood (Belsky & Fearon, 2002; Fraley, Roisman, & Haltigan, 2013). Children with non-optimal or poor relationships, in which they have learned not to trust on their caregiver's availability, are at increased risk to develop externalizing or internalizing problems at childhood age. Since maternal sensitivity has a major influence on infant and child development, identifying

its determinants is important. Most studies on determinants of maternal sensitivity have focused on the postnatal period with an almost systematic neglect of possible determinants in the pregnancy period (Bernier, Jarry-Boileau, Tarabulsy, & Miljkovitch, 2010). However, based on the aforementioned studies (Fuller, 1990; Shin et al., 2006; Siddiqui & Hägglöf, 2000) one might assume that MFA is a strong early predictor of maternal sensitivity in the early postnatal period. In this thesis, the main focus will be on the relationship between MFA and maternal sensitivity at 6 months postpartum.

Measuring maternal sensitivity

Maternal sensitivity is generally assessed by observing and evaluating videotaped mother-infant interactions. Observations of mother-infant interaction are known to vary in many ways. They vary in situation/activity (i.e., feeding, caregiving, free play, or face-to-face play), in structure (i.e., presence or absence of toys, time-constrained directed tasks or unstructured observations), and in setting (i.e., research laboratory, health care clinic, or the infant's home). Previous research showed that this variability in context of the observation influences maternal interactive behavior (Isabella, 1998; Miller, McDonough, Rosenblum, & Sameroff, 2002; O'Brien, Johnson, & Anderson-Goetz, 1989). Therefore it is important to apply measurement procedures that are minimally intrusive and valid across various contexts to evaluate behavior in mother-infant interactions (Weisz, 1978). In the studies described in this thesis, the quality of mother and infant interactive behavior is assessed using the Qualitative Scales of the Observational Ratings of Mother-Child Interaction of the National Institute of Child Health and Human Development (NICHD Scales). Maternal sensitivity evaluated by this instrument reflects positive, nonintrusive, responsive, and supportive maternal care and proved to be stable across a period from 6 to 36 months of age (NICHD ECCRN, 1999).

Aim of the thesis

The general aim of the studies presented in this thesis is to provide more insight into the construct of maternal fetal attachment (MFA), its determinants, and its relation with the quality of the mother-infant relationship in the postnatal period. First, the role of parental, contextual, and expected child characteristics on maternal fetal attachment are studied. Second, mother and infant interactive behaviors as a function of the specific situation are examined. Finally, the core aim of this thesis is addressed by investigating the effect of maternal fetal attachment on maternal sensitivity during the postnatal period.

"Expectant Parents" study

All studies presented in this thesis are part of a prospective, longitudinal cohort study called "Expectant Parents" ["In Verwachting"]. An important aim of the "Expectant Parents" study is to investigate the quality of parent-infant relationships from parents' perspectives, both in the prenatal and postnatal period. The study protocol of the "Expectant Parents" study is presented in Chapter 2 of this thesis. To examine the relationship that pregnant women develop with their fetus, its determinants, and its consequences, we have focused on (pregnant) women and their (unborn) infants from a community-based sample. As can been seen in Figure 1 on page 21 in Chapter 2, 466 pregnant women gave informed consent. Three hundred eleven of these women participated actively in the complete research protocol, 98 filled in questionnaires but did not participate in the home-visits, and 57 women participated passively by allowing the researchers to gather information from the midwife and National Health Care Centres. For the studies described in this thesis we will only focus on the women who participated in a home-visit or filled in questionnaires (n = 409). The mean age of these women was 31.21 years (*SD* = 4.51; range 17 – 44 years), more than half of the sample was primiparous (54%) and had Dutch nationality (82%). Years of education following primary school varied from 0-4 years (15%), 5-8 years (26%), to 9 years or more (60%). The mean gestational age at birth was 39.78 weeks (*SD* = 0.26; range 30 – 42 weeks) and 49% of the children were male.

Outline of the thesis

The present thesis includes one study protocol and three empirical studies. After this introductory chapter, *Chapter 2* describes the study protocol of the "Expectant Parents" study. In *Chapter 3*, the influence of parental, contextual, and expected child characteristics on MFA is examined. Furthermore, in *Chapter 4* the effect of situational variables on mother-infant interaction is studied and *Chapter 5* addresses the question whether MFA is related to postnatal maternal sensitivity. Finally, a general discussion and a summary of the findings are presented in *Chapter 6*.

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"Expectant Parents": Study protocol of a longitudinal study concerning prenatal (risk) factors and postnatal infant development, parenting, and parent-infant relationships *

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ABSTRACT

Background: While the importance of the infant-parent relationship from the child's perspective is acknowledged worldwide, there is still a lack of knowledge about predictors and long-term benefits or consequences of the quality of parent-infant relationships from the parent's perspective. The purpose of this prospective study is to investigate the quality of parent-infant relationships from parents' perspectives, both in the prenatal and postpartum period. This study therefore focuses on prenatal (risk) factors that may influence the quality of pre- and postnatal bonding, the transition to parenthood, and bonding as a process within families with young children. In contrast to most research concerning pregnancy and infant development, not only the roles and experiences of mothers during pregnancy and the first two years of infants' lives are studied, but also those of fathers.

Methods/Design: The present study is a prospective longitudinal cohort study, in which pregnant women (N=466) and their partners (N=319) are followed from 15 weeks gestation, until their child is 24 months old. During pregnancy, midwives register the presence of prenatal risk factors and provide obstetric information after the child's birth. Parental characteristics are investigated using self-report questionnaires at 15, 26, and 36 weeks gestational age and at 4, 6, 12, and 24 months postpartum. At 26 weeks of pregnancy and at 6 months postpartum, parents are interviewed concerning their representations of the (unborn) child. At 6 months postpartum, the mother-child interaction is observed in several situations within the home setting. When children are 4, 6, 12, and 24 months old, parents also complete questionnaires concerning the child's (social-emotional) development and the parent-child relationship. Additionally, at 12 months information about the child's physical development and well-being during the first year of life is retrieved from National Health Care Centres.

Discussion: The results of this study may contribute to early identification of families at risk for adverse parent-infant relationships, infant development, or parenting. Thereby this study will be relevant for the development of policy, practice, and theory concerning infant mental health.

INTRODUCTION

Developmental research has firmly established the quality of the relationship between an infant and his or her parent as an important factor influencing the child's later development (DeKleyn & Greenberg, 2008; Lyons-Ruth & Jacobvitz, 2008; Rees, 2005; Sroufe, 2005; Sroufe, Egeland, Carlson, & Collins, 2005; Weinfield, Sroufe, Egeland, & Carlson, 2008). When children develop a secure relationship with their parents or caregivers in their first years of life, they generally have better cognitive outcomes, better social interactions, display less behavioral problems, and achieve better at school (Thompson, 2008). Research in this area has mainly investigated the attachment relationships that infants form with their parents, thus focusing on the child's perspective of the relationship. In contrast, the attachment relationship from the parent's perspective has not been studied frequently. This concept, also known as *bonding*, may be of equal importance to later child development as the traditionally studied concept of infant-to-parent attachment. More research concerning predictors and long-term benefits or consequences of bonding is therefore needed (Barlow & Svanberg, 2009).

The development of the parent-infant attachment relationship does not start after the child is born, but already evolves during pregnancy (Brandon, Pitts, Denton, Stringer, & Evans, 2009; Raphael-Leff, 2005).The relationship a parent forms with the fetus is often referred to as *prenatal attachment* and has been described as the earliest, most basic form of human intimacy (Condon & Corkindale, 1997). Several definitions of prenatal attachment have been provided, many conceptualized in health research, but it is generally defined as the emotional tie or bond that develops between expectant parents and their fetus (Condon, 1993; Cranley, 1981). Researchers have pointed out that it is important to study prenatal attachment and factors related to its development, since it provides insightful information on later parent-infant bonding (Condon & Corkindale, 1997). Several studies found that the quality of the parent-fetus relationship was related to the quality of postnatal parent-infant relationships (Benoit, Parker, & Zeanah, 1997; Müller, 1996; Siddiqui & Hägglöf, 2000; Theran, Levendosky, Bogat, & Huth-Bocks, 2005). It is assumed that the prenatal parent-infant relationship influences the parent's daily interactions with the child after birth and subsequently affects the quality of the parent-infant relationship and development.

Next to these feelings of attachment during pregnancy, research concerning the parent-fetus relationship has focused on another concept known as *internal working models* or *representations* of the unborn child (Ainsworth & Bowlby, 1991; Bretherton, 1992). Representations are described as a set of tendencies to behave in particular ways in intimate relationships (Zeanah & Smyke, 2009). They provide information about the 'meaning' a child has to his or her parent by asking the parent about his or her experiences with and perceptions of the fetus, (future) parenting,

and the relationship with the fetus. The majority of research concerning internal working models has focused on postnatal representations, while studies on parents' prenatal representations are scarce. Since prenatal representations are found to be related to postnatal representations and postnatal parent-infant interaction, it is important that the quality of prenatal representations and its consequences are also further investigated (Benoit et al., 1997; Dayton, Levendosky, Davidson, & Bogat, 2010; Theran et al., 2005). In addition, it is unknown whether discrepancies between pre- and postnatal representations lead to parental adjustment problems once the child is born, possibly affecting the quality of postnatal bonding and later child outcomes.

Parent-infant attachment or bonding develops further after birth and continues to develop beyond the early postnatal period (Bruschweiler-Stern, 2009). Surprisingly, empirical research into the determinants, consequences, and stability of postnatal bonding is also limited (Benoit, 2004). Only a few studies have examined predictors and consequences of postnatal bonding and they suggest that prematurity, domestic violence during pregnancy, and maternal postpartum mood are related to adverse maternal bonding and adverse parent-infant interactions (Nicol-Harper, Harvey, & Stein, 2007; Reck et al., 2004; Singer et al., 2003; Zeitlin, Dhanjal, & Colmsee, 1999). Moreover, Brockington, Aucamp, and Fraser (2006) stressed that both severe disturbances, as well as less severe problems with parental bonding may lead to more negative parental care and may subsequently result in various forms of child abuse or neglect. Therefore, several parental, infant, and contextual risk factors are expected to influence the quality of the bonding process.

The present study has been designed to investigate prenatal (risk) factors that may influence the quality of pre- and postnatal parent-infant relationships and postnatal infant development within families with young children. Several determinants and consequences of the early parent-infant relationship will be investigated. Already during pregnancy, prenatal risk factors influencing the quality of the parent-infant relationship and later child development can be identified (Wilson et al., 1996). For example, emotional problems of mothers during pregnancy, problems in mothers' own childhood history, and deficits in parental cognitive functioning increase the possibility of problematic caregiving and child development (Davis et al., 2004; Muir et al., 1989). However, there is still considerable debate and a lack of knowledge about how specific risk factors are related to the long-term benefits or consequences of the parent-infant relationship. In contrast to most research concerning pregnancy and infant development, this study does not only focus on maternal characteristics, but also on the roles and experiences of fathers during pregnancy and the first two years of the infants' lives.

The following topics and research questions related to the parent-infant relationship will therefore be investigated in the current study:

1. The relationship between prenatal (risk) factors, postnatal infant development and quality of the parent-infant relationship. Can specific prenatal risk factors for adverse infant development, parenting, or parent-infant relationships be identified during pregnancy?
2. The transition to parenthood. Is there a discrepancy between the quality of prenatal and postnatal parent-infant relationships and parents' representations of the child? Do parents' prenatal expectations of the child's characteristics meet their postnatal experiences? How are these factors related to infant behavior and development?
3. Parental bonding over time. How stable are parents' feelings of bonding and do they change over time? Is the quality of early parent-infant bonding related to later child development?

METHODS/DESIGN

Enrollment and informed consent

Between November 2008 and July 2009, 835 pregnant women were invited by their midwives to participate in this study. Four midwifery practices in Eindhoven, the 5th largest city of the Netherlands, agreed to participate in the study. At the first routine visit (between 9 -15 weeks gestational age), midwives provided mothers with information about the purpose of the study and invited them to participate. The oral information was accompanied by an information brochure with specific information about the study, which each mother received. If mothers were interested in participation, one of the researchers contacted them by phone to provide additional information and asked whether they wanted to enroll in the study. Partners were not directly approached by the researchers but the mothers were informed about the importance of participation of their partners in the study. After parents received oral and written information about the protocol, both parents were asked for written consent. The informed consent form consisted of three different options. Parents could consent to (1) active participation in the complete research protocol, including two home visits, (2) active participation by filling in questionnaires but not by participating in home visits, or (3) passive participation by allowing the researchers to gather information from the midwife and National Health Care Centres, but without home visits or filling in questionnaires. Separate informed consent forms were sent to mothers and their partners. Once parents returned the signed forms, enrollment in the study was complete.

The "Expectant Parents" ["In Verwachting"] study protocol has been financed and approved by the Netherlands Organization for Health Research and Development (ZonMW, Grant 80-82405-98-074/157001020). It was also approved by the Medical

Ethics Committee of St. Elisabeth Hospital Tilburg (date: 13-08-2008, register number: NL 23376.008.08).

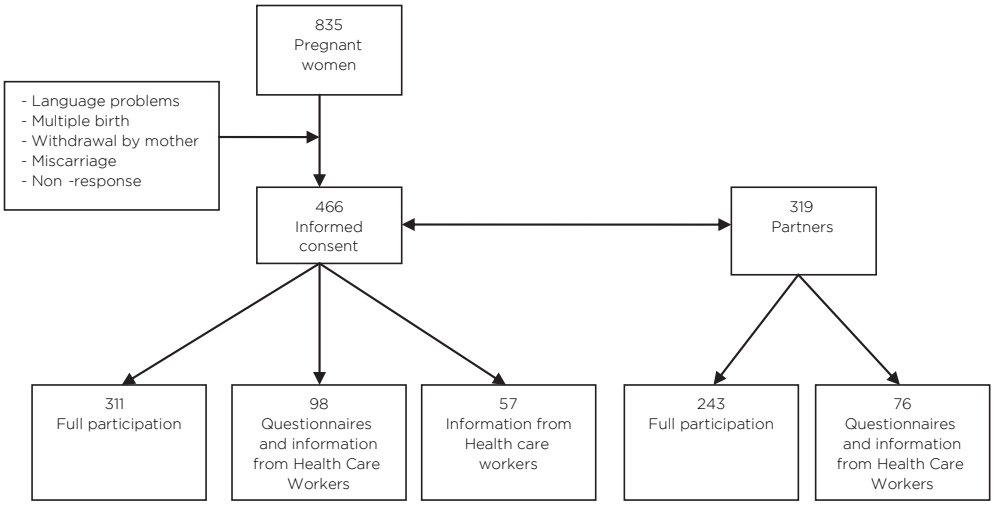

Figure 1 Flow chart of study population 'Expectant Parents'.

Participants

Of the 835 invited women, women with a poor understanding of the Dutch and English language, those expecting multiple births, and women who were over 20 weeks of gestation at enrollment, were excluded from participation. Reasons for not giving written consent were withdrawal by the mother, miscarriage, and non-responding mothers. As Figure 1 demonstrates, this resulted in 466 completed informed consent forms of expectant mothers and 319 informed consents of their partners. All parents hereby gave permission to the researchers to retrieve information about the pregnancy and delivery from their midwives and information about the development of the child in the first year of life from National Health Care Centres. Of these parents, 409 mothers and 319 fathers agreed to complete questionnaires, of which 311 mothers and 243 fathers also agreed to participate during home visits (full participation).

Study Design

The present study is a prospective longitudinal cohort study, in which pregnant women and their partners were followed from 15 weeks gestation until their child was 24 months old. As can be seen in Figure 2, pregnant women completed questionnaires at 15, 26, and 36 weeks gestational age. At 26 weeks of pregnancy, their partners also completed a questionnaire. At the same time a home visit took place during which

a standardized interview concerning the prenatal representations of the unborn child was conducted with both parents separately.

Postnatally, there were five more measurement waves (at birth and at 4, 6, 12, and 24 months postpartum). Obstetric information about the birth of the child, including birth weight, Apgar score, and possible complications was registered by the midwives in line with their general practice guidelines. Additionally, midwives provided information about the presence of possible prenatal risk factors within families by completing an adapted Dutch version of the Dunedin Family Services Indicator; DFSI) (Muir et al., 1989). At 4 and 6 months postnatally, both parents received questionnaires. At the child's age of 6 months, an interview about the representations of their child was administered with both parents at their home, and the mother-child interaction was observed in several contexts within the home. Interviews generally lasted between 30 and 60 minutes and the observation of mother-infant interactions lasted approximately 20 minutes. All home visits were video-recorded. When children were 12 months old, mothers completed questionnaires concerning the child's (social-emotional) development, and information about the child's physical development and well-being during the first year of life was retrieved from National Health Care Centres. At the child's age of 24 months, the last measures concerning parental characteristics, the parent-child relationship, and the child's development were completed by both parents.

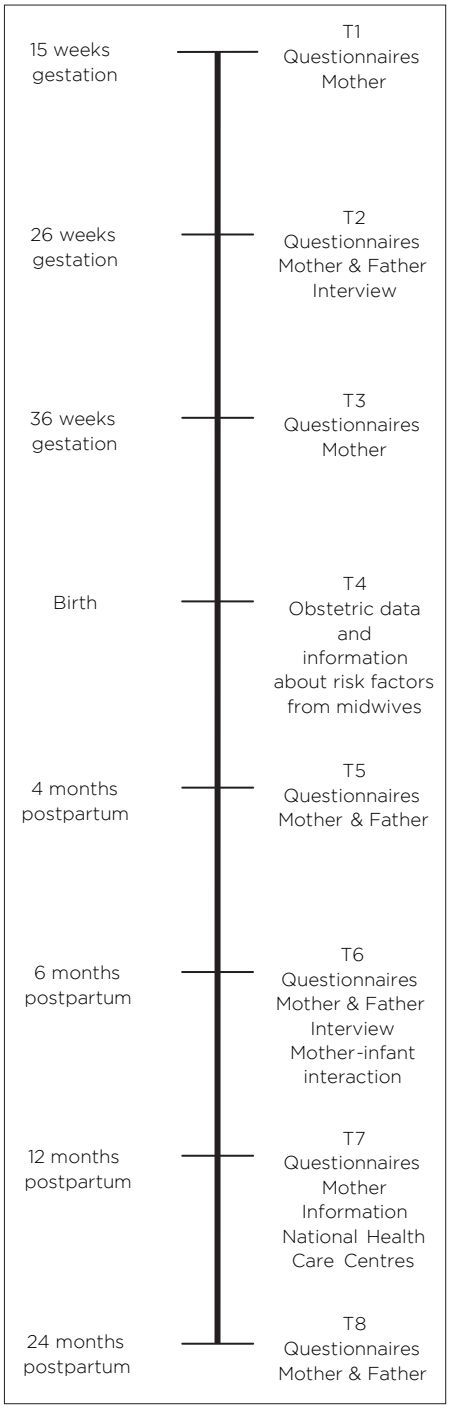

Figure 2 Time line study protocol 'Expectant Parents'.

Study Measures

Figure 3 shows which variables were investigated at different time points during the study. Generally, the study measures can be classified according to whether they concern parental characteristics, infant characteristics, or the parent-infant relationship. Therefore, the selected instruments are described below according to these categories.

Parental Characteristics

Parental characteristics were investigated using self-report questionnaires. To assess parental psychological well-being, the following questionnaires were used: Edinburgh Depression Scale (EDS; Cox, Holden, & Sagovsky, 1987), State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970), Symptom Check List; anxiety, depression, and hostility subscale (SCL-90; Arrindell & Ettema, 2003), Symptoms of Anxiety-Depression index (SAD-4; Denollet, Strik, Lousberg, & Honig, 2006), and Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983).

To assess parents' personality characteristics, the Quick Big Five (QBF; Vermulst & Gerris, 2005), Type D Scale (DS14; Denollet, 2005), and Ego Resiliency 89 Scale (ER89; Block & Kremen, 1996) were administered. Adult attachment style was measured with the Relationship Questionnaire Clinical Version (RQ-CV; Holmes & Lyons-Ruth, 2006) and the partner-relationship was evaluated with a subscale of the Questionnaire on Family Problems [Vragenlijst voor Gezinsproblemen] (VGP; Koot, 1997).

The Placenta Paradigm Questionnaire (PPQ; Raphael-Leff, 2005) and the Facilitator Regulator Questionnaire (FRQ; Raphael-Leff, 1983) were used to determine maternal orientations on pregnancy and their infants. Midwives used an adapted version of the Dunedin Family Services Indicator (DFSI; Muir et al., 1989) to register the presence of possible prenatal risk factors among parents.

Infant Characteristics

The following questionnaires were used to investigate infant development and behavior: Ages and Stages Questionnaire (ASQ; Bricker, Squires, & Mounts, 1995), Ages and Stages Questionnaire; Social-Emotional (ASQ-SE; Squires, Bricker, & Twombly, 2002), Infant Characteristics Questionnaire (ICQ; Bates, Freeland, & Lounsbury, 1979), Infant Toddler Social-Emotional Assessment (ITSEA; Carter & Briggs-Gowan, 2000), Brief Infant Toddler Social-Emotional Assessment (BITSEA; Briggs-Gowan & Carter, 2002), subscales of the Infant Behavior Questionnaire Revised (IBQ-R; Gartstein & Rothbart, 2003), Early Childhood Behavior Questionnaire (ECBQ; Putnam, Gartstein, & Rothbart, 2006), and Behavior Rating Inventory of Executive Function Preschool version (BRIEF-P; Gioia, Espy, & Isquith, 2002).

Information about the child's physical development and well-being during the first year of life was retrieved from National Health Care Centres.

Mothers	Fathers
T1: 15 weeks gestation • Depressive symptoms (EDS + SCL-90) • Anxiety (STAI + SCL-90) • Personality (DS14) • Demographic information	
T2: 26 weeks gestation • Prenatal representations of unborn child (WMCI + PRAM) • Prenatal expectations of infant temperament (ICQ) • Depressive symptoms (EDS + SCL-90) • Anxiety (STAI + SCL-90) • Personality (QBF) • Perceived stress (PSS) • Maternal orientation (PPQ) • Attachment style (RQ) • Prenatal attachment (MAAS)	**T2: 26 weeks gestation** • Prenatal representations of unborn child (WMCI + PRAM) • Prenatal expectations of infant temperament (ICQ) • Depressive symptoms (EDS + SCL-90) • Anxiety (STAI + SCL-90) • Personality (QBF) • Perceived stress (PSS) • Attachment style (RQ) • Prenatal attachment (PAAS) • Personality (DS14) • Demographic information
T3: 36 weeks gestation • Depressive symptoms (EDS + SCL-90) • Anxiety (STAI + SCL-90) • Relationship with partner (VGP) • Resiliency (ER89)	
T4: Birth • DFSI • Obstetric information	
T5: 4 months postpartum • Depressive symptoms (EDS + SCL-90) • Anxiety (STAI + SCL-90) • Personality (QBF + DS14) • Perceived stress (PSS) • Parent-child relationship (PBQ) • Child development (ASQ)	**T5: 4 months postpartum** • Depressive symptoms (EDS + SCL-90) • Anxiety (STAI + SCL-90) • Personality (QBF + DS14) • Perceived stress (PSS) • Parent - child relationship (PBQ) • Resiliency (ER89)
T6: 6 months postpartum • Representations of the child (WMCI + PRAM) • Mother-child interaction (NICH D) • Child temperament (ICQ) • Relationship with partner (VGP) • Mother-infant attachment (MPAS) • Parenting self -efficacy (PMP-SE) • Maternal orientation (FRQ) • Child development (ASQ) • Child social -emotional development (ASQ-SE)	**T6: 6 months postpartum** • Representations of the child (WMCI + PRAM) • Child temperament (ICQ) • Relationship with partner (VGP) • Father-infant attachment (PPAS) • Parenting self -efficacy (PMP-SE)
T7: 12 months postpartum • Depressive symptoms (EDS) • Anxiety (STAI) • Child development (ASQ) • Child social -emotional development (ASQ-SE) • Infant behavior (ITSEA + IBQ-R) • Information from National H ealth Care Centres	
T8: 24 months postpartum • Representations of the child (PRAM) • Mother-infant attachment (MPAS) • Parenting (NOSIK) • Relationship with partner (VGP) • Symptoms of anxiety and depression (SAD-4) • Personality (QBF, DS14) • Attachment difficulties (ADSI) • Infant behavior (EC BQ + BITSEA) • Child cognitive functioning (BRIEF-P) • Demographic information	**T8: 24 months postpartum** • Representations of the child (PRAM) • Father-infant attachment (PPAS) • Parenting (NOSIK) • Relationship with partner (VGP) • Symptoms of anxiety and depression (SAD-4) • Personality (QBF + DS14) • Attachment difficulties (ADSI) • Infant behavior (ECBQ) • Demographic information

Figure 3 Study protocol and assessments at different time points during the study.

Parent-infant relationship

To determine parents' representations of their (unborn) infant, the Working Model of the Child Interview (WMCI; Zeanah, Benoit, Barton, & Hirshberg, 1996) was conducted during home visits. At the same time, and also at 24 months, the Pictorial Representation of Attachment Measure (PRAM; Van Bakel, Vreeswijk, & Maas, 2009), a non-verbal measure of the parent-infant relationship, was administered. To evaluate the quality of mother-infant interactions, the NICHD scales (NICHD Early Child Care Research Network et al.,1999) were used.

In addition, the following questionnaires were used to give insight into the parent-fetus and parent-child relationship: Maternal Antenatal Attachment Scale (MAAS; Condon, 1993), Maternal Postnatal Attachment Scale (MPAS; Condon & Corkindale, 1998), Paternal Antenatal Attachment Scale (PAAS; Condon, 1993), Paternal Postnatal Attachment Scale (PPAS; Condon, Corkindale, & Boyce, 2008), Parental Bonding Questionnaire (PBQ; Brockington et al., 2001), and Attachment Difficulties Screening Instrument (ADSI; Stams et al., 2011).

To evaluate parenting behavior, the following scales were used: the Parental Stress Index [Nijmeegse Ouderlijke Stress Index-verkort] (NOSI-K; De Brock, Vermulst, Gerris, & Abidin, 1992), and Perceived Maternal Parenting Self Efficacy (PMP-SE; Barnes & Adamson-Macedo, 2007).

Data collection and management

The logistics of this study were carried out by three researchers (AM, CV, EdC) in close collaboration with the midwives participating in this study. Before starting data collection, a protocol was set up and discussed with participating midwives, to ensure that a uniform protocol was followed by all midwifery practices. Participating midwives were instructed on how to recruit pregnant women for participation in the study and how to register the presence of possible prenatal risk factors.

Questionnaires were sent to parents one or two weeks before the time point they should be completed or before the home-visits. All questionnaires were available in Dutch and English. Reminders were sent when parents failed to return the questionnaires. Table 1 shows the number of parents that participated at each measurement wave.

The researchers (AM, CV, CR) and several research assistants were trained to administer and code the WMCI, concerning parents' representations of their (unborn) children and to code observations of mother-child interactions. All interviews and mother-infant interactions were video-recorded and coded afterwards. A random subgroup of the interviews and observations was coded by more than one coder, to determine inter-rater reliability.

Table 1 Number of participants per time point of the study protocol.

Time	Measure	Mothers	Fathers
T1: 15 weeks gestation	Questionnaires	406	-
T2: 26 weeks gestation	Questionnaires	375	299
	Home visit	311	243
T3: 36 weeks gestation	Questionnaires	351	-
T4: Birth	Information concerning the birth	455	-
	DFSI completed by midwife	445	-
T5: 4 months postpartum	Questionnaires	354	274
T6: 6 months postpartum	Questionnaires	341	268
	Home visit	295	225
T7: 12 months postpartum	Questionnaires	299	-
	National Health Care Centres	[a]	[a]
T8: 24 months postpartum	Questionnaires	248[b]	186[b]

Note.
[a] Data currently not complete.
[b] For T8, 285 mothers and 246 fathers were approached.

Data preparation

Collected data were entered into an electronic database. Random samples of all manually processed questionnaires were double checked by the researchers to monitor the quality of the manual data entry. All measurements were checked by examination of the data, including their ranges, distributions, means, standard deviations, outliers, and logical errors.

Privacy Protection

Databases needed for answering specific research questions were centrally built from databases concerning different time points of the study. All information enabling identification of participants was erased from these databases, except identification numbers of each participant. Video-recordings of participants were stored on the computers of the researchers, which were only accessible with a password, and not on web-based directories.

Statistical analyses/power calculation

To answer the various research questions we will use structural equation modeling, regression analyses (HMR analyses), logistic regression analyses and odds-ratio's. Mediation and moderation analyses will follow Baron and Kenny's requirements (Baron & Kenny, 1986). The power calculation is based on one of the main questions that will be addressed about the effects of prenatal (risk) factors on infant development. Assuming a moderate effect size of .30 or .40, a power of .80 (i.e., the minimal power

for a similar study by J. Cohen, 1988), an alpha of .05, and 11 parameters/predictors, we need a sample size of 220 participants (the power will be .83 with p=11, r^2=.09 or the power will be .99 with p=11, r^2=.16). Abovementioned power calculations are exact calculations, based on results of Gatsonis and Sampson (1989). Allowing for loss to follow-up by 24 months postpartum, we estimated that a sample of at least 240-260 women would be sufficient to test our hypotheses.

DISCUSSION

With this study we aim to gain more insight into the relationships between prenatal (risk) factors, postnatal infant development and the quality of the pre- and postnatal parent-infant relationship. This investigation will lead to more knowledge about the transition to parenthood for both mothers and fathers, and the stability and change in parents' feelings of bonding over time. The longitudinal design with a multi-informant, multi-method approach offers the possibility to predict infant developmental outcomes in the first years of life from pregnancy onwards.

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3

Determinants of maternal fetal attachment in women from a community-based sample *

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ABSTRACT

Background: Maternal fetal attachment has been found to be an important predictor for the developing relationship between mother and child. During the last decades, research on determinants of maternal fetal attachment has yielded inconclusive and even contradictory results. Until now, a process model in which multiple determinants of maternal fetal attachment are studied concurrently is lacking. The present study evaluates a process model (based on Belsky's model of parenting, 1984) in which the specific contributions of parental, contextual, and expected child characteristics to maternal fetal attachment were examined.

Method: Participants, 351 pregnant women from a community-based sample, completed questionnaires concerning their personality, attachment security, partner support, perceived stress, expected child temperament, and maternal fetal attachment at 26 weeks gestational age. Based on Belsky's model, a set of competing structural equation models were formulated and evaluated with path analysis.

Results: Maternal fetal attachment was found to be multiply determined by parental, contextual, and expected child characteristics. These factors explained 19% of the variance in maternal fetal attachment. Pregnant women who were more extrovert, conscientious, and agreeable, reported having higher levels of maternal fetal attachment. In contrast, those women who perceived more stress and expected having an infant with a dull temperament, reported lower levels of maternal fetal attachment.

Conclusions: This study demonstrated that the theoretical framework of Belsky's model is applicable for explaining variations in the quality of the mother-fetus relationship in the pregnancy period. More knowledge of the determinants of maternal fetal attachment could help to identify mothers at risk for developing sub-optimal feelings of attachment.

INTRODUCTION

In developmental research, the quality of the early relationship between a mother and child has been found to be an important predictor for later child development (Sroufe, Egeland, Carlson, & Collins, 2005; Thompson, 2008). This relationship has primarily been studied from an attachment theory perspective and research in this area presumes that the mother-child relationship starts to develop in the child's first year of life and the quality of their daily interactions further shapes their attachment relationship (Bowlby, 1969/1982). However, from the mother's perspective, the relationship between her and her child does not start after the child's birth. Rather, it evolves during pregnancy and is often referred to as *maternal fetal attachment* (MFA). MFA is generally defined as the emotional tie or bond which normally develops between a pregnant woman and her unborn child (Condon, 1993; Cranley, 1981). Developing a relationship with the unborn child is the key developmental task in the psychological adjustment to pregnancy and parenthood (Raphael-Leff, 2005; Van den Bergh & Simons, 2009). In earlier research, MFA has been found to be positively associated with the well-being and positive health practices of the mother during pregnancy (Brandon, Pitts, Denton, Stringer, & Evans, 2009; Lindgren, 2001). The quality of the prenatal mother-fetus relationship is additionally predictive of the quality of the postnatal mother-infant relationship (Benoit, Parker, & Zeanah, 1997; Müller, 1996; Siddiqui & Hägglöf, 2000) and subsequently influences the child's later development. A secure relationship between mother and child in the child's first years of life has been associated with better cognitive outcomes, better social interactions, and less behavioral problems in the child (Sroufe et al., 2005; Thompson, 2008).

Since the introduction of the MFA construct by Cranley (1981), much research has been conducted into MFA, its determinants, and its consequences. Factors such as adequate family support, more psychological well-being, and progressed gestational age were associated with higher levels of MFA, whereas factors as maternal depression, anxiety, and substance abuse were more likely to hinder feelings of attachment towards the unborn child (Alhusen, 2008; Cannella, 2005). Until now, most of these studies were exploratory in nature and not theory-driven. In a meta-analytic study, factors such as social support, prenatal testing, gestational age, planned pregnancy, maternal age, parity, ethnicity, marital status, income, education, and maternal anxiety, self-esteem, and depression, were identified as determinants of MFA (Yarcheski, Mahon, Yarcheski, Hanks, & Cannella, 2009). However, these predictors had typically low to moderate effect sizes. Furthermore, all determinants were analyzed separately in relation to MFA, without taking into account intercorrelations between these determinants. Recently, Bouchard (2011) was the first to examine determinants of MFA simultaneously. She showed that in pregnant women, the quality of the partner relationship was positively associated with prenatal attachment, but only for women

with low levels of neuroticism or low levels of attachment to their own parents. This suggests that neuroticism might interfere with a pregnant woman's ability to become attached to her unborn child and that the partner relationship can facilitate the development of MFA in pregnant women who were not strongly attached to their parents (Bouchard, 2011). However, until now, a process model in which multiple and different determinants are studied concurrently in predicting MFA is lacking. In such a model the interplay between the different variables is accounted for, while multiple testing with an increased risk of type-1 error is avoided. Studying the determinants of MFA will expand the knowledge of early infant development.

In the present study, Belsky's (1984) ecological model of parenting directed the inclusion of potential determinants of the mother-fetus relationship. Previous research in infancy and toddlerhood has often applied Belsky's theoretical framework to study determinants of parenting. Individual differences in the quality of parental caregiving have frequently been explained by differences in determinants identified on the basis of this model. Belsky's model presumes that parenting is determined by multiple domains; characteristics of the parent, contextual sources of stress and support, and child characteristics. Since the introduction of this model, research has focused on

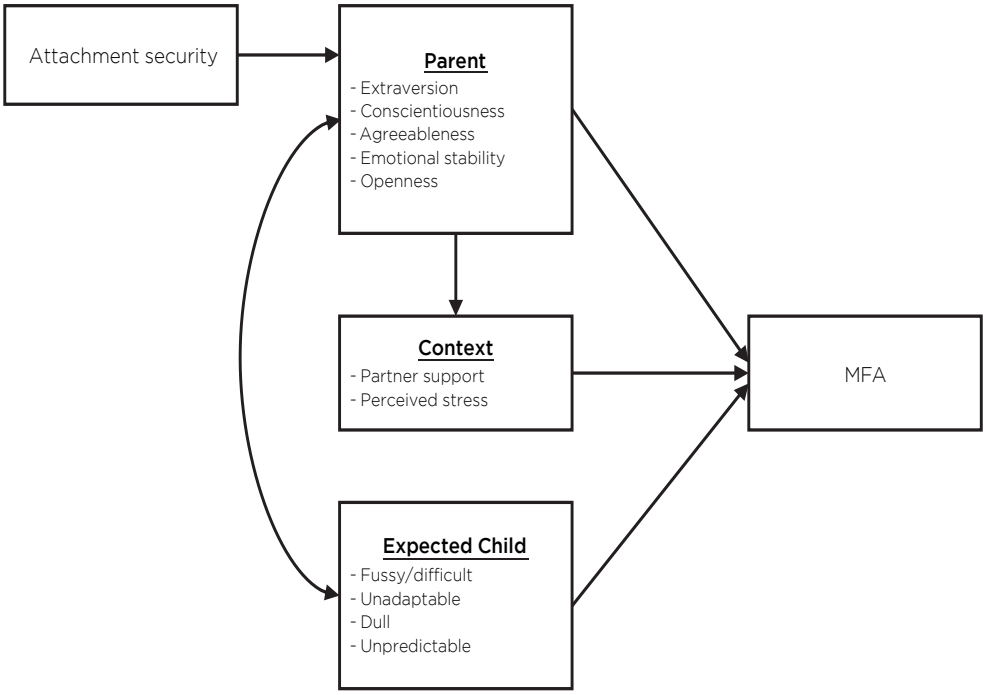

Figure 1 Model summarizing the hypothesized pattern of relations among parental, contextual, and expected child characteristics on MFA.

parts of the model, with only few studies examining the model as a whole. The model was confirmed for parents of infants (Belsky, Woodworth, & Crnic, 1996; Van Bakel & Riksen-Walraven, 2002), toddlers (Verhoeven, Junger, Van Aken, Deković, & Van Aken, 2007), school-aged children (Meyers, 1999), and adolescents (Luster, 1998). The model was also evaluated in specific caregiving situations. De Schipper, Riksen-Walraven, and Geurts (2007) applied the general model to caregiving behavior in child care centers and Belsky et al (1996) used it to identify dysfunctional families. All studies concluded that caregiving and parenting were determined by parental, contextual, and child characteristics.

Based on Belsky's process model we expect the following three domains of characteristics to determine maternal fetal attachment: (1) parental characteristics, (2) contextual characteristics, and (3) expected child characteristics. In Figure 1, our model of the determinants of MFA is presented. In the following paragraphs, we elaborate on different characteristics of each domain and how they are expected to relate to MFA within the perspective of earlier conducted research.

Parental characteristics

Belsky (1984) proposed parental personality as the most influential determinant of parenting. Personality influences parenting behavior both directly and indirectly (i.e., through the effect on contextual characteristics) (Belsky, 1984; Belsky & Barends, 2002). The impact of personality characteristics on the attachment relationship between mothers and their unborn child has received little attention in research until now. Bouchard (2011) recently identified neuroticism as a risk factor for lower levels of MFA. Individuals with high levels of neuroticism tend to respond with more negative emotions to stressful life events and view themselves and the surrounding world more negatively (Bouchard, 2011; Lahey, 2009). In pregnant women, this negative affectivity could interfere with their ability to become attached to their unborn child. In the postnatal period, research into the relationship between parental personality and parenting showed positive personality traits, such as agreeableness, extraversion, openness, and conscientiousness, to be related to warm and structured parenting. Negative personality traits, such as neuroticism, on the other hand, were associated with lower levels of supportiveness and less positive, responsive, and adaptive parenting (Kochanska, Friesenborg, Lange, & Martel, 2004; Prinzie, Stams, Deković, Reijntjes, & Belsky, 2009; Verhoeven et al., 2007).

In the present study we aim to get more insight into the relation between parental personality characteristics and the mother-fetus relationship. Parental personality is expected to be both directly and indirectly (through contextual characteristics) related to MFA. More specifically, higher levels of agreeableness, extraversion,

openness, and conscientiousness and lower levels of neuroticism are expected to be related to higher levels of MFA. Indirect effects are expected because the pregnant woman's personality influences the context (such as level of perceived stress) in which she develops feelings and thoughts towards her unborn child (Bouchard, 2011). For example, people high in neuroticism tend to be easily distressed and nervous, leading to higher levels of perceived stress and subsequently to lower levels of MFA.

Belsky (1984) further stresses the importance of parent's own developmental history, in particular parental attachment security, which shapes parents personality and psychological well-being. This will subsequently and indirectly affect parenting behavior. Research has confirmed this by relating parents' attachment representations of their own parents to future parenting behavior (Priel & Besser, 2000; Van IJzendoorn, 1995). Van Bakel and Riksen-Walraven (2002) also found that in one-year-olds, their parents own attachment security was related to the quality of the interactions they had with their infant and with the quality of the developing attachment relationship. Research in the prenatal period has revealed that mother's childhood memories of her own upbringing were an important determinant of the quality of mother's attachment relationship with her unborn child (Huth-Bocks, Levendosky, Bogat, & Von Eye, 2004). Pregnant women who experienced more emotional warmth from their mother during their own childhood were more likely to establish an affectionate relationship with the fetus (Siddiqui & Hägglöf, 2000). More recently, parental attachment security was found to be related to MFA in that more securely attached women reported more positive feelings of MFA, whereas insecurely attached women reported less positive feelings of MFA (Van Bussel, Spitz, & Demyttenaere, 2010). In line with Belsky's model and earlier findings of Van Bakel and Riksen-Walraven (2002), parental attachment security was expected to indirectly influence MFA through parental personality. Earlier research has established the relationship between parental attachment security and personality traits, in that secure attachment was negatively associated with neuroticism and positively with extraversion and agreeableness (Shaver & Brennan, 1992). In the present study, more securely attached women are thus expected to be more agreeable, more extrovert, and less neurotic, resulting in more positive feelings of attachment towards their unborn child.

Contextual characteristics

The social context in which the mother-fetus relationship is embedded is considered the second important domain in the process model of MFA. Generally, the social context domain is mainly studied in terms of social support and perceived stress. Studies on the relationship between overall social support and MFA, however, have yielded inconsistent results. A clear and positive association has been found between the quality of the partner relationship (partner support) and MFA (Cannella, 2005;

Van den Bergh & Simons, 2009). Pregnant women who were more satisfied about the support they received from their partner reported higher levels of attachment towards their unborn child (Condon & Corkindale, 1997; Hjelmstedt, Widström, & Collins, 2006). In his model, Belsky (1984) already hypothesized that overall support (e.g., partner support) was positively related to parenting by its influence on the psychological well being of parents. The relationship between support and parenting has also been empirically confirmed in the postnatal period by demonstrating that high levels of overall support (Cochran & Niego, 2002) and partner support (Van Bakel & Riksen-Walraven, 2002; Verhoeven et al., 2007) were positively associated with better parenting skills.

A second characteristic in the contextual domain is perceived stress. Higher levels of (perceived) stress were found to be associated with the development of poorer prenatal attachment (Cranley, 1981; Feldman, 2007). It seems that when pregnant women are experiencing high levels of stress, it is more difficult for them to focus on the developing relationship with their unborn baby. This subsequently results in lower levels of MFA.

In the current study both partner support and perceived stress are examined as possible determinants of MFA. Both characteristics are assumed to be directly related to MFA. Next they are also expected to be influenced by parental personality. Mothers who are more agreeable and open for example, will be more capable to elicit support from their partner during stressful periods. As mentioned before, mothers who are more agreeable or extrovert are also expected to experience less stress during their pregnancy period.

Expected child characteristics

The third and final domain in Belsky's model includes child characteristics. The amount and quality of parental caregiving that children receive also depend on the character or temperamental characteristics of the child. Previous research in the postnatal period has demonstrated that temperamentally difficult children generally receive lower maternal sensitivity (Kochanska et al., 2004; Van Bakel & Riksen-Walraven, 2002; Verhoeven et al., 2007). Although studying child characteristics during pregnancy is much more difficult, mothers are able to report on expected child temperament (i.e., fussy-difficultness, unadaptedness, dullness, and unpredictability) based on their experiences with the fetus. A study examining the relation between expected child temperament and MFA showed that pregnant women who reported more feelings of attachment perceived their fetuses to be less dull and more predictable (Zeanah, Carr, & Wolk, 1990). Moreover, research has demonstrated the importance of prenatal expectations of child temperament on the early mother-infant bond. Less positive expected child characteristics (such as dullness and unadaptedness) during pregnancy

were associated with a less adequate mother-infant bond after birth (Benoit et al., 1997; Pearce & Ayers, 2005). Since this expected child temperament is based on mother's ideas of the unborn child, the relationship between expected child temperament and parental personality will also be explored. In line with the aforementioned findings, we hypothesize that the expectation of having a temperamentally difficult child is negatively related to MFA.

Research question and hypotheses

In sum, the aim of the current study is to determine whether, how, and to what extent parental, contextual, and expected child characteristics contribute to MFA. Based on previous research of Belsky's model in mothers of infants up to adolescents, the three domains are all hypothesized to contribute to the quality of MFA. Personality traits (i.e., agreeableness, conscientiousness, emotional stability, and extraversion) are hypothesized to directly and positively influence MFA. Within the domain of contextual characteristics, we anticipate low levels of partner support and higher levels of stress to be directly and negatively related to MFA. With respect to the expected child characteristics, it is hypothesized that the expectation of more difficult temperament will generate lower levels of MFA. Additionally, indirect effects on MFA were anticipated. Parental attachment security is anticipated to be related to MFA through parental personality characteristics. More securely attached women are expected to be more agreeable, more extrovert, and less neurotic, resulting in more positive feelings of attachment towards their unborn child. Finally, it is hypothesized that personality characteristics will indirectly affect MFA through perceived partner support and stress of the pregnant woman.

METHOD

Participants and procedure

The present study was embedded in the 'Expectant Parents' study on prenatal risk factors and postnatal infant development. More details about recruitment of the participants and the data collection used in this project have been reported earlier and are only briefly summarized here (Maas, Vreeswijk, de Cock, Rijk, & van Bakel, 2012). At the first routine visit to their midwives, pregnant women were invited to participate. Women expecting multiple births or with a poor understanding of the Dutch and English language were excluded from participation. At approximately 26 weeks gestational age 375 participants filled in questionnaires concerning their personality, attachment security, perceived stress, expected temperament of their child, and maternal fetal attachment. Information of partner support was obtained by questionnaires at 36 weeks

gestational age. Prior to analyses, 24 participants were excluded from further analysis due to severe language problems (n=2), having six or more variables missing (n=6), or for filling in the MFA questionnaire after 31 weeks gestational age (n=16). This resulted in a sample of 352 participants and their characteristics are presented in Table 1. We excluded participants who filled in the MFA questionnaire after 31 weeks since MFA is known to increase during the course of pregnancy and this effect could influence our results (Cannella, 2005; Laxton-Kane & Slade, 2002; Yarcheski et al., 2009).

Instruments and measures

Parental characteristics

Parental personality. Participants described their own personality using a Dutch adaptation of the Quick Big Five inventory (QBF; Vermulst & Gerris, 2005), which assesses (1) *extraversion* (tendency to be social, fun loving, and optimistic), (2) *conscientiousness* (tendency to be well organized and purposeful), (3) *agreeableness* (tendency to be cooperative, friendly, and helpful), (4) *emotional stability* [reverse coded as neuroticism] (degree to which a person is nervous, anxious, and irritable), and (5) *openness* (tendency to enjoy new experiences and to demonstrate active imagination). Each dimension was represented by six adjectives. Examples of adjectives are: Cooperative (agreeableness), irritable (emotional stability), and talkative (extraversion). Participants could indicate on a 7-point scale (1 = very untrue for me, 7 = very true for me) the degree to which a trait adequately described their personality. Cronbach's alphas for these personality traits were .90, .88, .85, .84, and .79 respectively. Previous studies have established the test-retest reliability of the QBF (Vermulst & Gerris, 2005).

Attachment security. Parental attachment security was assessed using the Relationship Questionnaire Clinical Version (RQ-CV; Holmes & Lyons-Ruth, 2006). In this self-report instrument five prototypical descriptions of the main types of attachment (i.e., secure, dismissing, preoccupied, fearful, and distrustful) are provided. An example of a description used in this questionnaire is: "I want to be completely emotionally intimate with others, but I often find that others are reluctant to get as close as I would like. I am uncomfortable being without close relationships, but I sometimes worry that others don't value me as much as I value them". Participants were asked to choose the description that best characterizes the way they generally act in close relationships. Depending on their answers, participants were categorized into one of the five attachment types. For the present study, the distinction between secure versus insecure (i.e., dismissing, preoccupied, fearful, or distrustful) was used. Earlier research with the RQ-CV has shown convergent validity with interview ratings of attachment (Holmes & Lyons-Ruth, 2006).

Table 1 Intercorrelations, means, and standard deviations for the study variables.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	M / %	SD	%‡
Parent																						
Attachment security[a]	-																			0.36	0.48	5
Extraversion	-.24	-																		5.24	1.10	0
Conscientiousness	.00	.11	-																	5.08	1.07	0
Agreeableness	-.21	.32	.28	-																5.75	0.64	0
Emotional stability	-.29	.36	.16	.21	-															4.88	1.04	0
Openness	-.05	.24	.07	.28	.13	-														4.74	0.93	0
Context																						
Partner support	-.06	.08	-.05	.05	.22	.10	-													8.92	1.38	7
Perceived stress	.22	-.28	-.11	-.30	-.62	-.20	-.30	-												26.99	5.41	1
Expected Child																						
Fussy/difficult	.00	-.03	-.19	-.19	-.13	-.25	-.03	.14	-											31.30	4.91	1
Unadaptable	.01	-.16	-.08	-.16	-.16	-.22	.00	.10	.58	-										15.98	3.77	0
Dull	-.01	-.10	-.12	-.18	-.04	-.19	.05	.02	.47	.46	-									12.53	2.54	1
Unpredictable	-.04	.03	-.13	-.06	-.01	-.14	.14	-.07	.58	.41	.31	-								20.81	3.55	0
Covariates																						
Parity[b]	-.05	.06	.11	.01	.01	.02	.18	.07	-.18	-.02	-.11	-.25	-							55%		0
Education	-.28	.07	.00	.14	.17	.14	.09	.21	.06	.03	.01	.11	-.01	-						11%		1
Maternal age	-.15	.01	.02	-.03	.14	-.02	.01	-.10	.01	-.03	.12	.02	.28	.33	-					31.51	4.37	0
Income	.26	.10	.05	.12	.21	.07	.20	-.32	-.04	-.08	.13	.01	.02	.54	.44	-				5%		11
Ethnicity[c]	.10	-.15	.02	-.09	-.15	-.10	-.22	.15	-.14	-.04	-.24	-.07	.00	-.13	-.18	-.22	-			85%		0
Planned pregnancy[d]	.07	-.08	.00	-.14	-.08	-.07	-.11	.16	.03	.09	-.02	-.01	.01	-.22	-.12	-.28	.00	-		85%		18
Maternal Fetal Attachment																						
Quality of Attachment	-.06	.18	.17	.26	.10	.10	.08	-.17	-.16	-.14	-.20	-.12	.10	-.01	-.19	-.09	-.06	.03	-	49.93	3.21	0

Note. N = 351. Estimates based upon full information maximum likelihood. ‡ Percentage missing. Reference category: [a]secure (65%), [b]first child (55%), [c]Dutch (85%), [d]planned (85%). Correlations (in absolute value) are significant if: r ≥ .105; p =.05; r ≥ .124; p =.01; r ≥ .164; p =.001

Contextual characteristics

Partner support. The quality of partner support was evaluated with a subscale of the Questionnaire on Family Problems (VGP; Koot, 1997). Partner support was assessed in the domain of childrearing as this specific support was expected to contribute more to MFA than a more global measure of support. Participants were asked five questions, such as "My partner supports me too little". Cronbach's alpha was .58 and evidence supporting the validity of the subscale has been reported earlier (Van Bakel & Riksen-Walraven, 2002).

Perceived stress. The Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983) was used to measure perceived stress of the participants. This self-report scale measures the degree to which a respondent is able to handle day-to-day problems and hassles and how often she felt nervous and stressed. An example is: "In the last month, how often have you felt that things were going your way?" The PSS consists of 14 items which have to be answered on a 4-point rating scale, ranging from 1 (never) to 4 (always). Cronbach's alpha was .84. This measure has been used before in samples of pregnant (and non-pregnant) women and has shown good test-retest reliability and good validity (S. Cohen et al., 1983).

Expected child characteristics

Expected child temperament was measured with the prenatal version of the Infant Characteristics Questionnaire (ICQ; Bates, Freeland, & Lounsbury, 1979; Pearce & Ayers, 2005). Four temperamental dimensions were identified through principal component analyses: (1) *fussy-difficultness* (9 items), (2) *unadaptedness* (5 items), (3) *dullness of expression* (4 items), and (4) *unpredictability* (6 items). Participants were asked to report the expected temperament of their unborn child on a 7-point Likert-scale range from 1 (very easy) to 7 (very difficult). An example of a question is: "How well will your baby adapt to new situations?" Higher scores indicated a more difficult temperament. Cronbach's alphas of the subscales were .80, .77, .53, and .51 respectively and these were comparable with earlier reported findings (Bates et al., 1979).

Maternal fetal attachment

The Maternal Antenatal Attachment Scale (MAAS; Condon, 1993) was used to assess MFA. This self-report questionnaire focuses on attitudes, thoughts, and feelings towards the unborn child and consists of 19 items. The present study focuses on the 'Quality of Attachment' (QA) subscale of the MAAS which measures the quality of mother's affective experiences (i.e., closeness, tenderness, a desire to know, and positive feelings) towards the unborn child. Responses on the 11 items were given on a 5-point rating scale (a score of 1 represents absence of feelings towards the fetus

and a score of 5 is indicative of very strong feelings towards the fetus). The minimum score for QA is 11 and the maximum score is 55, higher values indicate greater QA. Earlier research has reported a good Cronbach's alpha (α>.80) for the global scale and support for construct validity (Condon & Corkindale, 1997; Laxton-Kane & Slade, 2002). Cronbach's alphas in this study were adequate; global scale = .76, QA = .66.

Statistical analysis

Based on Belsky's conceptual model a set of competing structural equation models were formulated. In all models we controlled for the following covariates; parity, education, maternal age, income, ethnicity, and whether the pregnancy was planned or not. Models were specified starting from the covariance matrix and fitted by means of full information maximum likelihood making use of all available information under the missing at random (MAR) assumption. Model fit was evaluated based upon commonly recommended goodness-of-fit indices (see e.g., Hu & Bentler, 1999), including the χ^2 of the model fit, the confidence interval for the root mean square error of approximation (RMSEA), the Tucker-Lewis Index (Zeitlin, Dhanjal, & Colmsee, 1999), and chi-square difference tests ($\Delta\chi^2$) for nested models. Because the full model was too comprehensive for a clear graphical presentation, the detailed results are reported sequentially in line with the respective regression equations that make up the full model (i.e., simultaneous analysis, but presentation in parts). At the end of the results section, a concise and comprehensive graphical summary is provided summarizing the effects and relations among the construct blocks using multivariate effect sizes (Cohen, 1988).

RESULTS

Descriptive statistics and correlation analysis

In Table 1 the descriptive statistics and correlations between the study variables are presented. Within the Parent block, inspection of the correlation matrix reveals that the personality dimensions show low to moderate positive associations (range r = [.07, .36]). With respect to the Context block more partner support is associated with less perceived stress (r = -.30). Within the Expected Child block, the positive correlations (range r = [.31, .58]) between all four different dimensions of expected child temperament (i.e., fussy-difficultness, unadaptedness, dullness, and unpredictability) indicate that mothers have a rather concurrent global positive or negative expectation of their child's temperament. To more clearly describe the relations between the various construct blocks a structural equation modeling approach was followed.

Four competing formulations of Belsky's conceptual model

Based upon Belsky's conceptual model we formulated four alternative structural equation models. A summary representation of all four models is provided in Figure 2.
(1) The first model is a rather descriptive model (*Saturated Model*) that assumes that all different blocks are connected to each other. Note that each block possibly includes more than one variable, and hence the corresponding arrows also represent multiple effects. The model is ordered in a sense that it starts with parental attachment security, impacting on parental personality characteristics, and these on their turn affect contextual characteristics. All these characteristics in combination with expected child characteristics are assumed to influence the final outcome variable, maternal fetal attachment (MFA). The residual error terms for the Expected Child block are allowed to correlate with those of the Parent and Context block. For clarity, residual error terms and control variables are omitted in the graphical display. Note that the control variables influence each outcome within the full model.
(2) The second model (*Belsky's Model*) is more restrictive and more closely resembles Belsky's original theoretical model. The Expected Child block is restricted to be unrelated to the Parent and Context blocks, and parental attachment security is only allowed to directly impact the Parent block (but not the other blocks anymore). The latter restriction implies that parental attachment security, through its potential impact on parental personality characteristics, can only have an indirect effect on MFA.
(3) Given that in the prenatal period, the child is in fact not yet physically present, the Expected Child block addresses mothers' expectations of their unborn child. In contrast to the original model of Belsky, it is therefore reasonable to assume that the variables in the Parent block are correlated with the variables in the Expected Child block. This last adaptation gives rise to a third model (*Adapted Model*).
(4) As an extreme baseline reference model we included a model where the key construct blocks are only being affected by the control variables (i.e., all construct-relevant effects are restricted to zero). If this fourth model (*Null Model*) provides the best fit, Belsky's model is considered to be completely not-applicable in the prenatal context.

The model comparison results in Table 2 show that the Null Model can be safely rejected. Furthermore, the Adapted Model provides an equally good but more parsimonious fit than the Saturated Model, and a significantly better fit than the strict Belsky's Model. Thus, our model of choice is the Adapted Model. These results empirically confirm our conceptual framework and have some implications. First, the effect of parental attachment security on MFA is only indirect and can be fully explained by its effect on the intermediate Parent block. Second, the contextual characteristics are unrelated to the expected child characteristics, but –as anticipated given the prenatal setting– the parental personality characteristics are related to expected child characteristics.

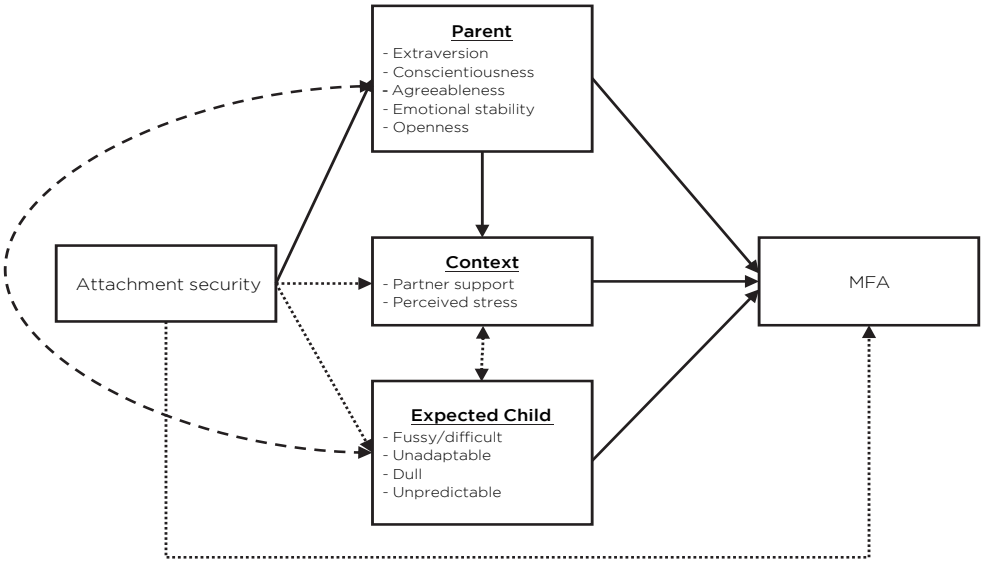

Figure 2 Four competing formulations of Belsky's conceptual model.
Note. For clarity of presentation, residual error terms and covariates are not depicted.
Saturated model includes all arrows;
Belsky model omits all dotted and dashed arrows;
Adapted model omits all dotted arrows;
Null model omits all arrows.

Table 2 Model comparison among 4 competing formulations of Belsky's conceptual model.

Model	χ^2	df	RMSEA	TLI	$\Delta\chi^2$	df	*p*
Saturated	0.00	0	0	1	.		
Adapted	20.592	15	[.000,.064]	.950	21	15	.150
Belsky	92.125	35	[.051,.085]	.782	72	20	<.001
Null	283.589	41	[.116,.144]	.211	192	6	<.001

Effect of attachment security on personality

Table 3 shows that insecurely attached pregnant women scored lower on the personality domains of extraversion, agreeableness, and emotional stability. For conscientiousness and openness no significant differences between the two parental attachment security groups were found. Furthermore, when we focused on the covariates, we found that women with Dutch nationality were more extrovert, women with one or more children were more conscientiousness, women with a lower age were more agreeable, and women with a higher educational level were more open.

Table 3 Standardized direct effects on parental personality characteristics (*N*=351).

Predictor	Extraversion			Conscientiousness			Agreeableness			Emotional stability			Openness		
	β	*Z*	*p*	*β*	*Z*	*p*	*β*	*Z*	*p*	*β*	*Z*	*P*	*β*	*Z*	*P*
Parent															
Attachment security[a]	-.22	-4.02	.000	.02	0.29	.772	-.17	-3.07	.002	-.24	-4.60	.000	-.01	-0.10	.920
Covariates															
Parity[b]	.07	1.27	.204	.11	2.05	.040	.04	0.71	.477	-.01	-0.16	.872	.05	0.88	.377
Education	-.02	-0.24	.808	-.03	-0.44	.662	.08	1.20	.229	.02	0.33	.743	.15	2.36	.019
Age of mother	-.09	-1.41	.160	-.03	-0.54	.590	-.13	-2.14	.032	.03	0.55	.585	-.11	-1.70	.089
Income	.05	0.63	.527	.09	1.21	.225	.04	0.56	.577	.09	1.29	.196	.00	-0.05	.963
Ethnicity[c]	-.14	-2.55	.011	.03	0.56	.573	-.07	-1.34	.180	-.10	-1.84	.066	-.10	-1.76	.079
Planned pregnancy[d]	-.06	-0.97	.331	.01	0.16	.873	-.11	-1.75	.081	-.03	-0.47	.642	-.04	-0.70	.482
R^2		.082			.017			.075			.116			.037	

Note.
Reference category: [a]secure (65%), [b]first child (55%), [c]Dutch (85%), [d]planned (85%)

Effect of personality on partner support and perceived stress

Subsequently, the effect of the five personality dimensions on partner support and perceived stress was examined (Table 4). More agreeable pregnant women perceived less stress and more emotional stability was associated with less perceived stress and more partner support. Women being pregnant with their first child, women with a higher income, and women with Dutch nationality, received more support from their partner. Moreover we found that women with a lower income perceived more stress.

Table 4 Standardized direct effects on contextual characteristics (*N*=351).

	Partner support			Perceived stress		
Predictor						
	β	*Z*	*p*	*β*	*Z*	*p*
Parent						
Extraversion	-.02	-0.33	.739	-.01	-0.12	.905
Conscientiousness	-.06	-1.15	.251	.02	0.45	.653
Agreeableness	-.01	-0.19	.846	-.14	-3.16	.002
Emotional stability	.19	3.28	.001	-.54	-12.45	.000
Openness	.07	1.19	.233	-.08	-1.87	.061
Covariates						
Parity[a]	-.17	-3.08	.002	.08	1.79	.073
Education	-.06	-0.88	.379	.01	0.20	.841
Age of mother	-.07	-1.00	.315	.04	0.75	.456
Income	.17	2.12	.034	-.19	-3.47	.001
Ethnicity[b]	-.17	-3.18	.001	.01	0.27	.787
Planned pregnancy[c]	-.07	-1.21	.262	.05	0.96	.336
R^2		.156			.464	

Note.
Reference category: [a]first child (55%), [b]Dutch (85%), [c]planned (85%)

Effect of parental, contextual, and expected child characteristics on MFA

Standardized direct effects (β) of each predictor on MFA are presented in Table 5. Within the Parent block, extraversion, conscientiousness, and agreeableness emerged as significant predictors when controlling for all other variables. The more extrovert, conscientious, and agreeable a pregnant woman is, the more feelings of attachment she will develop during pregnancy. In the Context block, perceived stress emerged as significant negative predictor, indicating that perceived stress in a pregnant women leads to lower levels of MFA. Within the expected child characteristics block, only dullness emerged as a dominant significant predictor when controlling for all other variables. The expectation of a dull child seems to decrease a pregnant woman's

feelings of attachment towards her unborn child. We also found some effects of the covariates. Having a first child, a younger maternal age, and a lower income were related to higher levels of MFA.

Table 5 Standardized direct effects on MFA (*N*=351).

	MFA		
Variable			
	β	*Z*	*p*
Parent			
Extraversion	.11	1.97	.049
Conscientiousness	.11	2.17	.030
Agreeableness	.14	2.48	.013
Emotional stability	-.08	-1.17	.243
Openness	-.05	-0.97	.332
Context			
Partner support	.05	0.88	.382
Perceived stress	-.16	-2.29	.022
Expected Child			
Fussy/difficult	-.02	-0.31	.759
Unadaptable	-.01	-0.13	.894
Dull	-.12	-1.96	.050
Unpredictable	-.11	-1.73	.083
Covariates			
Parity[a]	-.11	-2.00	.046
Education	.07	1.15	.249
Maternal age	-.12	-2.00	.046
Income	-.14	-2.11	.035
Ethnicity[b]	-.10	-1.84	.066
Planned pregnancy[c]	.04	0.68	.495
R^2		.191	

Note.
Reference category: [a]first child (55%), [b]Dutch (85%), [c]planned (85%)

Summary

A parsimonious representation of the results is given in Figure 3, in which the relations are summarized at the level of the construct blocks using multivariate effect sizes (see e.g., Cohen, 1988; Heise, 1972). The multivariate effect of attachment security on the Parent block is relatively small ($\eta_{.p}^2$ = 0.10, $F(5, 342) = 7.92$, $p < .001$), with univariate percentages of explained variance averaging to .07 with range [.02, .12] . This implies

that mother's own parental attachment security is one of the determinants for her personality. The effect of the Parent block on the Context block is small to moderate (η_{-p}^2 = 0.22, F(10, 696) = 19.99, p < .001), with univariate percentages of explained variance varying between 16% for partner support and 46% for perceived stress. This implies that personality mainly influences how a pregnant woman anticipates and deals with the level of stress she experiences. The multivariate set correlation between the Parent block and the Expected Child block is .43 (F(20, 1379) = 3.68, p < .001), which indicates that there is a moderate relationship between the personality of the mother and her expectations towards the temperament of the unborn child.

All construct blocks simultaneously explained 19% of the variance in our key outcome variable MFA. The unique contribution to the percentage of explained variance for the Parent, Context, Expected Child, and Covariates block are 6%, 3%, 4%, and 6%, respectively (χ^2(5) = 20.57, p < .001; χ^2(2) = 6.58, p = .037; χ^2(4) = 14.40, p = .006; χ^2(6) = 23.72, p < .001). This indicates that all blocks provide a significant relative contribution, with the Parent block – the personality of the mother – being slightly more prominent than the other key construct blocks Context and Expected Child.

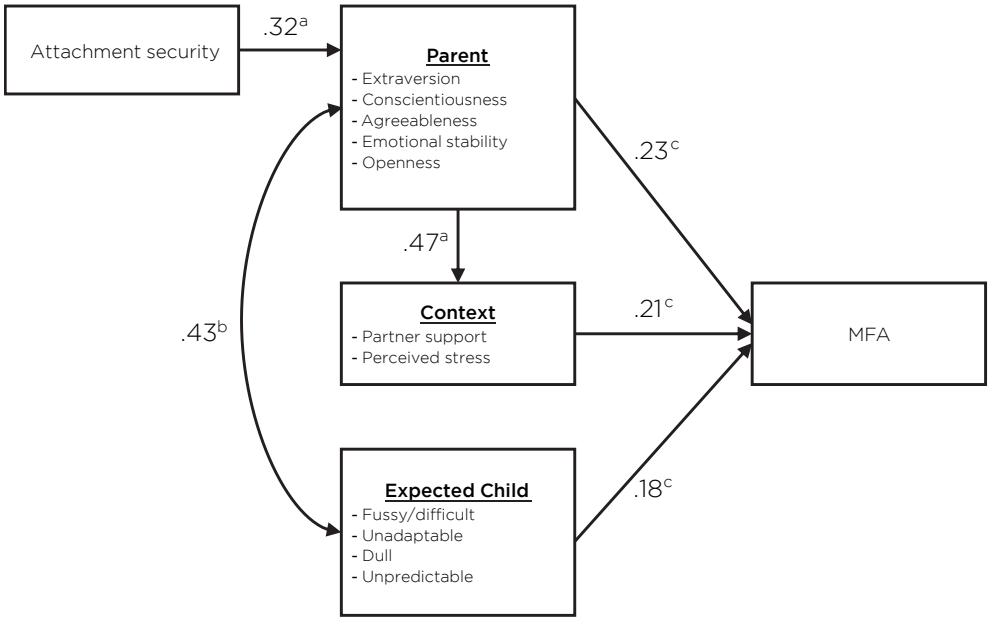

Figure 3 Comprehensive summary of the results.
Note.
[a]Multivariate effect $\sqrt{1- \text{Wilks } \lambda}$; [b]Generalized set correlation ; [c]formative Block effect.

DISCUSSION

The current study is among the first to examine characteristics of the parental, contextual, and expected child domain in relation to MFA in a community-based sample of pregnant women. Previous research on identifying determinants of MFA was often inconclusive and inconsistent (Alhusen, 2008; Cannella, 2005; Yarcheski et al., 2009). This study examined a process model in which multiple and different determinants of MFA were studied simultaneously and intercorrelations between the included variables were also taken into account. Based on Belsky's process model of parenting (Belsky, 1984), parental, contextual, and expected child characteristics were studied in relation to MFA. Path analysis showed MFA to be multiply determined by characteristics of each domain, where the parental domain was found to explain the largest amount of variance of MFA. Our findings are generally in line with Belsky's ecological model of parenting (Belsky, 1984).

With regard to parental characteristics, it was hypothesized that parental attachment security would affect the pregnant woman's personality and thereby MFA. Insecurely attached pregnant women were found to be less extrovert, less agreeable, and less emotionally stable. These women were indeed more negative in their affection and this might have resulted in less positive feelings towards their unborn child. Previous studies have also found parental attachment security to be related to the quality of mother's attachment relationship towards her unborn child. More securely attached pregnant women were more able to establish an affectionate relationship with their unborn child (Huth-Bocks et al., 2004; Siddiqui & Hägglöf, 2000; Van Bussel et al., 2010).

When we focus on parental personality, this study identified extraversion, conscientiousness, and agreeableness as determinants of MFA. As predicted and consistent with findings in the postnatal period (Prinzie et al., 2009), the current study showed that pregnant women scoring high on positive personality traits were more able to initiate a relationship with their unborn child. It thus seems that already during pregnancy these personality traits play an important role in the developing mother-child relationship. In contrast with the findings of Bouchard (2011) who identified neuroticism (in this study reverse coded as emotional stability) as a risk factor for lower levels of MFA, the current study failed to replicate that finding. Although one could speculate that less emotionally stable women were reluctant to participate in the study, the mean scores and range of emotional stability did not indicate a skewed distribution. Perhaps the relationship between emotional stability and MFA is more indirect in that this personality trait influences the context in which mother develops feelings and thoughts about her unborn child (Bouchard, 2011).

As expected, links between parental personality and characteristics from the contextual domain (i.e., partner support and perceived stress) were found. A higher level of emotional stability in pregnant women was associated with more partner support. Additionally, more agreeable and emotionally stable women perceived lower levels of stress. These findings are in line with previous findings that people with higher levels of emotional stability tend to be less distressed and nervous, leading to lower levels of perceived stress (Lahey, 2009). We thus can conclude that the pregnant woman's personality influences the context in which she develops feelings of attachment towards her unborn child.

Although the results indicated a significant block effect of the contextual domain, the individual predictor partner support failed to explain variance in MFA beyond other predictors. This is in contrast with our hypothesis and findings in earlier studies, which yielded evidence that more satisfaction with the partner relationship is associated with higher levels of MFA (Condon & Corkindale, 1997; Hjelmstedt et al., 2006). Since the measure used in our study to assess partner support was specifically aimed to capture support from the partner in childrearing situations in the postnatal period, it may be a less adequate tool for use during pregnancy. This could be a reason for the absence of a significant association between partner support and MFA and the relatively low Cronbach's alpha we found in this study compared to the high Cronbach's alpha which was demonstrated in postnatal research (Van Bakel & Riksen-Walraven, 2002). The other predictor in the contextual block, perceived stress, was found to be negatively related to the level of MFA. Pregnant women with higher levels of stress were less able to fully engage in an affectionate relationship with their fetus, resulting in lower levels of MFA. This relationship between perceived stress and MFA was established in previous studies (Cranley, 1981; Feldman, 2007).

In the domain of the expected child characteristics, dullness of expression was, as anticipated, found to contribute uniquely to MFA beyond the parental and contextual characteristics. Expected child temperament such as fussy-difficultness, unadaptedness, and unpredictability were slightly, negatively related to with MFA, but did not explain variance in MFA beyond other predictors. These results are partially in line with a previous study on the relationship between expected child temperament and MFA. Pregnant women with higher levels of MFA imagined their fetus as less dull and more predictable (Zeanah et al., 1990). Belsky's (1984) process model of parenting, already considered characteristics from the child domain as least predictive. This limited contribution of child characteristics to parenting was confirmed in infants and toddlers (Van Bakel & Riksen-Walraven, 2002; Verhoeven et al., 2007). During pregnancy, the contribution of characteristics from the child domain may be even less profound, due to absence of the actual child. Although the present study only showed small effects of expected child temperament on MFA, expected temperament during pregnancy was found to be an important predictor for the postnatal mother-infant

bond in earlier studies (Benoit et al., 1997; Pearce & Ayers, 2005). Therefore it could be informative to study prenatal expectations of the child temperament in relation to the developing mother-infant relationship.

Some limitations of the current study should be emphasized. First, maternal self-report was the sole source of information regarding the different predictors and MFA, possibly leading to response bias. Nevertheless, the distributions of all study variables were in line with previous findings. Because all characteristics of the three domains were based on maternal report, the independence of the three domains could be limited due to shared common method variance. Inspection of the correlation matrix, however, reveals predominantly low bivariate correlations between the different determinants of each of the domains and path analysis identified each domain to be an independent predictor of MFA. We therefore assume that response bias barely affected our results. Furthermore, only pregnant women and not their partners were included in the study. Subsequent studies should focus on the development of the relationship between father and fetus as well, since fathers' involvement in the child's upbringing is currently increasing (Maume, 2011). Another limitation is that any causal interpretation of the results is limited because of the cross-sectional nature of this study. Longitudinal research is needed to address the direction of the effects of these determinants on MFA. A final limitation concerns the measurement of partner support used in this study. It is possible that a more specific and valid measurement of partner support during pregnancy could have produced the anticipated findings.

The results of the current study may have important implications for clinical practice. As has been stated before, MFA is found to be important for mother's well-being and positive health practices during pregnancy. Moreover, higher levels of MFA were associated with positive maternal behaviors towards the child during infancy and thereby influence later child development (Benoit et al., 1997; Müller, 1996; Siddiqui & Hägglöf, 2000). Establishing negative predictors of MFA can thus be helpful for early identification of pregnant women who are at risk for developing sub-optimal feelings of MFA. Health care professionals can use this knowledge for preventive interventions at an early stage, to enhance feelings of attachment in these women during pregnancy. Increasing the quality of mothers' feelings towards their unborn child before birth, may promote the development of an optimal mother-child relationship after birth.

In sum, findings of the present study were generally consistent with Belsky's ecological model of parenting, providing good support for the applicability of Belsky's model for explaining variations in the quality of the mother-fetus relationship in the pregnancy period. Our model provides more insight into the complex interplay among the relations between parental, contextual, and expected child characteristics and MFA. Follow up studies are necessary to examine the causal relationship between parental, contextual, and expected child characteristics, the quality of the prenatal and postnatal mother-child relationship, and infant/child outcomes.

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Effect of situation on mother-infant interaction *

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ABSTRACT

Research has shown that the early parent-infant relationship is of critical importance for children's developmental outcomes. While the effect of different settings (e.g., at home, laboratory, or clinic) on mother-infant interactive behavior is well studied, only few researchers systematically examined the effect of situational variables (e.g., feeding, caregiving, free play, and face-to-fact interaction) on mother-infant interaction. In the present study the effect of situational variables within the home setting on the quality of mother-infant interaction at 6 months was examined as well as the consistency in the quality of behaviors of mother and infant across these situations. During a home visit 292 mother-infant dyads were videotaped in three different situations (i.e., free play, face-to-face play, and diaper change). Interactive behaviors of mother and infant were assessed with the NICHD global ratings scales. Results showed substantial effects of the situation on the interactive behavior of the mother-infant dyad. Despite the observed situational effects, maternal sensitivity to non-distress, intrusiveness, stimulation of development, and positive regard and all five infant behavioral scales remained stable across the different situations. Insight into situational effects within the home setting on the quality of mother-infant interactive behavior may assist researchers to make well-informed decisions about measuring the parent-infant interaction in one or more specific situations.

INTRODUCTION

It is widely assumed that the early parent-infant relationship is of critical importance for children's developmental outcomes. The relationship between parent and infant influences the personal, social, psychological, social-emotional, and cognitive development of the child (Lyons-Ruth & Jacobvitz, 2008; Sroufe, 2005; Thompson, 2008). Sensitive, responsive, and stimulating parenting is considered to be the primary component of an environment that is most likely to promote optimal psychological and behavioral functioning of the child (O'Brien, Johnson, & Anderson-Goetz, 1989). In contrast, less optimal parenting is associated with difficulties in the child's development and behavior, possibly resulting in poor peer relationships and school-related problems later in life (Sharp et al., 1995).

Over the past decades, assessment and measurement of the quality of the parent-infant relationship in child developmental research has evolved. Initially, data collection methods mainly involved self-report measures by parents or observations of parental behavior and infant responses in vivo by a professional (Rubin, 1963). Nowadays, the parent-infant relationship is often assessed by analyzing videotaped parent-infant interactions using global rating scales. For research as well as for clinical purposes, these parent-infant interactions are videotaped and observed in various observational *situations/activities,* such as caregiving, free play, or face-to-face play. Observations vary in many ways. They may vary in structure, in the presence or absence of toys, and from time-constrained directed tasks (such as making a jigsaw puzzle or building a tower with blocks) to lengthier unstructured observations of everyday interactions and routine activities during which parents and infants behave as they would usually do during daily events. Furthermore, observations are conducted in different *settings*, including for instance a research laboratory, health care clinic, or in the infants' home. Studies assessing the quality of the parent-infant relationship by observations of videotaped parent-infant interactions have yielded inconclusive results with regard to their link with children's developmental outcomes (Isabella, 1998; Miller, McDonough, Rosenblum, & Sameroff, 2002; O'Brien et al., 1989). Since behavioral observations of parents and infants have been conducted in various situations/activities (such as feeding, caregiving, free play, and face-to-face interaction) and in various settings (e.g., at home versus laboratory or clinic), questions arise about the degree to which these different contexts influence the evaluation of the parent-infant interactions. This variability in context may partially explain why parental interactive behaviors measured in one specific situation or setting may show significant correlations with later outcomes, while similar results were not found in studies using other situations or settings (Isabella, 1998; Miller et al., 2002; O'Brien et al., 1989).

Although several researchers have compared caregiver and infant behaviors across different *settings* such as the home setting versus a research laboratory (Belsky,

1980; Bornstein et al., 2006; Miller et al., 2002; O'Brien et al., 1989; Van Bakel & Riksen-Walraven, 2002), few studies have specifically examined how *situational* variables or various activities within these settings may affect parent or infant behavior (Isabella, 1998; Leyendecker, Lamb, & Scholmerich, 1997; Masur & Turner, 2001; Seifer, Sameroff, Anagnostopolou, & Elias, 1992). In the present study we examine differences in the quality of mother-infant interaction at the infant's age of 6 months, observed in the home setting in three different situations. Does the quality of mother-infant interaction vary during caregiving, free-play, or structured play situations? Weisz (1978) already stressed the importance of using measurement procedures that are minimally intrusive and valid across various contexts and advised researchers to determine which observation procedure reflects the most natural interactions between parent and infant. Since the home setting is most familiar to both mother and infant, and thereby probably reflects more natural interactions, this study is conducted within the infants' home.

Earlier studies examining the influence of different situations/activities on interactive behavior have mainly focused on the effect of different situations in the laboratory (Miller et al., 2002), or were performed in parent-child dyads with older infants (Masur & Turner, 2001). Miller et al. (2002) for example studied the influence of situation in 7-month-old infants in the laboratory and found mothers to be more involved and positive, yet less sensitive, more intrusive, and more rejecting during face-to-face interactions than during free play. The infants were more negative and more aroused in the face-to-face situation. The face-to-face situation was a more structured play situation in which the infant was seated in front of the parent and in which the parent was asked to interact with the infant in the absence of toys. Comparisons between free-play and face-to-face situations in the laboratory and at home also showed strong differences in the quality of interactions within the mother-infant dyad. The quality of maternal interactive behavior was found to be highest in face-to-face situation in the lab and lowest in the free play situation at home (O'Brien et al., 1989; Van Bakel & Riksen-Walraven, 2002). The few studies in which the influence of different situations/activities and different settings on interactive behavior were compared, demonstrated that variation in situations had more effect on parent and infant behavior than differences in settings had (Leyendecker, Lamb, Schölmerich, & Fricke, 1997; Miller et al., 2002; O'Brien et al., 1989; Seifer et al., 1992).

It is remarkable that the quality of the interactive behavior of parents and young infants in different *situations/activities* within *the home setting* has received relatively little attention. The few available studies show contradictory results and generally studied only naturalistic occurring behaviors. Leyendecker, Lamb, Schölmerich, and Fricke (1997) found mother's behavior during play interactions to be highly active, with more dyadic engagement between her and her 12-week-old infant, compared to their interactive behaviors during feeding and caregiving (such as diaper change, bathing, and dressing) episodes. From this study, it seems that at this young age,

highly structured contexts such as feeding, or to a lesser extent caregiving, elicit less interactive and less positive behaviors than situations that have a more playful, unstructured nature, such as play situations. In contrast, Isabella (1998) found higher levels of sensitivity in naturalistic interactions such as normal daily routine, including caregiving or feeding than in free-play interactions, although she also found mothers to be more rejecting in the naturalistic interactions. This finding was also confirmed in the study of Joosen, Mesman, Bakermans-Kranenburg, and van IJzendoorn (2012), who recently found maternal sensitivity during free play to be lower than during bathing. Seifer et al. (1992) also focused on naturalistic interactions and found that caregiving situations elicit more spontaneous, responsive, and less negative behaviors from both mother and infant than feeding situations, despite the fact that both are familiar activities for the parent-infant dyad. Nevertheless, caution is raised with regard to the representativeness of naturalistic observations, as they provide less opportunity than more structured contexts for observing parents interacting with their children (Belsky, 1980; Isabella, 1998; O'Brien et al., 1989; Seifer et al., 1992). Naturalistic observations are mostly comprised of various situational contexts and each context might lead to different kinds of interactive behavior (Isabella, 1998).

In addition to differences in interactive behavior of the parent-infant dyad per situation/activity, concordance of the interactive behavior across different situations may reveal knowledge about the consistency of parental interactive behavior. Behavioral consistency across situations would stress the individual characteristics of the dyadic interaction, where inconsistency would emphasize the importance of the situation in which the parent-infant dyad is studied. Results from studies that examined individual behavioral consistency showed that although mothers displayed more positive behavior in face-to-face and free play situations compared to caregiving episodes, other behaviors such as involvement, responsiveness, sensitivity, and positive emotion were consistent across situations (Joosen et al., 2012; Masur & Turner, 2001; O'Brien et al., 1989). These findings suggest that maternal behaviors such as involvement and positive affect may be a reflection of personality characteristics such as agreeableness and ego-resilience which are found to be less affected by changes in situation. Furthermore, infants' positive behavior was less consistent than their negative behavior (Masur & Turner, 2001; Miller et al., 2002).

In sum, earlier studies concerning parent-infant interactions in different situations/activities examined predominantly naturalistic occurring interactions, generally focused on differences between settings, and were performed with older children. The purpose of the current study is to examine the quality of mother-infant interaction in 6 months olds across three different semi-structured situations within the home setting. Three familiar, daily occurring situations: Free play (with toys), face-to-face play (interaction without toys), and a caregiving situation (diaper change) will be examined. Given the results of earlier research, we expect that maternal sensitivity

and positive affect is higher during face-to-face play and free play than during diaper change. For the interactive behavior of the infant, we expect more positive, more social, and less negative behavior during play situations compared to the caregiving situation. To distinguish between the influence of mother-infant characteristics and situational effects, we will examine which behaviors of the parent-infant dyad remain stable across situations, thereby assessing the consistency in the quality of behavior of the mother and infant separately.

METHOD

Participants

The current study is part of the 'Expectant Parents' study, a prospective longitudinal cohort study on prenatal risk factors and postnatal infant development (Maas, Vreeswijk, de Cock, Rijk, & van Bakel, 2012). The sample of the present study consisted of 292 mother-infant dyads. The mean age of the mothers was 32.46 years (SD = 4.27), ranging from 18 to 42 years. Most participants were white Caucasian women with Dutch Nationality (80%), 95% were married or cohabiting, 88% were employed, 65% finished college, and 49% of the women were primigravida. The mean age of the infants at the time of the home visit was 6.10 months (SD = 0.28; range 5 – 7 months) and 51% of them was male.

Procedure

The mother and infant were visited in their homes when the infant was 6 months of age. During this home visit, a semi-structured procedure was followed. The mother-infant dyad was videotaped in three different situations/activities. In the first episode, mother and infant were asked to interact face-to-face without toys (2 minutes) while the infant was seated in front of the mother. In the second episode, a caregiving (diaper change) situation was observed (time varied between 1 and 9 minutes), and in the third episode mother and infant played during 7 minutes with a standard set of toys provided by the home visitor. In all three situations, mothers were instructed to "interact with your child as you would normally do", and to try to ignore the camera. Seventy-three percent of the dyads were videotaped in the aforementioned order. Some children (21%) were sleeping at the beginning of the home-visit and when they woke up, they first got a diaper change. In 6% of the cases the procedure started with the free play situation. In the analyses we checked for order effects.

Measures

The quality of parent-infant interactive behavior was rated by using the Qualitative Scales of the Observational Ratings of Mother–Child Interaction of the National Institute of Child Health and Human Development (NICHD Scales; NICHD Early Child Care Research Network [ECCRN] et al., 1999).

Quality of parent interactive behavior. Eight parent interactive behavior dimensions were assessed: (1) *Sensitivity/responsiveness to distress:* The degree to which the parent responds consistently, promptly, and appropriately to the infant's cries, frets, or other expressions of negative affect; (2) *Sensitivity/responsiveness to non-distress:* How the parent observes and responds to the infant's social gestures, expressions, and signals; (3) *Intrusiveness:* The extent to which the parent is overcontrolling and overinvolved, or the interaction is mainly adult-centered; (4) *Detachment/disengagement:* Assesses the degree to which the parent appears emotionally uninvolved or disengaged, the parent is unaware of the infant's needs for appropriate interaction to facilitate involvement with objects or people; (5) *Stimulation of development:* How the parent encourages and actively tries to foster the infant's development; (6) *Positive regard:* The degree to which the parent expresses positive feelings such as love, respect, and admiration to the infant; (7) *Negative regard:* Assesses the parent's discontentedness and disapproval of the infant; (8) *Flatness of affect:* The degree to which the parent is animated during the interaction (NICHD ECCRN, 1999).

Quality of infant interactive behavior. Infant interactive behavior was assessed in five dimensions: (1) *Positive mood:* The extent to which the infant is satisfied, content, and pleased with the situation overall; (2) *Negative mood:* The extent to which the infant cries, fusses, frowns, tenses body while crying, or otherwise expresses his/her discontentment; (3) *Activity level:* How motorically active the infant is; (4) *Sociability:* The degree to which the infant actively participates in his/her social world; (5) *Sustained attention:* Assesses the infant's sustained involvement with the world, including objects and people (NICHD ECCRN, 1999).

Ratings are based on both the quality and quantity of observed behaviors. In infancy and toddlerhood each dimension of the NICHD scale is scored using a 4-point rating scale, ranging from 1 (*not at all characteristic)* to 4 *(highly characteristic*) (NICHD ECCRN, 1999). For example, a rating of 3 or 4 is given if the infant is sociable, but if the infant is not sociable, a 1 or 2 rating is given. The interpretation of the scores depends on the specific dimension. Higher quality of parent-infant interaction is indicated by higher scores on the parental scales Sensitivity to distress, Sensitivity to non-distress, Stimulation of development, and Positive regard and on the infant scales Positive mood, Activity level, Sociability, and Sustained attention. Additionally, better parent-infant interactions are characterized by lower scores on Intrusiveness, Detachment,

Negative regard, and Flatness of affect from the parental scale and Negative mood from the infant scale (NICHD ECCRN, 1999).

Because earlier research suggests that composites of global ratings of mother-infant interaction have better psychometric properties and demonstrate better validity than the individual scales, a *maternal sensitivity composite* score for each situation was computed (Egeland, Kalkoske, Gottesman, & Erickson, 1990). The maternal sensitivity composite was calculated as the sum of Sensitivity of non-distress, Intrusiveness (reverse coded), and Positive regard and represented positive, nonintrusive, responsive, and supportive maternal care. According to earlier research, the maternal sensitivity composite at 6 months has good internal consistency with a Cronbach's alpha coefficient of .75 (NICHD ECCRN, 1999).

Observations of the parent-infant interaction were rated independently by two trained coders blind to background information of the dyad. Reliability indicators of the individual behavioral dimensions were determined trough percentage agreement of 35 cases (Horowitz, Logsdon, & Anderson, 2005; NICHD SECCYD, n.d.). Mean percentage agreement for all maternal and infant scales was good (between 71 and 100%), except for Sensitivity to distress and Stimulation of development (55% and 59% respectively) (Table 1). Since infant distress was rare during the observations, Sensitivity to distress scores of the mother were often missing. In the face-to-face and caregiving situation mothers also rarely stimulated the development of the infant. This could explain the modest agreement for these two scales. These reliability scores are in line with earlier publications of agreement data in observation of 6-months-olds and their mothers with the NICHD rating scales (NICHD SECCYD, n.d.). Inter-rater reliability on the maternal sensitivity composite was calculated as the intraclass correlation coefficient (ICC). The ICC (single rater, absolute agreement) was .65 which indicates moderate agreement.

Statistical analyses

First, the effects of situational variables on mother and infant behavior and on the maternal sensitivity composite scores were studied, comparing the quality of behaviors across three different situations. Since the 13 behavioral dimensions were rated on a 4-point ordinal rating scale, differences between the three situations were evaluated with the non-parametric Friedman Test. A repeated measures analysis of variance (ANOVA) was conducted to study the effects of situational variables on the maternal sensitivity composite scores. Second, the consistency of behaviors of mother and infant and the maternal sensitivity scores across situations was studied with ICC's (average rater, consistency). All statistical analyses were performed using SPSS 19.0 for Windows.

RESULTS

Preliminary analyses

To be certain that our findings were due to situational/activity effects instead of order effects, we checked with a one-way between groups multivariate analysis of variance if differences in the maternal sensitivity scores of free play, face-to-face play, and the diaper change situation could be found in the different order groups. No differences were found among the groups (F (6, 534)=0.85, p=.532; Wilks' Lambda=0.98), so order will not be taken into account in further analyses. We also examined the effect of duration of the diaper change situation on individual maternal and infant behaviors. Small, but significant correlations between duration and Sensitivity to non-distress (r = .20, p = .001), Stimulation of development (r = .30, p < .001), Positive regard (r = .23, p < .001), and Detachment (r = -.12, p = .041) were found. For infant behavior, duration was only related to Positive mood (r = .24, p < .001).

Effect of situational/activity variables on parent and infant behavior

Situational effects on maternal and infant behavior were evaluated with Friedman's Tests. The mean ratings across the three situations are shown in Table 1. Significant mean-level differences (p < .01) were found for seven (except for Negative regard) of the eight maternal behavioral dimensions and for all infant behavior dimensions. Post-hoc analyses using the Bonferroni correction (resulting in a significance level of p < .017) were performed to indicate in which situations mean values were significantly different (Table 1). Concerning maternal interactive behavior, post-hoc analyses showed that in the face-to-face situation mothers' Positive regard was higher and Flatness was lower compared to the caregiving situation. Stimulation of development and Positive regard was lowest in the caregiving situation. During diaper change, mothers were also more detached than during free play but not significantly more detached than in the face-to-face situation. Stimulation of development was highest during free play. Although the Friedman tests of Sensitivity to distress, Sensitivity to non-distress, and Intrusiveness were significant, the post-hoc analyses did not reveal significant differences among the three situations. No significant differences between the three situations were found for Negative regard. A one-way repeated measure ANOVA showed that the mean scores of the maternal sensitivity composite significantly differed among the three situations F(2, 544) = 14.88, p < 0.001 (Table 1). Post-hoc test using the Bonferroni correction revealed that the maternal sensitivity composite score of the face-to-face situation (M = 10.18, SD = 0.96) was significantly higher than of the free play situation (M = 9.94, SD = 1.37) and the caregiving situation (M = 9.77, SD = 1.21), respectively p = .007 and p < .001.

Table 1 Descriptive statistics, Friedman tests, and agreement for interactive behavior in three situations.

	Free play (*n* = 291)			Face-to-face play (*n* = 287)			Diaper change (*n* = 289)			Friedman tests	Inter-rater agreement
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	$\chi 2$ [1]	%[3]
Parent NICHD-scales											
Sensitivity to distress	3.24[a]	.70	2 – 4	3.26[a]	.59	2 – 4	3.03[a]	.77	2 – 4	10.60**	55
Sensitivity to non-distress	3.10[a]	.71	1 – 4	3.13[a]	.60	1 – 4	2.98[a]	.67	1 – 4	12.96**	79
Intrusiveness	1.16[a]	.45	1 – 4	1.09[a]	.30	1 – 3	1.01[a]	.10	1 – 2	30.01***	99
Detachment	1.09[a,b]	.30	1 – 3	1.02[a]	.13	1 – 2	1.26[b]	.56	1 – 3	61.60***	99
Stimulation of development	2.69[a]	.81	1 – 4	2.38[b]	.79	1 – 4	1.99[c]	.91	1 – 4	151.47***	59
Positive regard	2.97[a,b]	.61	1 – 4	3.14[a]	.47	1 – 4	2.80[b]	.65	1 – 4	67.60***	90
Negative regard	1.02	.18	1 – 3	1.00	.06	1 – 2	1.02	.13	1 – 2	3.20	100
Flatness of affect	1.34[a]	.63	1 – 4	1.03[b]	.18	1 – 3	1.49[a]	.73	1 – 4	110.99***	96
Infant NICHD-scales											
Positive mood	1.94[a]	.65	1 – 4	2.42[b]	.77	1 – 4	1.95[a]	.74	1 – 4	98.12***	78
Negative mood	1.43[a]	.70	1 – 4	1.26[a]	.59	1 – 4	1.37[a]	.80	1 – 4	10.42**	96
Activity level	2.52[a]	.63	1 – 4	2.32[b]	.70	1 – 4	2.52[a]	.75	1 – 4	22.91***	71
Sociability	2.00[a]	.67	1 – 4	2.76[b]	.81	1 – 4	2.14[a]	.79	1 – 4	147.10***	74
Sustained attention	3.19[a]	.69	1 – 4	2.74[b]	.82	1 – 4	2.75[b,c]	.77	1 – 4	68.32***	73
Maternal sensitivity composite	9.94	1.37	4 – 12	10.18	.96	6 – 12	9.77	1.21	6 – 12	14.88***,[2]	0.65[4]

Note. [a,b,c] Means with different superscripts significantly differ from each other according to Bonferroni post-hoc tests ($p < .017$).
[1] Chi-square, *df* = 2.
[2] F-value, *df* (2, 544).
[3] % agreement between coders across three situations (*n* = 35).
[4] Intraclass correlation coefficient.
**$p < .01$. ***$p < .001$.

With regard to infant behavior across the three situations, infants were more sociable and displayed more positive affect in the face-to-face episode than in free play and during diaper change. Infant activity level was found to be lowest in the

face-to-face situation. Infant Sustained attention was higher in free play compared to face-to-face and caregiving. For Negative mood, the post-hoc analyses displayed no significant differences between the three situations.

Consistency across situations/activities

The second goal was to assess behavioral consistency across the three situations. To address individual stability across situations, ICC's were computed for both maternal and infant interactive behavior (Table 2). Sensitivity to non-distress, Stimulation of development, and Positive regard were significantly correlated across all three situations with ICC's varying between .39 and .71 ($p < .001$). For Sensitivity to distress, Detachment, and Flatness, no significant correlations were found between the face-to-face play and the diaper change situation, although the ICC's of the three maternal behaviors between these two situations and free play were significant. For Negative regard, only a small correlation was found between the free play and diaper change situation. The level of consistency for the maternal sensitivity composite scores across the three situations ranged from moderate to high (ICC = .49 to .72, $p < .001$).

For infants, the behavioral scales Positive mood, Negative mood, Activity level, and Sociability were positively correlated across the three situations (ICC's ranged from .28 to .57, p varied between <.01 and <.001). For Sustained attention significant positive correlations were found between diaper changing and free play, and diaper changing and face-to-face play but not for the free play and face-to-face play situation.

Table 2 Intraclass correlation coefficients across three situations ($N = 292$).

	Free play Face-to-face play	Free play Diaper change	Diaper change Face-to-face play
Parent NICHD-scales			
Sensitivity to distress	.54*	.61**	.33
Sensitivity to non-distress	.61***	.66***	.46***
Intrusiveness	.43***	.16	.35***
Detachment	.18*	.39***	.07
Stimulation of development	.57***	.67***	.68***
Positive regard	.43***	.71***	.39***
Negative regard	-.01	.23*	-.01
Flatness of affect	.23*		.05
Infant NICHD-scales			
Positive mood	.37***	.44***	.28**
Negative mood	.40***	.40***	.46***
Activity level	.57***	.44***	.34***
Sociability	.29**	.35***	.29**
Sustained attention	.16	.22*	.36***
Maternal Sensitivity Composite	.56***	.72***	.49***

*$p < .05$. **$p < .01$. ***$p < .001$.

DISCUSSION

In the past decades many studies assessed the quality of the parent-infant relationship by observations of videotaped parent-infant interactions in various settings and across different situations/activities. The contextual variability may partially explain inconsistent results in studies examining the relationship with children's developmental outcomes. While the effect of different settings (e.g., at home, laboratory, or clinic) on behavior of the parent-infant dyad is well studied, only few researchers systematically examined the effect of situational variables (e.g., feeding, caregiving, free play, and face-to-fact interaction). In the present study the effect of situational variables within the home setting on the quality of mother-infant interaction at 6 months was examined, by comparing the quality of interactions across three different situations/activities: Free play (with toys), face-to-face play (interaction without toys), and a caregiving situation (diaper change). Furthermore, the consistency in the quality of behaviors of mother and infant was evaluated. In accordance with the results of earlier studies, we found substantial effects of different situations on mother and infant behavior. Despite the observed situational effects, most maternal and infant behaviors remained stable across the different situations.

Strong differences in ratings of quality of behavior across situations in mother-infant interaction were found. As expected, Positive regard was highest and Flatness was lowest in face-to-face play, suggesting that face-to-face interactions evoke more positive responsivity. Mothers in those situations are more animated than in a caregiving situation. When considering differences in maternal sensitivity composite scores, similar results were obtained, with mothers to be most sensitive during face-to-face play. During the face-to-face interaction, the infant was placed in front of the parent at eye level, which may have limited any form of distraction from external stimuli and prompted the mother to direct her attention towards the infant and vice versa. The absence of toys or other objects may stimulate parents to play more active games to entertain their infants and the parents hereby express more intense positive affect to keep the infant fully engaged (Miller et al., 2002). During free play mothers showed the highest levels of stimulation towards their infant. Because play is an active situation that requires joint attention, this might explain the more interactive and stimulating behaviors in parents. In the diaper change situation, mothers hardly stimulated the infant and they showed less positive regard towards the child. These daily occurring and repeatedly recurring situations may elicit more routine behaviors, which result in less interactive and less positive behaviors of the mother than in more playful situations. It seems that the more sensitive, positive, and stimulating mothers may compensates for this with the investment of more time in caregiving since we found an effect of duration of the diaper changing situation on maternal behavior. Further, no clear differences in parents' Intrusiveness and Negative regard

across situations were found, suggesting that these dimensions are not affected by situational variables.

Consistent with the results of mothers, we found that infants also were more sociable and displayed more positive mood during face-to-face play, which may suggest that these interactions in infants at this age already evoke more positive interactivity than during free play and a caregiving situation. As is mentioned before, the face-to-face procedure may limit any form of distraction from external stimuli for both mother and infant. The finding that infant activity was lowest in the face-to-face situation may indicate that the infants were merely focused on their mother's behavior and face and were less distracted by external stimuli such as toys. The direct attention of the infant towards the mother may result in more positive interactive behavior. Infants' sustained involvement with their environment, including objects, was highest during free play. Research has shown that interest in face-to-face play peaks between 3 and 5 months. From 6 months onwards infants become more and more interested and fascinated by objects and external stimuli (Lamb, Morrison, & Malkin, 1987). Infants of this age are increasingly able to sustain joint object attention, explore the environment, and manipulate objects, resulting in changed play preferences towards more object-play instead of face-to-face play (Feldman, Greenbaum, Mayes, & Erlich, 1997; Power, 2000).

Our results show variability in quality of interactions across situations/activities and stress the importance of considering situational variables in evaluating the parent-infant relationship. Moreover, Seifer et al. (1992) stated that the proportion of variance in parent-infant interaction explained by situational effects far outweighed the variance explained by factors such as sex of the child, social status, birth order, or mothers' mental illness. In line with earlier research (Leyendecker, Lamb, & Scholmerich, 1997; Leyendecker, Lamb, Schölmerich et al., 1997; Masur & Turner, 2001), we conclude that highly structured, goal-directed situations such as diaper change produce less interactive and less positive behaviors than more unstructured, non-goal directed situations such as free play situations. Since mothers in face-to-face situations are more sensitive and animated than in other situations, observing mother and infant behavior only in caregiving situations may not give a complete picture of the quality of the parent-infant interactive behavior. General aspects of parents' and infants' behavioral styles, in different situations should be studied before conclusions about the general and daily quality of their interactions can be drawn. Observations of behavior in just one specific situation may not be representative for overall interactive behaviors of the parent-infant dyad.

To distinguish between the influence of situational effects on the one hand and parent-infant characteristics on the other, we examined which behaviors of the parent-infant dyad remained stable and consistent across situations/activities. Most maternal behaviors were fairly to moderately consistent across the free play and face-

to-face play situation, and across free play and the diaper change situation. Between face-to-face play and the diaper change episode, however, no significant relations were found for Sensitivity to distress, Detachment, Negative regard, and Flatness of affect. The correlations in the maternal sensitivity composite scores show the same pattern, whit the lowest correlation being found between face-to-face play and the diaper change episode. This inconsistency between face-to-face and diaper change might be explained by the different situational characteristics; maternal behaviors in a structured situation such as diaper change differ from behaviors in a more unstructured situation as face-to-face play. O'Brien et al. (1989) already demonstrated that positive behaviors were more consistent across situations than negative behaviors (e.g., detachment, negative regard, and flatness).

We found the infant's behavior moderately correlated across the different situations, indicating that even at 6 months children's interactive behavior can already be consistent across different situations. This consistency stresses the importance of the individual characteristics of the dyadic interaction in addition to the influence of situational effects.

Several limitations of the present study should be acknowledged. First, only the interactions between infants and their mothers were studied. Although mothers are often the primary caregivers, nowadays fathers play a more active role in the upbringing of their children. In studying the parent-infant relationship and relating this to developmental outcomes, it is important to look at the whole family context and this should be considered in future studies (Volling, McElwain, Notaro, & Herrera, 2002). In addition, mainly low-risk (well educated, working, and not single) mothers participated in this study. Because negative behaviors are less common in low-risk samples (Bornstein et al., 2006), to some extent confirmed by the low range in Negative regard and Detachment in this sample (see Table 1), different results may be obtained in a high-risk sample. Replication of the results in a clinical or high-risk sample is therefore recommended. Observations of parent-infant interaction during brief 1 - 9 minute sequences may limit the generalizability of the results. Longer observation periods may increase the likelihood that infant and parents ignore the observer and behave more as they normally would (Leyendecker, Lamb, & Scholmerich, 1997). Finally, although we examined situational effects cross-sectionally, it should be noticed that from a transactional perspective (Sameroff, 2004) maternal and infant interactive behavior are organized across time in which both affect each other. Further work is needed to study consistency in maternal and infant behavior over time.

In sum, the results of the present study revealed clear differences in the quality of parent-infant interaction at 6 months of age between mother and child across different situations/activities. Insight into differences in quality of parent-infant interactive behavior across different situations within the home setting may assist researchers to make well-informed decisions about measuring the parent-infant interaction in one or

more specific situations, and to inform mental health clinicians regarding use of these measures in research and practice. In line with the significant differences found so far, longitudinal research is needed to shed more light on the predictive value of the parents' and infants' interactive behavior for the child's later development.

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5

Maternal fetal attachment as an early predictor for maternal sensitivity at 6 months *

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ABSTRACT

Introduction: Earlier research has identified maternal sensitive behavior as an important factor for the quality of the mother-infant relationship and the child's emotional and cognitive development later in life. Until now little is known about early predictors of maternal sensitivity. The present study examines whether it is possible to detect early signs of maternal sensitivity during pregnancy by focusing on the relationship between maternal fetal attachment and maternal sensitivity.

Method: Participants were 273 women and their (unborn) infants. Mothers' feelings of attachment towards the fetus were assessed by the Maternal Antenatal Attachment Scale at 26 weeks of gestation. At the infant's age of 6 months, maternal sensitivity was assessed in three different situations (i.e., face-to-face play, caregiving, and free play) using the NICHD global rating scales and mothers completed the Maternal Postnatal Attachment Scale about their current feelings of attachment.

Results: Mothers with higher levels of maternal fetal attachment displayed more maternal sensitivity towards their 6-month-old infant in caregiving and free play situations, even when controlling for covariates such as parity, ethnicity, maternal education, maternal age, and postnatal attachment. No associations were found in the face-to-face situation.

Conclusions: This study shows that mothers who reported a higher quality of maternal fetal attachment were more sensitive while interacting with their infant. Acknowledgement and assessment of prenatal feelings towards the unborn baby may be recommended in infant health care services.

INTRODUCTION

Maternal sensitivity to infant behavior is of critical importance for the quality of the mother-infant relationship. Sensitivity is defined as the ability to accurately perceive and interpret the infant's behavioral signals and communications, and to respond appropriately to them (Ainsworth, Bell, & Stayton, 1974). Earlier research has identified maternal sensitivity as a major predictor for secure attachment in infants in the first year postpartum (De Wolff & van IJzendoorn, 1997). Further research has also shown long term associations between maternal sensitivity, infant's attachment security, and the child's emotional and cognitive development later in life (Belsky & Fearon, 2002; Fraley, Roisman, & Haltigan, 2013). Poor maternal sensitivity, for example, was found to be associated with insecure attachment relationships, which subsequently were related to poorer social interactions and more behavioral problems in childhood (Bigelow et al., 2010; Sroufe, 2005; Thompson, 2008). Maternal sensitivity has thus been proven to be important for infant and child development.

Until now, most of the studies on maternal sensitivity and the quality of the mother-infant relationship have focused on the postnatal period. Ainsworth and her colleagues (1978) for example, showed that maternal sensitivity is already present and observable in the first half year after birth and predicts the infant-mother attachment relationship at 12 months. However, nowadays it is recognized that the relationship between mother and infant already starts to develop during pregnancy (Condon, 1993; Cranley, 1981). The emotional tie or bond between a pregnant woman and her unborn child is referred to as maternal fetal attachment (MFA) and is known to develop during the course of pregnancy (Condon, 1993; Cranley, 1981; Laxton-Kane & Slade, 2002). A subsequent logical question is whether it is possible to detect early signs of postnatal maternal sensitivity during pregnancy? Are mothers who behave more affectionately towards the fetus also more affective and sensitive in the postnatal period? The present study focuses on MFA and its relationship to maternal sensitivity in the postnatal period.

To date, only few studies have examined whether a mother's affectionate relationship with her unborn child was related to maternal sensitivity in the postnatal period. Fuller (1990) demonstrated a positive association between MFA during the 35th to 40th week of pregnancy and mothers' sensitive behavior during feeding a few days after birth. In addition, mothers with stronger feelings towards their fetus reported to be more sensitive 6 weeks postpartum (Shin, Park, & Kim, 2006). However, this latter study has some limitations. MFA was measured postpartum on the basis of mothers' recollections of the pregnancy period and maternal sensitivity was not observed, but assessed by a self-report questionnaire, making it difficult to interpret and generalize the results found in this study. Siddiqui and Hägglöf (2000), in contrast, measured MFA during the third trimester of pregnancy and observed maternal involvement

during a play situation 12 weeks postpartum. They found that higher levels of MFA were associated with higher levels of postnatal maternal involvement.

In sum, empirical research into the relationship between MFA and postnatal maternal sensitivity is still limited. Furthermore, previous research has only focused on the association between MFA and maternal sensitivity in the first days, weeks, or months postpartum. Studies focusing on associations after the first three months postpartum are still missing. During the first 6 months, infants grow in their sensitivity towards their social partners, especially parents, and this forms the foundation for their further social development (Bornstein & Tamis-LeMonda, 2010). Particularly in this period, sensitivity and adequate responsiveness are important parental behaviors. Therefore, in this study the relationship between MFA and postnatal maternal sensitivity at 6 months postpartum will be examined. In a recent study we identified differences in maternal sensitivity across different situations. Mothers were found to be more sensitive in a face-to-face situation (a structured play situation in which the infant was seated in front of the mother and in which the mother was asked to interact with the infant in the absence of toys) than during diaper change or in free play situations (Maas, Vreeswijk, & van Bakel, 2013). To obtain a better understanding of the influence of MFA on maternal sensitivity in different contexts at 6 months, in the current study maternal sensitivity is observed in three different situations (i.e., face-to-face play, caregiving, and free play). If MFA is found to be an early predictor of maternal sensitivity, mother-infant dyads at risk for developing sub-optimal attachment relationships could already be identified during pregnancy. Intervention programs aimed at improving the developing relationship between mothers and their unborn babies could then also be set up for mothers who are uncertain about, or unaware of their feelings of attachment towards their fetus.

METHOD

Participants

The present study is part of a larger longitudinal project called 'Expectant Parents' on prenatal risk factors and postnatal infant development. More details about recruitment of the participants and the data collection used in this project have been reported earlier and are briefly summarized here (Maas, Vreeswijk, de Cock, Rijk, & van Bakel, 2012). At the first routine visit to their midwives, pregnant women were invited to participate in the longitudinal study. Women expecting multiple births or with a poor understanding of the Dutch and English language were excluded from participation. At 6 months postpartum, 295 women were visited at home. One of these women refused to participate in the mother-infant observations and two mothers gave birth to a child with severe abnormalities and therefore their observations were not

included in the analyses. Of the remaining 292 eligible mother-infant dyads, 19 women were excluded from further analyses due to having a gestational age above 31 weeks when completing the MFA questionnaire (n=16), due to severe language problems (n=2), and one for not completing the MFA questionnaire. This resulted in a sample of 273 mother-infant dyads. Women who filled in the MFA questionnaire after 31 weeks gestational age were excluded from the analyses, since MFA is known to increase during the course of pregnancy (Laxton-Kane & Slade, 2002). The mean age of the women was 31.87 years (*SD* = 4.19; range 17 – 42 years), mean gestational age when filling in the prenatal questionnaire was 25.53 weeks (*SD* = 1.23; range 23.3 – 30.7 weeks), and more than half of the sample (52%) were primiparous. Most participants had Dutch Nationality (85%). Years of education following primary school varied from 0-4 years (8%), 5-8 years (25%), to 9 years or more (67%). The mean age of the infants at the time of observation was 6.08 months (*SD* = 0.26; range 5 - 7 months) and 51% was male.

Procedure

At approximately 26 weeks gestational age, participants completed a MFA questionnaire to assess their feelings of attachment towards the fetus. At 6 months postpartum, participants were asked to fill in a questionnaire about their current feelings of attachment towards their infant. Additionally, during a home visit the interaction of the mother-infant dyad was videotaped in three different situations. First, mothers were asked to interact face-to-face without toys (2 minutes) while the infant was seated in front of the mother. Subsequently, a caregiving (diaper change) situation was observed (time varied between 1 and 9 minutes), and in the third situation mother and infant played for 7 minutes with a standard set of toys provided by the home visitor. In all of the three situations, mothers were instructed to "interact with your child as you would normally do", and to try to ignore the camera. Seventy three percent of the dyads were videotaped in the aforementioned order. Since some children (22%) were sleeping at the beginning of the home-visit, the diaper change situation was first recorded when they woke up. In 5% of the cases the procedure started with the free play situation.

Measurements

Maternal fetal attachment

MFA was assessed with the Maternal Antenatal Attachment Scale (MAAS; Condon, 1993; Van Bussel, Spitz, & Demyttenaere, 2010). This self-report questionnaire consisting of 19 items focuses on attitudes, thoughts, and feelings of the mother towards the unborn child. Responses were given on a 5-point rating scale (a score

of 1 represented absence of feelings of attachment towards the fetus and a score of 5 represented very strong feelings of attachment towards the fetus). The minimum score is 19 and the maximum score is 95. Higher values indicate more feelings of attachment towards the unborn child. Internal consistency in the current study was adequate (α = .76) and in line with earlier research (Condon & Corkindale, 1997; Laxton-Kane & Slade, 2002).

Maternal postnatal attachment

Mother's feelings of attachment towards her 6-month old infant were assessed with the Maternal Postnatal Attachment Scale (MPAS; Condon & Corkindale, 1998), the postnatal counterpart of the MAAS. This self-report questionnaire focuses on the emotional bond or tie of affection experienced by the mother towards the infant. Just like the MAAS, the questionnaire consists of 19 items and higher scores indicate more feelings of attachment towards the infant. Test-retest reliability of the MPAS has proven to be good with an intraclass correlation coefficient of .70 (Condon & Corkindale, 1998). The internal consistency in this study was also adequate (α = .74).

Maternal sensitivity

The quality of mothers' interactive behavior at 6 months postpartum during the three videotaped situations was rated by using the Qualitative Scales of the Observational Ratings of Mother-Child Interaction of the National Institute of Child Health and Human Development (NICHD Scales; NICHD Early Child Care Research Network [ECCRN], 1999). Maternal sensitivity was calculated as the sum of the subscales 'Sensitivity to non-distress' (i.e., how the mother observes and responds to the infant's social gestures, expressions, and signals), 'Intrusiveness' (i.e., the extent to which the mother is overcontrolling and overinvolved, or the interaction is mainly adult centered), and 'Positive regard' (i.e., the degree to which the mother expresses positive feelings such as love, respect, and admiration to the infant) (Haltigan, Roisman, & Fraley, 2013; NICHD ECCRN, 1999). Intrusiveness was coded reversely. As each subscale was scored on a 4-point rating scale (1= 'not at all characteristic' to 4 = 'highly characteristic'), the maternal sensitivity composite had a possible range of 4 – 12 with higher scores representing more positive, nonintrusive, responsive, and supportive maternal care. Maternal sensitivity at 6 months has, according to earlier research, good internal consistency (α = .75) (NICHD ECCRN, 1999).

Observations of the mother-infant interaction were rated by two trained coders blind to background information of the dyad. Thirteen percent of the observations were coded by both coders, and substantial inter-rater reliability was obtained (79 – 99% agreement). This is in line with earlier publications of agreement data in observations of 6-months olds and their mothers with the NICHD rating scales (NICHD SECCYD, n.d.). Inter-rater reliability of maternal sensitivity was calculated as

the intraclass correlation coefficient (ICC). The ICC (single rater, absolute agreement) was .65, which indicates moderate agreement.

Statistical analyses

Descriptive sample characteristics were examined first. To check whether the order of the different situations/activities in which mother-infant interaction was observed (i.e., face-to-face play, diaper change, free play) had an effect on maternal sensitivity, a one-way between groups multivariate analysis of variance was used. No differences were found among the different order groups (F (6, 500) = .47, p=.829), so order will not be taken into account in further analyses. After this, a repeated measures analysis of variance (ANOVA) was conducted to study differences in maternal sensitivity across the three situations. Relationships between potential covariates and the predictor or outcome variable were investigated next with Pearson correlation coefficients. The selection of potential covariates was based on theoretical perspectives. Associations between MFA and maternal sensitivity were first evaluated using univariate regression analyses, after which regression analyses including covariates (i.e., parity, ethnicity, maternal education, maternal age, and postnatal attachment) were carried out. Analyses were performed for each situation/activity separately. All statistical analyses were performed using SPSS 19.0 for Windows.

RESULTS

Preliminary analyses

Descriptive statistics for the main study variables are presented in Table 1. The mean MFA score was 75.29 (SD = 6.25), which is significantly lower than the mean of the maternal postnatal attachment score (M = 83.17, SD = 5.85; t(263) = -17.77, p < .001). Maternal sensitivity scores for free play, diaper change, and face-to-face play situations were M = 10.01 (SD = 1.32), M = 9.81 (SD = 1.17), and M = 10.20 (SD = 0.94) respectively. A one-way repeated measures ANOVA showed that maternal sensitivity was significantly higher in the face-to-face situation compared to the free play and diaper change situation (F(2, 510) = 14.13, p < .001).

Correlation analyses were used to examine relations between potential covariates, MFA, and maternal sensitivity (Table 1). Women with higher levels of MFA were found to be more sensitive in free play (r = .16, p = .011) and during diaper change (r = .16, p = .012). Parity was found to be negatively associated with MFA (r = -.27, p < .001) and maternal sensitivity (r = -.19, p = .002) during diaper change. Primiparous mothers reported higher levels of MFA and were more sensitive than multiparous women when changing their infants' diaper. Having a non-Dutch nationality was associated with lower levels of maternal sensitivity during free play (r = -.20, p = .001)

and diaper change (r = -.14, p = .025). Additionally, more years of education after primary school were associated with higher levels of maternal sensitivity during free play (r = .19, p = .002) and diaper change (r = .21, p = .001). The results did not show a significant association between maternal age and maternal sensitivity, but maternal age was found to be negatively associated with MFA (r = -.28, p < .001), indicating that older women had lower levels of MFA. Finally, correlational analyses did not reveal a significant association between maternal postnatal attachment and postnatal maternal sensitivity in the three situations. However, maternal postnatal attachment was significantly associated with MFA (r = .30, p < .001). Women with higher levels of prenatal attachment also tend to report higher levels of postnatal attachment.

Relationship between MFA and maternal sensitivity at 6 months

Univariate analyses showed significant positive associations between MFA and maternal sensitivity in free play, F(1, 268)= 6.58, p = .011, and during diaper change, F(1, 262)= 6.43, p = .012. In contrast, MFA and maternal sensitivity failed to be significantly associated in the face-to-face situation, F(1, 266)= 1.40, p = .237. After controlling for parity, ethnicity, maternal education, maternal age, and maternal postnatal attachment in the regression analyses (Table 2), MFA was still a significant predictor of maternal sensitivity in free play (β = .17, p = .010) and during diaper change (β = .15, p = .021). Mothers who reported higher levels of attachment during pregnancy, showed more sensitive behavior during free play and caregiving interactions with their infant 6 months postpartum. The results thus show that MFA has a predictive value with respect to maternal sensitivity, even when controlling for postnatal attachment. In the free play situation, the covariates ethnicity (β = -.18, p = .004) and maternal education (β = -.17, p = .011) also significantly contributed to maternal sensitivity. Having a non-Dutch nationality and receiving 0 – 4 years of education (compared to > 9 years) after primary school resulted in lower levels of maternal sensitivity in the free play situation. During diaper change, maternal education (β = -.16, p = .012) and parity (β = -.18, p = .005) significantly contributed to maternal sensitivity. First-time mothers displayed more maternal sensitivity than mothers who already had one or more children. In total, the predictor variables explained 10% of the variance in maternal sensitivity in the free play situation and 12% of the variance in maternal sensitivity in the diaper change situation. No significant associations were found for the face-to-face situation.

Table 1 Means, standard deviations, ranges, and correlations for the study variables.

Variable	1	2	3	4	5	6	7	8	9	*M*	*SD*	Min.	Max.
Covariates and predictors													
1. Parity[a]													
2. Ethnicity[b]	-.02												
3. Maternal education[c]	-.03	-.17**											
4. Maternal age	-.29**	-.13*	.30**							31.87	4.19	17	42
5. Maternal postnatal attachment	-.07	-.04	-.16**	-.14*						83.17	5.85	56	94
6. Maternal fetal attachment	-.27**	.01	-.08	-.28**	.30**					75.29	6.25	54	91
Outcome parameters													
7. Maternal sensitivity free play	-.06	-.20**	.19**	.07	.05	.16*				10.01	1.32	5	12
8. Maternal sensitivity diaper change	-.19**	-.14*	.21**	.09	.06	.16*	.54**			9.81	1.17	6	12
9. Maternal sensitivity face-to-face play	.03	-.09	.01	.01	.07	.07	.40**	.34**		10.20	0.94	6	12

Note. N varies between 256 and 273.

[a] 0 = primiparous, 1 = multiparous.

[b] 0 = Dutch, 1 = non-Dutch.

[c] Maternal education was split in three groups of years of education following primary school; 1 = 0-4 years, 2 = 5-8 years, 3 = more than 9 years

*$p \leq .05$. **$p \leq .01$.

Table 2 Regression analyses between prenatal attachment and postnatal maternal sensitivity.

	Maternal Sensitivity								
	Free play			Diaper change			Face-to-face play		
	B	SE B	β	B	SE B	β	B	SE B	β
Parity[a]	-.03	.17	-.01	-.44	.16	-.18**	.14	.13	.07
Ethnicity[b]	-.66	.23	-.18**	-.31	.20	-.09	-.20	.17	-.07
Maternal Education[c]	-.81	.32	-.17*	-.73	.29	-.16*	.13	.24	.04
Maternal Education[d]	-.25	.19	-.08	-.31	.17	-.11	-.09	.14	-.04
Maternal age	.01	.02	.04	.04	.02	.13	.00	.02	-.01
Postnatal attachment	.00	.02	.02	.01	.01	.05	.01	.01	.04
Prenatal attachment	.04	.01	.17**	.03	.01	.15*	.01	.01	.08
F-value	*F*(7, 251) = 4.01			*F*(7, 246) = 4.86			*F*(7, 249) = .78		
R^2	.10***			.12***			.02		

Note.
[a] 0 = primiparous, 1 = multiparous.
[b] 0 = Dutch, 1 = non-Dutch.
[c] 0-4 years versus ≥ 9 years of education after primary school.
[d] 5-8 years versus ≥ 9 years of education after primary school.
*$p \leq .05$. **$p \leq .01$. ***$p \leq .001$.

DISCUSSION

This study, which is among the first of this kind, demonstrated that attachment towards the fetus is related to postnatal maternal sensitivity. Mothers with more feelings of attachment during pregnancy displayed more maternal sensitivity towards their 6-month-old infants as observed during free play and caregiving interactions. Even after controlling for mothers' reported postnatal feelings of attachment and other covariates (i.e., parity, ethnicity, maternal education, and maternal age), MFA remained positively related to maternal sensitivity. No significant associations were found in face-to-face interaction.

The results of the present study are in line with previous findings. Fuller (1990) demonstrated a similar connection between MFA during the third trimester of pregnancy and sensitivity during caregiving (i.e., feeding) immediately after birth. Siddiqui and Hägglöf (2000) reported that mothers with higher levels of MFA in the last trimester of pregnancy displayed more positive maternal involvement during play at 12 weeks postpartum. Those studies, as well as the present study, show that mothers' feelings of attachment towards the fetus predict mothers' postnatal sensitivity during play and caregiving. The current study additionally demonstrates that the effect of MFA on maternal sensitivity extends to 6 months postpartum and thus is even more enduring than previously shown. This finding is important because particularly in the first 6 months after birth maternal sensitivity and responsiveness are main parental tasks influencing later child development (Bornstein & Tamis-LeMonda, 2010).

In the face-to-face situation, no associations between MFA and maternal sensitivity were found. Free play and caregiving, such as diaper changing, are more naturalistic, everyday situations compared to face-to-face play and therefore probably yield more valid insight into maternal sensitivity at 6 months. Moreover, in face-to-face situations distraction from external stimuli is limited, which prompts the mother to direct her attention towards her infant (Maas et al., 2013). As a consequence, the display of sensitive behavior by mothers in this situation showed less variation. The face-to-face situation seems less fit for evaluating mother-infant interactions.

Remarkably, no significant association was found between mothers' current reported feelings of attachment towards their infant and maternal sensitivity at 6 months postpartum. It seems that prenatal feelings of attachment are more important in predicting postnatal maternal sensitivity than current feelings of attachment. Mothers with higher levels of MFA may feel more strongly connected with their infants soon after birth than mothers with lower levels of MFA. It could be that in the latter group positive maternal behaviors take a longer time to develop. Alternatively, the failure to find a significant connection between postnatal feelings of attachment and postnatal maternal sensitivity could result from the fact that feelings of attachment as conceptualized with Condon's postnatal measure are dissimilar from those captured by observed maternal sensitivity. The construct of maternal attachment during pregnancy may be more similar to observed maternal sensitivity. The moderate significant correlation between the MAAS and MPAS suggest some overlap in these constructs but also emphasizes differences between these constructs. Another explanation could be the influence of social desirability. It could be possible that social desirability plays a role in mothers' responses on a questionnaire that assesses feelings of love, pride, and involvement with their infant. Lack of attachment of a mother towards her baby is considered as socially undesirable, even more undesirable than the absence of feelings of attachment of a mother towards her fetus. Therefore it could be that the discrimination ability between high and low attachment scores of the MPAS is limited. To some extent this is confirmed by the left-skewed distribution of the MPAS in this study.

Notably, some covariates had an effect on maternal sensitivity. Mothers who received between 0 – 4 years of formal education after primary school were less sensitive during free play and diaper change than mothers with more years of education after primary school. This result is in line with previous studies, where higher levels of maternal education were found to be associated with higher levels of maternal sensitivity (NICHD et al., 1999; Pederson et al., 1990; Van Bakel & Riksen-Walraven, 2002). Higher educated mothers may have developed more adequate skills to foster their children's development. During their years of education and functioning in higher qualified jobs with more responsibilities, they may have developed attitudes like tolerance and patience which may positively influence the interactions with

their infants (Van Bakel & Riksen-Walraven, 2002). Also mothers' ethnic and cultural background contributed to maternal sensitivity in the free play situation. It appeared that non-Dutch mothers displayed less maternal sensitivity than Dutch mothers during free play. From the literature it is known that ethnic background is a determinant of mother-infant interaction (Cho, Holditch-Davis, & Belyea, 2004). Since the two coders who rated the observations both had Dutch nationality, there might have been a bias in the coding of the mothers with a different ethnic background. Furthermore, it was found that during diaper change primiparous mothers were more sensitive than multiparous mothers. This could be explained by the fact that for the latter group, changing diapers has become more of a routine task. The experiences they have with their older child or children in changing diapers made them more prone to display habitual behavior, which might probably be more efficient and less sensitive.

One of the strengths of the present study is that maternal sensitivity was evaluated by assessing videotaped observations of mother-infant interaction instead of using self-report questionnaires of maternal sensitivity, which may be subject to response bias. Mothers' own perceptions of their sensitivity are more subjective and influenced by social desirability because of their own involvement in the dyadic interaction. Observed maternal sensitivity by trained coders, in contrast, is more objective. The subjectiveness in mothers' own perception has been shown in earlier research where mothers' had to evaluate the attachment relationship of their children. Results indicated that observed attachment relationships, but not mothers' self-reported attachment relationships, were a valid measure (Van IJzendoorn, Vereijken, Bakermans-Kranenburg, & Riksen-Walraven, 2004). Another strength of the present study is that mother-infant interactions were observed in three different situations which provide a better understanding of maternal sensitivity in different domains of interaction of the mother-infant dyad.

Some limitations in the present study need to be considered as well. First, self-report questionnaires were used to assess the prenatal and postnatal mother-infant relationship. Although these questionnaires are well validated (Condon, Corkindale, Boyce, & Gamble, 2013; Van Bussel et al., 2010), response bias and social desirability could nevertheless challenge their validity. Furthermore, caution is needed when one wants to generalize the present findings since mainly highly educated, low-risk women participated in this study. From the literature it is known that negative behaviors (such as intrusiveness and hostility) are less common in low-risk samples (Bornstein et al., 2006). So different results may be obtained in a high-risk sample where more negative interactive behaviors may be present. However, results in the present sample showed considerable variation in the distinct maternal behavioral scales, with some mothers also showing intrusive behavior towards their infant. Nevertheless, future research should be replicated in higher risk samples.

The findings of this study have practical relevance for gynecologists, obstetricians, midwives, nurses, and other health care professionals who work with pregnant women. By assessing the developing feelings of pregnant women towards their fetus, mother-infant dyads at risk for developing sub-optimal attachment relationships could already be identified early during pregnancy. Given the uncovered associations between MFA and actual interactive behavior, an obvious extension of this research should focus on the question whether interventions aimed to strengthen MFA also have an effect on subsequent mother-infant interaction. Preventive intervention programs could be offered to high-risk pregnant women to support them to explore their feelings of affection towards their fetus which may strengthen their unfolding prenatal relationship (Fuller, 1990). As the findings of the present study show, higher levels of prenatal attachment are associated with more positive interactive behavior after birth.

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6

General discussion

The general aim of the studies presented in this thesis was to provide more insight into the construct of maternal fetal attachment, its determinants, and its relation with the quality of the mother-infant relationship in the postnatal period. Although the importance of the mother-infant relationship -from the mother's perspective- is acknowledged in developmental research for years, knowledge about predictors and consequences of the quality of the mother-infant relationship is still lacking (Barlow & Svanberg, 2009). As has been postulated in the introduction of this thesis, the development of the mother-infant relationship starts before the birth of the child and is referred to as maternal fetal attachment (Brandon, Pitts, Denton, Stringer, & Evans, 2009; Condon, 1993; Cranley, 1981). This thesis extends the existing knowledge of maternal fetal attachment and identifies predictors of the early mother-infant relationship. In this final chapter, the main findings of the studies reported in this thesis are discussed and this chapter will conclude with implications for clinical practice and suggestions for future research.

The "Expectant Parents" study

The studies presented in this thesis are embedded in the "Expectant Parents" study. The purposes and details of this prospective longitudinal cohort study are presented in *Chapter 2*. To examine the relationship that pregnant women develop with their fetus, its determinants, and its consequences, we have focused on (pregnant) women and their (unborn) infants from a community-based sample. Due to examining different time points and different research questions, the sample size of the studies described in this thesis differ per study. The attrition analysis of the studies in this thesis showed that younger mothers, with less years of education after primary school were more likely to be lost to follow-up. For the study described in Chapter 3, we also found an effect of ethnicity on the lost to follow-up group. Women with a non-Dutch background were more likely to drop out of this study than women with Dutch nationality. However, this effect of ethnicity was not seen in the studies described in Chapter 4 and 5. Selective loss to follow-up only results in bias when the associations between determinants and outcomes differ among those who stayed in the study and those who were lost to follow-up. Since outcome data are missing in the lost to follow-up group, it is not possible to test whether this is actually the case. However, mothers' feelings of attachment towards their unborn child at 26 weeks gestational age of the group women who participated in the home visit 6 months postpartum did not differ significantly from the women who were lost to follow-up. Furthermore, in Chapter 5 we demonstrated an effect of maternal educational level and ethnicity on the outcome measure of maternal sensitivity. Women who received between 0-4 years of formal education after primary school displayed lower levels of maternal sensitivity during free play and diaper change and women with a non-

Dutch background were less sensitive during free play. These findings suggest that this selective loss to follow-up does not have a high impact on our results, it might even have led to an underestimation of the observed effect sizes.

Determinants of maternal fetal attachment

Earlier review studies that examined determinants of the mother-fetus relationship often showed inconclusive and inconsistent results (Alhusen, 2008; Cannella, 2005; Van den Bergh & Simons, 2009; Yarcheski, Mahon, Yarcheski, Hanks, & Cannella, 2009). The majority of the studies described in these reviews had small sample sizes with a maximum of 100 participants, were exploratory in nature instead of theory-driven, and failed to apply appropriate multivariate analyses. High quality research on identifying factors influencing MFA was strongly needed. The study presented in *Chapter 3* was the first to examine a process model -based on Belsky's (1984) model of parenting- in which multiple and different determinants of the parental, contextual, and expected child domain were studied concurrently in predicting maternal fetal attachment. Results of path analysis demonstrated that MFA is multiple determined by influences from parental, contextual, and expected child domain. Parental characteristics (i.e., parental personality and parental attachment security), contextual characteristics (i.e., partner support and perceived stress), and expected child characteristics (i.e., expected child temperament) were each found to explain a significant and unique portion of the variance in the quality of the mother-fetus relationship. The parental domain was found to explain the largest amount of variance of MFA. These findings showed that the domains which determine the quality of parenting also play an important role before birth of the child in determining the relationship between a mother and her fetus thereby generally confirming Belsky's model (1984) in the pregnancy period.

Focusing more specifically on the individual characteristics the results of our study showed that parent's own attachment security was associated with parental personality, which confirmed earlier research (Huth-Bocks, Levendosky, Bogat, & Von Eye, 2004; Siddiqui, Hägglöf, & Eisemann, 2000; Van Bakel & Riksen-Walraven, 2002; Van Bussel, Spitz, & Demyttenaere, 2010a). Women who reported to have insecure attached relationships were less extrovert, less agreeable, and less emotionally stable, which resulted in less affection towards their unborn child. Moreover, parental personality was also found directly associated with MFA. Consistent with feelings of affection experienced in the postnatal period (Prinzie, Stams, Dekovi , Reijntjes, & Belsky, 2009), pregnant women scoring high on positive personality traits (such as extraversion, conscientiousness, and agreeableness) displayed more feelings of attachment towards the fetus during pregnancy. Another finding of the model was that parental personality was associated with factors from the contextual domain.

Higher levels of agreeableness and emotional stability were associated with lower levels of perceived stress and a higher level of emotional stability was associated with more partner support. In contrast with earlier studies (Condon & Corkindale, 1997; Hjelmstedt, Widström, & Collins, 2006), partner support did not explain unique variance in MFA. This could be explained by the fact that the instrument which was used to assess partner support was not valid and adequate for use in the pregnancy period. Perceived stress during pregnancy and the expectation of having a dull child predicted lower levels of MFA and these findings confirmed previous studies (Cranley, 1981; Feldman, 2007; Zeanah, Carr, & Wolk, 1990).

Although the results of this study extend the existing knowledge of determinants of MFA, some questions remain to be answered. For example, our study only focused on determinants that were described in Belsky's original model of parenting since we wanted to examine if this model was also applicable during pregnancy. Furthermore we choose to focus on determinants which are known to be fairly stable such as parental personality in contrast with more fluctuating determinants such as psychological well-being of the mother (i.e., symptoms of anxiety or depression). The validity of Belsky's model has been confirmed in different periods across the life span, from infancy until adolescence (Belsky, Woodworth, & Crnic, 1996; Luster, 1998; Meyers, 1999; Van Bakel & Riksen-Walraven, 2002; Verhoeven, Junger, Van Aken, Deković, & Van Aken, 2007) and the results of our study extend the importance of these determinants on the mother-infant relationship into the pregnancy period. Nevertheless after interpreting the results of our study there are still some contradictions in the effects of specific predictors (i.e., partner support) on MFA. Several factors may have contributed to these conflicting results: (a) researchers used different conceptual definitions for key variables; (b) different instruments with varying psychometric properties were used to measure MFA (all focusing on different aspects of this construct) and the other key variables; (c) most of the studies were not theory-driven but exploratory in nature; and (d) methodological aspects such as variation in design, sample size, time periods, and research population (Cannella, 2005; Van den Bergh & Simons, 2009). This variation has to be kept in mind when interpreting or generalizing the findings of this and previous studies.

Interactive behaviors between mother and infant

As has been stated in the introduction, two sides of the mother-infant relationship can be distinguished; mother's (experiences of) feelings towards her infant and her behaviors associated with these feelings (Sluckin, Herbert, & Sluckin, 1983). During the pregnancy period, solely mother's cognitive and emotional aspects of the relationship between her and her unborn child can be evaluated. In the postnatal period maternal interactive behavior can be evaluated as well to get more insight into the mother-infant relationship.

The importance of the quality of maternal interactive behavior for the mother-infant relationship has been demonstrated in earlier studies. Sensitive, responsive, and stimulating maternal interactive behaviors were associated with more positive psychological, cognitive, and behavioral functioning of the child, whereas poorer quality of maternal interactive behaviors were associated with an increased risk of difficulties in the child's development and behavior (Belsky & Fearon, 2002; Fraley, Roisman, & Haltigan, 2013; O'Brien, Johnson, & Anderson-Goetz, 1989; Sharp et al., 1995). Although the effects of maternal interactive behavior for later developmental outcomes of the child have been frequently studied, findings were often inconclusive and sometimes conflicting (Isabella, 1998; Miller, McDonough, Rosenblum, & Sameroff, 2002; O'Brien et al., 1989). Part of this inconsistency may be due to the variation in the context in which the mother-infant dyad is observed, for example variation in situation/activity (i.e., feeding, caregiving, free play, or face-to-face play), in structure (i.e., presence or absence of toys, time-constrained directed tasks, or unstructured observations), and in setting (i.e., research laboratory, health care clinic, or the infant's home). Earlier studies examining the influence of different observational contexts on the quality of maternal interactive behavior mainly focused on differences in situations within the laboratory or focused on differences between the laboratory and the infant's home setting. Until now, the influence of different situations within the home setting has received little attention in research. The study presented in *Chapter 4* focused on the influence of different observational situations within the home setting and examined interactive behavior of mother and infant in three different situations at 6 months postpartum.

For this study mothers and their infants were observed in three different situations. In the first episode, mother and infant were asked to interact face-to-face without toys while the infant was seated in front of the mother. In the second episode, a caregiving (i.e., diaper change) situation was observed, and in the third episode mother and infant played with a standard set of toys provided by the home visitor. This study revealed differences in the quality of the different interactive behaviors. In face-to-face situations mothers displayed more positive responsivity and were more sensitive than during the caregiving- and free play situation. Also the infants displayed more sociability and positive mood in the face-to-face situation. A specific aspect of maternal behavior, stimulation, was particularly observed in the free play situation. These results confirm the study of Leyendecker, Lamb, Schölmerich, and Fricke (1997) who demonstrated that structured situations such as diaper change, bathing, and dressing, elicit less interactive and less positive behaviors than more unstructured play situations, such as free play. In contrast with our findings, previous research has also demonstrated that higher levels of maternal sensitivity where especially observed during a caregiving situation instead of a free play situation (Isabella, 1998; Joosen, Mesman, Bakermans-Kranenburg, & van IJzendoorn, 2012).

Although all previous studies focused on different situations within the home setting, results seem inconsistent. However, these studies often concerned different situations/activities in which the observation took place. Moreover, differences in further methodological aspects of these studies should be considered as well. All these studies used different instruments to evaluate interactive behavior and different coding procedures varying from 20 second observation / 10 second record intervals (Leyendecker et al., 1997) to a 30 minute observation of mother and infant behavior (Isabella, 1998). Some studies relied only on naturalistic observations (Leyendecker et al., 1997), whereas we used a more structured context (Chapter 4) (Maas, Vreeswijk, & van Bakel, 2013), and others used a combination of the two situations (Isabella, 1998; Joosen et al., 2012). Whereas some researchers argue that naturalistic observations are most ecologically valid and representative for interactive behaviors (Isabella, 1998; Joosen et al., 2012), others claim that these naturalistic observations are comprised of several different normal daily activities (such as feeding, caregiving, and in a lesser extent free play), providing less opportunity to actually observe mothers interacting with their infants than more structured contexts (Belsky, 1980; O'Brien et al., 1989). In addition, there were sometimes notable differences in the sample characteristics among studies; for example the infant's age at the time of observation varied from 1 until 9 months in the different studies. Since research has shown that during the first year of life infants play preferences change from face-to-face play towards more object-play (Feldman, Greenbaum, Mayes, & Erlich, 1997; Power, 2000), it is important to consider age differences of the sample in comparing the results of different studies. In addition to variation in situation/activity, these more methodological aspects also may have influenced the evaluation of mother and infant interactive behaviors.

In sum, this study demonstrated variations in mother-infant interactions in different situations within the home setting. From these findings, it is seems rather plausible that differences in observational context could be a major determinant of the inconsistencies found in previous research into the relation between interactive behaviors and the child's later developmental outcomes. Observing interactive behaviors of mother and infant in a specific context may be more predictive of specific child outcomes than observing interactive behaviors displayed in other contexts. Besides this effect of context, methodological aspects need to be considered as well. Therefore, it is essential that researchers make well-informed decisions about in which situation or situations they observe mother-infant interaction and how they evaluate the interactive behavior. Moreover it is important that researchers in their manuscripts give an explicit description about the situation(s) in which the mother-infant dyad is observed and about the measurements they used to evaluate the interactive behavior.

The effect of maternal fetal attachment on maternal sensitivity

Research has shown long term associations between maternal sensitivity, infant's attachment security, and the emotional and cognitive development during infancy and later childhood (Belsky & Fearon, 2002; De Wolff & van IJzendoorn, 1997; Fraley et al., 2013). In view of the fact that maternal sensitivity has a major influence on the development of the child, identifying its determinants is important. Until now, research concerning determinants of maternal sensitivity has predominantly focused on the postnatal period and neglected the existence of possible determinants during pregnancy. To gain more insight into early determinants of maternal sensitivity, the effect of MFA on maternal sensitivity in a face-to-face, caregiving, and free play situation was examined in the final study of this thesis (*Chapter 5*). Results demonstrated that mothers with more intense feelings of attachment during pregnancy displayed more maternal sensitivity towards their 6-month-old infant as observed during free play and caregiving interactions. The effect of MFA on maternal sensitivity remained even after controlling for covariates as parity, ethnicity, maternal education, maternal age, and postnatal feelings of attachment.

The findings of this study supported the assumption of Cranley (1993) that MFA can be regarded as part of a continuum of feelings and behaviors which develop during pregnancy and extend into the postnatal mother-infant relationship. First, this study confirmed the association between MFA and mothers' postnatal feelings of attachment found in earlier studies (Mercer & Ferketich, 1994; Müller, 1996; Reading, Cox, Sledmere, & Campbell, 1984; Van Bussel, Spitz, & Demyttenaere, 2010b). Second, this study identified MFA as an early predictor for postnatal maternal sensitivity at 6 months postpartum. Until now, only few studies have examined the relationship between MFA and postnatal maternal sensitivity and their results were in line with our findings (Fuller, 1990; Shin, Park, & Kim, 2006; Siddiqui & Hägglöf, 2000). Fuller (1990) demonstrated that mothers with higher levels of MFA in the third trimester of pregnancy were more sensitive to their infants cues, held their infants closer, made more eye contact, and verbally stimulated their infants more during feeding in the first days after birth. Moreover, Shin et al. (2006) demonstrated that mothers with stronger feelings towards the fetus, reported to be more sensitive 6 weeks postpartum. And finally, Siddiqui and Hägglöf (2000) associated higher levels of MFA during the third trimester of pregnancy with higher involvement and more stimulation of the mother while interacting with her infant 12 weeks postpartum. However, these previous studies have only focused on maternal sensitivity during the first three months after birth. The results of this study showed that the effect of MFA on maternal sensitivity extends to 6 months postpartum and thus is even more enduring than previously shown. Given that maternal sensitivity in the first 6 months after birth has important implications for later child development, the knowledge that its predictors already

manifest themselves during pregnancy opens opportunities for early interventions to optimize the mother-infant relationship even before the child is born.

Strenghts and limitations of the studies

Several strengths of the studies described in this thesis should be noted. First, these studies examined a relatively large, community-based sample. Second, it is one of the few existing studies which investigated the different determinants of the model of Belsky extensively. A third strength was the longitudinal character of the study described in Chapter 5. Pregnant women were followed from their pregnancy period until their child was 6 months of age. Our study was one of the first that linked mothers' feelings towards their fetus at 26 weeks gestational age to postnatal maternal interactive behavior 6 months postpartum. Most studies concerning the influence of prenatal factors have only focused on health outcomes of mother and infant and did not observe mother-infant interactions. Moreover, interactive behavior of mother and infant was evaluated by observational measures instead of self-report questionnaires. In studying mother-infant interactions, advantages of observations over maternal reports are that observations are more objective, not influenced by social desirability, and less influenced by parental mood (Aspland & Gardner, 2003). Earlier research already demonstrated that observed attachment relationships were more valid than mothers' self-reported attachment relationships (Van IJzendoorn, Vereijken, Bakermans-Kranenburg, & Riksen-Walraven, 2004). Another strength of these studies was that interactive behavior was observed in different situations providing a better understanding of mother-infant interaction in different domains.

Despite the strengths of our studies, the results must be interpreted within the context of their limitations. First, MFA and its possible determinants (i.e., parental personality, parental attachment security, partner support, perceived stress, and expected child characteristics) were measured with self-report questionnaires. Although these questionnaires are well validated, response bias, and social desirability could nevertheless challenge their validity. Given that the distributions of all our study variables were in line with previous findings we do not expect that response bias and social desirability significantly affected our findings. Moreover, our research population mainly consisted of healthy, well educated, low-risk women and their (unborn) infants. Even though midwives invited all woman who came in for a routine check in the first trimester of pregnancy to participate, it could be that healthier and families experiencing less problems were more likely to participate in the 'Expectant Parents' study. Some of our findings suggest that this sample bias may have influenced our results. For instance, while observing interactive behaviors of mother and infant we saw a low range in negative behaviors such as negative regard and detachment. From the literature is known that these negative behaviors are less common in low

risk samples (Bornstein et al., 2006). However, since 83% of the pregnant women in the Netherlands start their pregnancy control with midwives (Stichting Perinatale Registratie Nederland, 2011) it is to be expected that the population of this study will show normal variation and is representative for "normal", healthy Dutch families. The variety in our population is strengthened by the observation of an effect of educational level and ethnicity on maternal sensitivity. In addition, only (pregnant) women and their (unborn) infants were examined in these studies. Although mothers are also nowadays still the primary caregivers, father's involvement in the child's upbringing is rising (Maume, 2011). Since fathers, just as mothers, develop an affectionate relationship with their unborn child (Condon, 1993), interactive behaviors between father and infant also deserve the attention of researchers. Their interactions might be both quantitatively and qualitatively differ from those typically observed within the mother-infant dyad since fathers are known to spend a larger proportion of time with their infant in playful interactions, whereas mothers predominantly focus on comforting and caregiving. It is possible that different relations will be seen when father-infant interactions are observed. Therefore subsequent studies should also focus on the relationship between the father and his (unborn) child and study this relationship with respect to developmental outcomes of the child later in life.

Clinical implications

The results of our study have practical relevance for gynecologists, obstetricians, midwives, nurses, and other health care professionals who work with pregnant women. MFA is important for pregnancy, health, and birth outcomes for both mother and infant (Lindgren, 2001). Additionally, this and previous research has shown that mothers with more and stronger feelings towards their fetus reported more and stronger feelings to their infant in the postnatal period and displayed more sensitive interactive behavior (Fuller, 1990; Mercer & Ferketich, 1994; Müller, 1996; Siddiqui & Hägglöf, 2000). It is crucial that clinicians working with pregnant women are well aware of the possible negative effects of low levels of MFA on the developing relationship between mothers and infants. Our findings that MFA is determined by characteristics from the parental, contextual, and expected child domain highlight the significance of evaluating these aspects in pregnant women during pregnancy. Special attention should be given to determinants like maternal personality, perceived stress of pregnant women, and women's expectations of their infant's temperament. These determinants could be classified into two groups; factors which can be influenced by preventive intervention efforts and those that are unlikely to be influenced by such interventions. Factors which can be influenced, such as mothers' perceived stress and expectations of their unborn child's temperamental characteristics, can be taken as the main focus of intervention programs during pregnancy. Educating the parents (i.e., psycho-education) about

the salient effects of experienced stress during pregnancy may also have a positive effect on the development of MFA. On the other hand factors that are unlikely to be affected by intervention efforts, such as parental personality, parity, maternal age, and income are nevertheless important to identify during pregnancy, because these may increase the risk for developing sub-optimal feelings towards the fetus. As far as we know, mothers' feelings towards their fetus are not yet evaluated in the Netherlands. Inquiring about these feelings in normal prenatal care could be beneficial for both mother and infant. Women with low levels of MFA may benefit from early preventative interventions to increase their feelings of attachment during pregnancy. More feelings of attachment of mothers towards their fetus enhance maternal and fetal health during pregnancy and promote the development of an optimal mother-infant relationship in the postnatal period. Along with a higher quality of the mother-infant relationship, the child's cognitive, social, emotional, and physical development later in life will be positively affected.

Suggestions for future research

Although findings of this thesis have led to a better understanding of the determinants and consequences of maternal fetal attachment, more research is still needed. Future studies should make use of psychometric well validated and reliable instruments, being based on relevant theory, and being conducted in more diverse research populations. For example, studies examining MFA in high-risk and different ethnic populations will expand the knowledge of psychosocial and cultural determinants of MFA. Moreover, since maternal sensitivity in these studies was only assessed at 6 months postpartum, it remains unclear whether the effect of MFA on maternal sensitivity is persistent after this period. Future studies examining the long-term effects of MFA on the mother-infant relationship should be conducted. Furthermore, we have only focused on maternal sensitivity as an outcome measure. It would be interesting to examine the effects of MFA on others aspects such as postpartum maternal mental health, infant/child developmental outcomes, and infant-mother attachment. The majority of the suggested studies can be conducted within the context of the 'Expectant Parents' study and in future research the focus will be on these aspects to expand the existing knowledge of MFA even more.

General conclusion

One of the objectives of the 'Expectant Parents' study is to identify prenatal (risk) factors related to the quality of the mother-infant relationship. This thesis identified determinants of maternal fetal attachment and demonstrated that low attachment feelings of a mother towards her unborn child can be considered as a risk factor

for developing a sub-optimal mother-infant relationship in the postpartum period. In contrast with other prenatal risk factors, such as single parenthood, parental psychopathology, or the existence of pregnancy complications, lower levels of MFA are more often seen in low risk families. Intervention programmes aimed to enhance MFA may be beneficial for the general population in which other strong prenatal risk factors are less present.

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Samenvatting

In de afgelopen 30 jaar is het belang van de vroege relatie tussen moeder en kind voor de latere ontwikkeling van dit kind veelvuldig aangetoond. Onderzoek op dit gebied is echter voornamelijk gebaseerd op de gehechtsheidstheorie en heeft zich vooral gericht op de relatie tussen moeder en kind vanuit het perspectief van het kind. Onderzoek naar de relatie tussen moeder en kind vanuit het perspectief van de moeder heeft veel minder aandacht gekregen. Dit is opmerkelijk omdat uit het beschikbare onderzoek blijkt dat een verstoorde moeder-kind relatie, bijvoorbeeld als gevolg van emotionele problemen van de moeder, sterk gerelateerd is aan een negatieve ontwikkeling bij het kind.

Inmiddels is er voldoende bewijs dat de band tussen moeder en kind al ontwikkelt tijdens de zwangerschap. De relatie tussen moeder en foetus start in het algemeen vanaf de 10e zwangerschapsweek en wordt meer intens naarmate de zwangerschapsduur toeneemt. Een betere kwaliteit van de moeder-foetus relatie, die weerspiegeld wordt door veel denken aan de foetus en erg betrokken zijn bij de zwangerschap, bleek geassocieerd met gezonder gedrag van de moeder tijdens de zwangerschap. Deze moeders dronken geen alcohol, rookten niet, volgden een zwangerschapscursus en verdiepten zich in de verschillende ontwikkelingsfases van de zwangerschap. Een minder goede kwaliteit van de moeder-foetus relatie aan de andere kant, bleek samen te hangen met symptomen van angst, depressie en emotionele instabiliteit van moeder en meer gevoelens van irritatie van moeder naar haar ongeboren kind. Welke factoren de moeder-foetus relatie bepalen en wat de gevolgen van deze prenatale relatie zijn voor de kwaliteit van de moeder-kind relatie in de postnatale periode is onvoldoende onderzocht. De studies die in dit proefschrift beschreven worden, hadden tot doel de bestaande kennis op dit gebied te vergroten.

Alle studies die zijn beschreven in dit proefschrift maken onderdeel uit van de prospectieve, longitudinale cohort studie “In Verwachting”. De opzet van de ‘In Verwachting’ studie staat beschreven in **hoofdstuk 2**. Een belangrijk doel van deze studie was het onderzoeken van de kwaliteit van ouder-kind relaties vanuit het perspectief van de ouder, zowel in de prenatale als postnatale periode. Om de relatie tussen moeder en foetus, de determinanten en de gevolgen hiervan te beschrijven, werden in dit proefschrift alleen die vrouwen bestudeerd die vragenlijsten invulden bij 26 weken zwangerschap en 6 maanden postpartum en participeerden in een huisbezoek 6 maanden postpartum. Dit resulteerde in een populatie van 409 vrouwen en 292 kinderen.

In **hoofdstuk 3** zijn verschillende factoren onderzocht waarvan verwacht werd dat ze samen zouden hangen met de moeder-foetus relatie. Eerdere wetenschappelijke studies naar mogelijke determinanten van deze relatie, zoals symptomen van angst of depressie en sociale steun, waren niet altijd consistent in hun bevindingen. Dit zou

een gevolg kunnen zijn van de onderzoeksopzet van deze studies. De meerderheid van de studies was exploratief van aard in plaats van gebaseerd op onderliggende theorieën en veel studies bevatten relatief kleine onderzoeksgroepen. Bovendien is nauwelijks gebruik gemaakt van multivariate analyses. In hoofdstuk 3 is een model beschreven waarin de bijdrage van verschillende ouder-, omgevings- en kindkenmerken op de moeder-foetus relatie is onderzocht. Het model -dat is gebaseerd op het theoretische model van Belsky- veronderstelt dat opvoeding bepaald wordt door psychologische kenmerken van de ouder zelf, omgevingskenmerken zoals stress en steun en kenmerken van het kind. Eerder emprisch onderzoek heeft de toepasbaarheid van dit model bevestigd bij ouders van baby's, peuters, kinderen en jong volwassenen. Uit de resultaten van de studie beschreven in hoofdstuk 3 blijkt dat ook de relatie tussen moeder en foetus bepaald wordt door ouder- (d.w.z., persoonlijkheid en de gehechtheidstijl van de ouder), omgevings- (d.w.z., steun van de partner en stress) en kind (d.w.z., verwacht temperament van het kind) kenmerken en bevestigt hiermee de waarde van Belsky's model tijdens de zwangerschap. Vooral zwangere vrouwen die extrovert, consciëntieus en aardig zijn, bleken een betere kwaliteit van de moeder-foetus relatie te rapporteren. Tevens werd gevonden dat zwangere vrouwen die meer stress hadden tijdens de zwangerschap of de verwachting hadden dat zij een minder opgewekt kind zouden krijgen, een minder goede kwaliteit van de moeder-foetus relatie rapporteerden. Er werden ook relaties tussen de drie domeinen onderling gevonden. Moeders met een onveilige hechtingsstijl waren minder extrovert, aardig en emotioneel stabiel wat resulteerde in minder affectie naar de foetus. Aardige en emotioneel stabielere moeders ervoeren minder stress en de emotioneel stabielere moeders ervoeren daarnaast meer steun van hun partner.

Zes maanden na de geboorte is bij de moeders en kinderen uit de "In Verwachting" studie de kwaliteit van de moeder-kind interactie bepaald tijdens een huisbezoek. De bevindingen van eerder onderzoek waar de kwaliteit van moeder-kind interacties in kaart wordt gebracht, zijn niet altijd eenduidig. Dit zou het gevolg kunnen zijn van de verschillende manieren waarop moeder en kind zijn bestudeerd. Zo kan er variatie optreden in de situatie/activiteit (zoals voeden, verschonen, spelen), in de structuur (de aan- of afwezigheid van speelgoed, tijdsgebonden of ongestructureerde observaties) en in de setting (laboratorium versus thuissituatie) waarin de observaties plaatsvinden. In **hoofdstuk 4** is onderzocht wat de invloed van verschillende situaties (een face-to-face, een verschonings- en een vrij spel situatie) binnen de thuissituatie op het interactieve gedrag van moeder is en kind is. Moeders in de face-to-face situatie bleken meer responsief en sensitief te zijn dan in een verschonings- en vrij spel situatie. Ook de kinderen waren in de face-to-face situatie socialer en positiever. Deze studie laat zien dat het gedrag van moeder en kind deels afhangt van de situatie

waarin deze wordt beoordeeld. Het is belangrijk hier in toekomstig onderzoek naar de kwaliteit van moeder-kind interactie rekening mee te houden.

Tot op heden heeft onderzoek naar determinanten van sensitiviteit van moeder zich vooral toegespitst op de postnatale periode. In **hoofdstuk 5** is onderzocht of de moeder-foetus relatie de sensitiviteit van moeder in de postnatale periode kan voorspellen. De resultaten van deze studie lieten zien dat moeders met een betere kwaliteit van de moeder-foetus relatie meer sensitieve gedragingen tonen 6 maanden na de geboorte in een verschonings- en vrij spel situatie. Deze bevindingen komen overeen met eerder onderzoek en bevestigen dat de moeder-foetus relatie gezien kan worden als een continuüm van gevoelens en gedragingen die de basis vormen voor de latere moeder-kind relatie.

In **hoofdstuk 6** worden de belangrijkste bevindingen van dit proefschrift samengevat. Vervolgens worden methodologisch sterke en zwakke punten van de studie, de klinische implicaties en overwegingen voor toekomstig onderzoek besproken.
Voor zover bekend wordt in Nederland de kwaliteit van de moeder-foetus relatie nauwelijks in kaart gebracht. Het in kaart brengen van deze relatie zou klinisch gezien echter waardevol kunnen zijn. Vrouwen met een lagere kwaliteit van de moeder-foetus relatie zouden baat kunnen hebben bij vroege preventieve interventies om de kwaliteit van de relatie tussen haar en haar foetus te verbeteren met als doel de latere ontwikkeling van het kind positief te beïnvloeden. De bevindingen van dit proefschrift zijn daarom belangrijk voor alle professionals die met zwangere vrouwen werken.

List of publications

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Janneke

About the author

Janneke Maas was born on August 5th 1979 in Eindhoven, the Netherlands. In 1997 she completed secondary school at the Pius-X-College in Bladel. In the same year she started her study Health Sciences with specialization Movement Sciences at Maastricht University. After three years, she combined her study of Movement Sciences with studying Physiotherapy at Hogeschool Zuyd in Heerlen. She graduated from both studies in 2003. From 2004 to 2005 Janneke worked as a research assistant on a project evaluating a screening tool for depression in general practice at the Julius Center, UMC Utrecht. In 2005 she started working as a research assistant at Generation R, Erasmus MC assessing infant neuromotor development. Later, between 2006 and 2008, she became research coordinator on the Generation R Focus Cohort, Erasmus MC. In June 2008 she started as a PhD-student at the department of Developmental Psychology at Tilburg University. She conducted her research on the quality of the relationship between mother and fetus and how this affects the postnatal relationship between mother and infant. Janneke is currently working as a teacher of the bachelor and master program of Psychology at Tilburg University.

Janneke lives together with Harm Lavrijsen and they have two children: A boy named Tuur (born on the 2nd of February 2011) and a girl named Meis (born on the 29th of June 2013).