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The transition to motherhood: Maternal well-being and mother-child bonding until four months postpartum

The role of mothers' early maladaptive schemas, attachment style and the Newborn Behavioral Observation

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A dissertation for the degree of Philosophiae Doctor, April 2023

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Acknowledgement

Words cannot express my gratitude to my primary supervisor, Catharina E A Wang, for her valuable inspiration, guidance, patience, and support in every phase of this work. I am grateful for her always believing in me. I also want to express my gratitude to my secondary supervisors, Jens C Thimm and Gerit Pfuhl for their excellent guidance, support, and encouragement.

In addition to my supervisors, I want to express my gratitude to the rest of "Northern Babies" research team: Ragnhild Sørensen Høifødt, Agnes Bohne and Inger Pauline Landsem for discussions, contributions, and support. I have really enjoyed being part of this highly competent team and have learned a lot. Moreover, I am grateful to Kamilla Rognmo and Gábor Csifcsák for valuable collaboration on statistics and writing on some of the papers.

Next, I would like to express my gratitude to the Department of Psychology (IPS) at UIT – The Arctic University of Norway and the division of Children and Adolescent`s Psychiatric Outpatient Clinic in Tromsø at the University Hospital North Norway. This project was situated at these two locations as I was enrolled in "The National Program for Integrated Clinical Specialist and PhD-training for Psychologists in Norway". This program made this PhD work possible. Thanks should also go to my colleagues at IPS, which I have enjoyed working with and for the needed coffee breaks when inspiration has been low.

I am also grateful to Vibeke Moe and her collegeagues in the "Little in Norway" study team. The research team and the "Little in Norway" study were important inspiration for choosing some of the research instruments and the development of the longitudinal design of the Northern Babies study.

Additionally, I would also like to thank the midwives in Tromsø for recruiting participants and to the participants who took part in the study.

Further, a special thanks to my family, especially my fiancée Linn Kathrin Karlsen Ilstad, my children Sebastian, Johan and Olav, and parents John Sverre Nordahl and Bodil Gamman. Their patience, emotional support, and belief in me has kept my motivation high during this process. I am forever grateful. Moreover, I am grateful to Finn Ernst Ilstad and Aud Harriet Karlsen Ilstad for support with my children and household during this process.

Preface

In 2015 I became a member of the "Northern Babies" research team and as I was enrolled in "The National Program for Integrated Clinical Specialists and PhD-Training for Psychologists in Norway", I could pursue both my clinical and research interests.

The original research team consisted of Professor and project leader Catharina E A Wang, Associate Professor (now Professor) Jens C Thimm, post doc (now Associate Professor) Ragnhild S Høifødt, Associate Professor (now Professor) Gerit Pfuhl, PhD-student Linn Kathrin K Ilstad, and myself. In 2016 Ilstad left the research team to pursue clinical work, but PhD student Agnes Bohne joined our team.

The foundation for developing the study was the acknowledgment of the importance of the transition period to parenthood for the parents and the child's development. We were interested in identifying factors that have a negative influence on parents' experiences of the period of transition to parenthood, and determining whether it was possible to identify parents at risk of developing postpartum depression. Further, we wanted to explore early markers of dysfunctional parent-child dyads and children at risk for early unhealthy development. It was decided that part of the focus of the study would be on cognitive variables that might be important for maternal postpartum depression and qualities of the mother-infant relationship. The cognitive variables decided upon were rumination and early maladaptive schemas (EMSs). EMSs have been theorized to be created by parents' own adverse childhood experiences (Young et al., 2003) and may also contribute as a potential mechanism for the intergenerational transmission of adversities. Related to EMSs, we also had an interest in adult attachment styles. Professor Wang and Professor Thimm were of central importance for the implementation of a cognitive focus in the study. Moreover, parents` processing of infant facial expressions might be also of great importance for the parent-infant relationship, and research on depression in general suggests that the ability to interpret facial expressions might be influenced by depression (Bourke et al., 2010). We developed a database of pictures of infant faces (Maack et al., 2017), and three experimental tests aiming to tap into attention to, memory of and implicit associations of infant faces were therefore created for this study. Professor Gerit Pfuhl was mainly responsible for the imagee database and the development of these cognitive tests.

Further, due to the potential challenges in the transition to parenthood, we wanted to include an intervention in the study to explore the potential benefits of early intervention on maternal mental health, child development and qualities of the parent-child relationship. We came in contact with Associate Professor Inger Pauline Landsem, who is a trained instructor in Newborn Behavioral Observation (NBO), which is an intervention aimed at sensitizing parents to the capacities and signals of their babies (Nugent et al., 2007). In addition, well-baby clinics in the municipality of Tromsø were interested in implementing the NBO in their work. We saw this as a golden opportunity and decided on the NBO as our intervention in the Northern Babies study, and Associate Professor Landsem became a key resource as a member of the Northern Babies research team.

As the planning of the study progressed, we came in contact with Associate Professor (now Professor) Vibeke Moe at the University of Oslo and her colleagues from the "Little in Norway" study (Moe et al., 2019). The research team and the "Little in Norway" study were important inspiration for choosing some of the research instruments and the development of the longitudinal design of the Northern Babies study. The main factors that distinguish our study from the "Little in Norway" study are the cognitive focus, experimental tests, and the inclusion of an intervention.

During the course of the Northern Babies project, I have contributed and participated from the early planning of the study, and in the recruitment and data collection of the Norther Baby (NorBaby) study. During my PhD period, I have also contributed to articles outside the scope of this PhD. These are a protocol article published in BMJ Open with myself as joint first author (Høifødt et al., 2020; Høifødt et al., 2017), an article on the Tromsø infant face database (Maack et al., 2017), and an article on the processing of infant facial expressions in individuals with major depression and expectant parents (Bohne et al., 2021). Further, I have been a co-author of the three articles by PhD candidate Agnes Bohne.

For my PhD project I chose to explore some of the research questions from the NorBaby study. I became especially interested in adult attachment styles, EMSs, and bonding, partly because attachment and EMSs provide a theoretical understanding of how childhood relational experiences with important others impact experiences and views of oneself and relationships in adulthood. I therefore decided to focus on these concepts in my PhD. In addition, I became increasingly interested in whether receiving the short intervention, the Newborn Behavioral Observation would be related to maternal well-being and qualities of the

mother-infant relationship. The choices for my PhD focus were also partly decided by time concerns, thus I wanted to write about data from early measurement points that all participants had completed. Lastly, for this thesis, I decided to focus on female participants in order to simplify the focus of the papers. In the beginning of recruitment, we were also concerned as to whether we would get enough male participants.

The three papers for this thesis were published some time ago, and research with parallels to our papers has been published since then. This will be documented in the introduction.

Summary

The transition to motherhood may be experienced as overwhelming and difficult by many women. The present thesis explores factors that may be associated with maternal well-being and with mothers' relationship to the fetus/infant. It is based on self-report data and has a special focus on how mothers' early maladaptive schemas (EMSs), their adult attachment style and a short intervention, the Newborn Behavioral Observation, which aims to sensitize mothers to infants' signals and needs, are related to parenting stress, symptoms of depression and the mother-infant and mother-fetus relationship. The thesis is part of a Tromsø population-based study (the NorBaby study) and is designed as a prospective longitudinal study following prospective mothers from pregnancy and until a mean of four months postdelivery, and the intervention part of the study was designed as a non-randomized cluster-controlled design.

The purpose of the present thesis was: 1) to examine the association between mothers` EMSs and maternal-fetal bonding during pregnancy. Further, to explore symptoms of depression as a mediator in this association, 2) to explore the association between mothers` attachment styles and the quality of maternal infant bonding around six weeks postpartum. Further, to investigate parenting stress as a mediator of the association between adult attachment style and mother-infant bonding, and 3) to evaluate the NBO as a universal preventive intervention within the regular well-baby clinic service. We investigated whether receiving the NBO was associated with maternal symptoms of depression and parenting stress, mother-infant bonding, maternal confidence, reflective functioning, and satisfaction with and benefit from postpartum follow-up care.

Results indicate that EMSs, especially from the domain of disconnection and rejection domain, was related to poorer maternal-fetal bonding. Maternal symptoms of depression were found to mediate the relationship between EMSs and maternal-fetal bonding. Maternal attachment style, especially attachment avoidance, was related to poorer mother-infant bonding. Parenting stress mediated the relationship between attachment style and mother-infant bonding. Receiving the NBO-intervention was not associated with lower levels of maternal depressive symptoms and parenting stress, nor with stronger mother-infant bonding, better reflective functioning, or higher maternal confidence. However, the NBO was associated with increased knowledge about the infant`s signals. There may be limited benefits of the NBO in a well-functioning population of new mothers. The results on EMSs and adult

attachment styles may have implications for identification of mothers at risk of bonding difficulties to their unborn child and their infant.

List of papers

Paper 1. Nordahl, D., Høifødt, R. S., Bohne, A., Landsem, I. P., Wang, C. E. A., & Thimm, J. C. (2019). Early maladaptive schemas as predictors of maternal bonding to the unborn child. *BMC Psychology*, *7*(1), 23. doi: 10.1186/s40359-0279-9

Paper 2. Nordahl. D., Rognmo, K., Bohne, A., Landsem, I. P., Moe, V., Wang, C. E. A, & Høifødt, R. S. (2020). Adult attachment style and maternal-infant bonding: the indirect path of parenting stress. *BMC Psychology*, *8*(1), 1-11. doi: 10.1186/s40359-020-00424-2

Paper 3. Høifødt, R. S., Nordahl. D., Landsem, I. P., Csifcsak, G., Bohne, A., Pfuhl, G., Rognmo, C., Braarud, H. C., Goksøyr, A., Moe, V., Slinning, K., & Wang, C. E. A. (2020). Newborn Behavioral Observation, maternal stress, depressive symptoms, and the mother-infant relationship: results from the Northern Babies Longitudinal Study (NorBaby). *BMC Psychiatry,* 20. doi: 10.1186/s12888-020-02669-y

List of abbreviations

EPDS		Edinburgh Postnatal Depression Scale
ECR		Experiences in Close Relationships
MAAS		Maternal Antenatal Attachment Scale
	IPF	Intensity of preoccupation with the fetus
	QMB	Quality of maternal bonding
MCQ		Maternal Confidence Questionnaire
MPAS		Maternal Postnatal Attachment Scale
NBO		Newborn Behavioral Observation
PRFQ		Parental Reflective Functioning Questionnaire
	CMS	Certainty about Mental States
	IC	Interest and Curiosity
	PM	Pre-Mentalizing
PSI		Parenting Stress Index
CD		Child Domain
PD		Parent Domain
PD5		Parent Domain with 5 subscales
	CO	Competence
	DP	Depression
	IS	Isolation
	RO	Role Restriction

SP   Spouse

YSQ-S3   Young Schema Questionnaire-Short Form 3
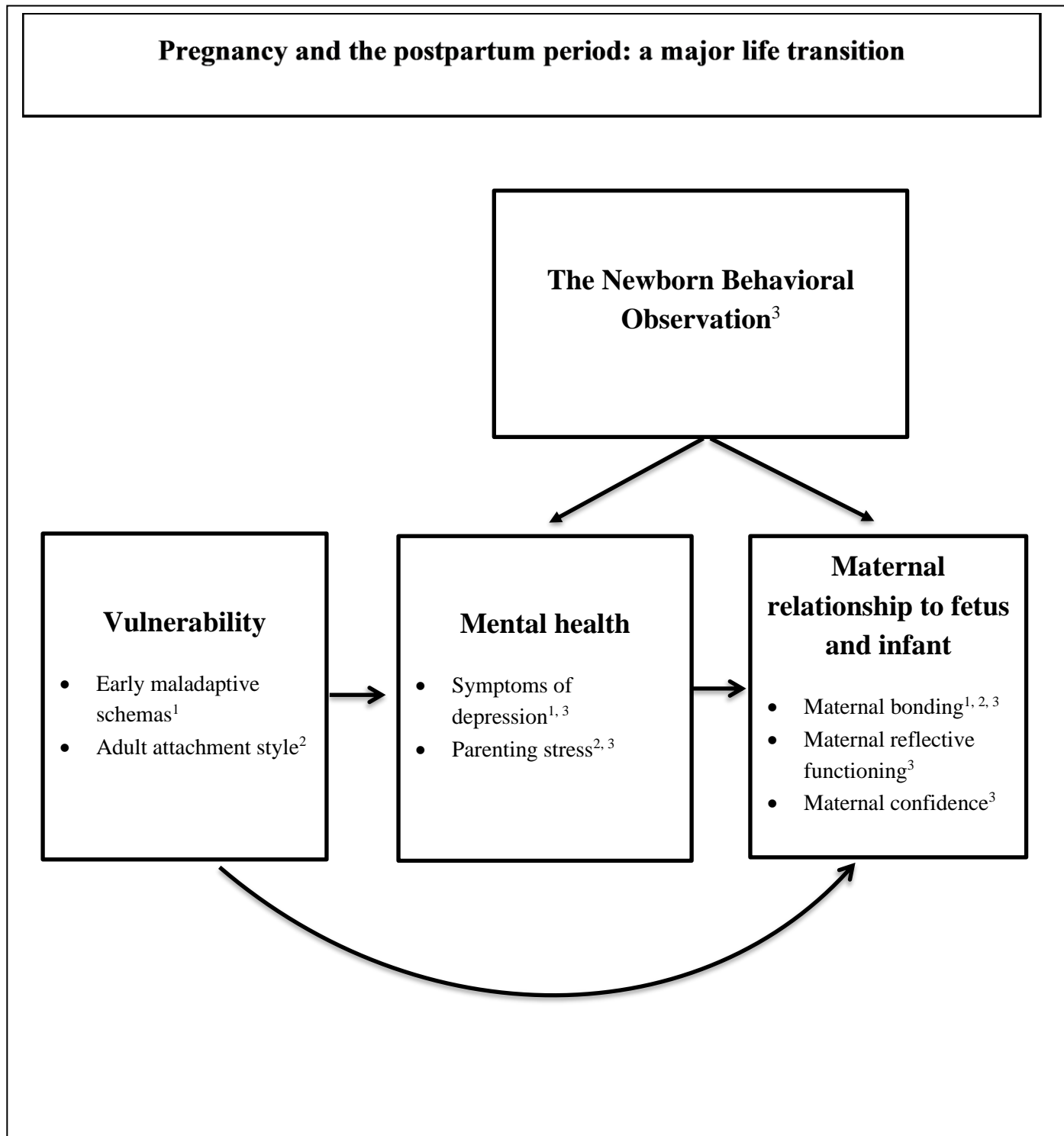
1   Introduction

In the present thesis I wish to present and discuss some aspects of the maternal perspective of the life transition of having children. I will focus on maternal self-reported symptoms of depression and stress experiences, and self-reported quality of the maternal relationship to the fetus and infant, respectively, in the pre- and postpartum period. Figure 1 presents the theoretical model on which the three papers were based. In the first paper, we examined the relationships between mothers' early maladaptive schemas (EMSs), symptoms of depression, and the quality of maternal-fetal bonding. The second paper investigated the relationship between maternal attachment style to the partner, parenting stress and the quality of mother-infant bonding. The concepts of EMS and attachment style are rooted in schema theory (Young et al., 2003) and attachment theory (Cassidy & Shaver, 2016), respectively, and attempt to explain aspects of personality development. In brief, EMSs are cognitive and emotional themes that are more or less active at a given time, and have a negative influence on an individual's thinking and emotions about him/herself and other people (van Genderen et al., 2012; Young et al., 2003). Adult attachment style can be conceptualized as a two-dimensional model of attachment insecurity: 1) anxiety (fear of being abandoned or not loved by a partner) and 2) avoidance (unease with closeness and dependency) (Brennan et al., 1998). EMSs and attachment insecurity may be thought of as vulnerability (or at least risk) factors for emotional and relational difficulties. Thus, these constructs may be relevant to maternal mental health and to the quality of maternal-fetal/infant bonding in the transition to parenthood. In addition, in the two first papers, we explored whether maternal symptoms of depression and parenting stress mediate between EMSs and adult attachment style and the quality of maternal-fetal/infant bonding.

The newborn period can be overwhelming for mothers (Nyström & Öhrling, 2004) and mothers must respond sensitively to their newborn's signals and needs, as infants depend on their caregivers for regulation, healthy development, and survival (WHO, 2004). One can assume that mothers who mostly succeed in regulation and care for their infant feel more confident in the parenting role, and have a healthier parent-infant relationship and better mental health. Newborn Behavioral Observation (NBO) (Nugent et al., 2007) is an intervention which aims to increase parents' knowledge of newborns' signals and needs in order to enhance the parent-infant relationship. Accordingly, in the third paper, we investigated whether the NBO could increase maternal confidence and the mothers' reflective

functioning, benefit mother-infant bonding, and decrease parenting stress and symptoms of depression (see Figure 1).

Figure 1

The focus of this thesis

Pregnancy and the postpartum period: a major life transition

The Newborn Behavioral Observation[3]

Vulnerability

- Early maladaptive schemas[1]
- Adult attachment style[2]

Mental health

- Symptoms of depression[1, 3]
- Parenting stress[2, 3]

Maternal relationship to fetus and infant

- Maternal bonding[1, 2, 3]
- Maternal reflective functioning[3]
- Maternal confidence[3]

Note. [1]Measures included in paper one, [2]measures included in paper two, [3]measures included and intervention in paper three.

1.1 Pregnancy and the postpartum period: a major life transition

Having a baby is one of the most important and influential life experiences. The transition to parenthood begins even before childbirth and will result in everlasting changes in the women involved (Stern & Bruschweiler-Stern, 1998). Although the transition might be more profound for primiparous women, most parents find having a baby to a stressful experience, due to huge changes in aspects of life such as the partner relationship and needs for social support due to the pregnancy and birth (Canário & Figueiredo, 2016; Gjerdingen et al., 1993; Ni & Lin, 2011). The prenatal and postnatal periods are also physically demanding for women with significant changes in weight and body, nutrition requirements, and sleep patterns (Brummelte & Galea, 2016). Getting to know the new infant and settling into the role as a parent in the midst of all the changes can be particularly difficult. New parents may be preoccupied with finding out how to act as a parent and what family values are important. Moreover, this period might elicit memories of one's own childhood and experiences of caregivers and, depending on whether these experiences were good or bad, might result in distress (Christie et al., 2017).

Many new mothers experience mental health difficulties (Eberhard-Gran et al., 2002; Glavin et al., 2009; Shakeel et al., 2018), and mothers who find this life transition very demanding may have difficulty in being attuned to their infant. They may have problems in interpreting their infant's signals appropriately, regulating its state and taking care of its needs (Bernard et al., 2018; Dau et al., 2019; Epifanio et al., 2015; Mueller et al., 2019; Paulson et al., 2006; Stein et al., 2010). Due to the increased probability of difficulties in mother-child interaction, when new mothers have mental health difficulties, the child may be pushed into an unhealthy developmental trajectory (Feldman et al., 2009; Hoffman et al., 2017; Wurmser et al., 2006). Research on parent-infant relationship enhancing interventions and on vulnerability and risk factors for mothers, infants, and the mother-infant dyad is therefore important to increase our knowledge of the period surrounding childbirth and to develop better ways of helping mothers and infants at risk.

1.2   Maternal mental health

1.2.1   Depression

Nine to fourteen percent of Norwegian women in the postpartum period are above the screening cut-off point for depression (Eberhard-Gran et al., 2002; Glavin et al., 2009; Shakeel et al., 2018). A study on Norwegian women suggests that the prevalence of scoring above cut off for postpartum symptoms of depression is higher in ethnic minorities (12.7%) than in Western Europeans (4.8%) (Shakeel et al., 2018). The global prevalence of scoring above cut off for postpartum symptoms of depression is approximately 17% (Hahn-Holbrook et al., 2018; Shorey et al., 2018). Risk factors for postpartum depression include a history of mental health problems, mental health disturbance during pregnancy, adverse life events, a poor marital relationship, poor social support, hormonal changes and genetic factors (Couto et al., 2015; O'hara & Swain, 1996). A recent meta-analysis also found the personality trait of neuroticism to be related to increased symptoms of postpartum depression (Puyané et al., 2022).

Several studies have shown detrimental consequences of maternal depression for the child's development. A meta-analysis found that symptoms of depression during pregnancy negatively affected the infant's socio-emotional development (Madigan et al., 2018). Another meta-analysis found pre- and postnatal maternal symptoms of depression and anxiety to be adversely related to child development (Rogers et al., 2020). Moreover, a meta-analysis by Barnes and Theule (2019) found a small relationship between maternal depression and insecure attachment in one- to three-year-old children. A recent study has shown symptoms of postpartum depression to be related to infant social withdrawal at 2-3 and 8-12 months of age, but not at 4-7 months (Stuart et al., 2022). In a cohort study, parental depression before and after birth was related to child depression and failure to achieve educational milestones (Brophy et al., 2021). Parental symptoms of depression over the perinatal period have been found to be related to behavioral and regulation difficulties in children, and this relationship was mediated by postpartum parenting stress (Fredriksen et al., 2019).

1.2.2   Parenting stress

Parenting stress has been defined as *"a set of processes that lead to aversive psychological and physiological reactions arising from attempts to adapt to the demands of parenthood"* (Deater-Deckard, 2004, p. 6). Such reactions may include negative emotions and thoughts

about oneself and one's child (Deater-Deckard, 2004). Parenting stress arises from challenging characteristics of the child, characteristics of the parent and from the parenting role (Abidin, 1995). Potential source of stress includes adjusting to the infant, gaining a sense of competence as a parent, and maintaining and receiving support from the partner and the social system. Perceived difficult infant temperament is related to increased maternal parenting stress (Moe et al., 2018). Levels of parenting stress are suggested to be similar for first and second time mothers in the first month after birth (Krieg, 2007). Hattangadi et al. (2020) found that parenting stress during the first 16 months postpartum was related to mental health problems in children at three years of age. Parenting stress is also positively associated with maternal symptoms of depression in the postpartum period (Leigh & Milgrom, 2008).

1.3   The mother-infant relationship

The quality of the relationship between mother and-child is important for the child's mental health (Mäntymaa et al., 2004; Pinquart, 2017a, 2017b) and development (Madigan et al., 2019; Rocha et al., 2020). For example, meta-analyses have found that parental sensitivity was positively related to the child's language skills (Madigan et al., 2019), and parenting styles were found to have a slight association with child and adolescent internalizing (Pinquart, 2017b) and externalizing symptoms (Pinquart, 2017a).

Several factors may have an impact on the mother-infant relationship. Stern and Bruschweiler-Stern (1998) argue that experiences within a mother`s own family of origin have a major impact on forming her relationship with her child. Further, maternal prenatal and postnatal symptoms of anxiety and depression are related to poorer parent-infant interaction (Hakanen et al., 2019). A recent study found that maternal history of depression and clinical depression diagnosed during pregnancy were related to reduced quality of mother-infant interaction (Bind et al., 2021). Maternal depression probably increases irritability and hostility towards the child as well as disengagement from the child (Lovejoy et al., 2000). A meta-analysis (Bernard et al., 2018) found a small negative relationship between levels of maternal depression and maternal sensitivity in the first year postpartum, and that a clinical level of depression may have a particularly negative influence on sensitivity, thus giving some support to the notion that mothers with more symptoms of depression might respond less sensitively to infants' cues than those with fewer depressive symptoms. Accordingly, parenting and qualities of the mother-infant relationship might thus mediate the possible negative impact of

maternal mental health on child development. There are some indications of this as a meta-analysis found a small effect of problematic parenting as a mediator of associations between maternal mental health difficulties and child development in studies of children 0-132 months old (Goodman et al., 2020).

1.3.1 Different constructs for measuring mothers' relationship to the infant

Clearly, the quality of parenting and the mother-child relationship is important for a healthy child development (Madigan et al., 2019; Pinquart, 2017a, 2017b; Rocha et al., 2020). There are many constructs for describing and measuring parenting and different aspects of the maternal part of the mother-child relationship. Among them, mother-child bonding concerns the emotional ties from a mother to her child (Condon & Corkindale, 1998), parental reflective functioning taps into the maternal capacity to reflect on the child's internal states (Luyten et al., 2017), and maternal confidence refers to confidence in the parenting role (Zahr, 1991). Because the parents are the stronger part in the relationship, it is important that they are confident in the caregiving role. Mothers needs to reflect upon and interpret infants' needs and signals in a reasonable and accurate manner, also referred to as parental reflective functioning (Luyten et al., 2017). Further, the quality of emotions and thoughts towards the infant are measured with the concept of bonding (Condon & Corkindale, 1998).

1.3.1.1 Maternal bonding

The quality of maternal bonding to the fetus and infant is related to important child outcomes, such as socioemotional abilities in early childhood (Cildir et al., 2019; Le Bas et al., 2019). Whereas attachment describes the child's connection to its caregiver (Bowlby, 1988), maternal-fetal/infant bonding denotes the emotional ties from a mother to the fetus/infant (Condon, 1993; Condon & Corkindale, 1998). Maternal-fetal bonding may be measured as the emotional quality of mothers' experiences towards their fetus, and the intensity of their preoccupation for their fetus (Condon, 1993). Mother-infant bonding may be measured as hostility towards the infant, maternal degree of pleasure in interacting with the infant, in addition to the quality of mothers' emotional experiences towards the infant (Condon & Corkindale, 1998). Attachment and bonding have sometimes been used interchangeably for describing the maternal-fetal/infant relationship, but some state that mother-child bonding and attachment should be distinguished, thus not treated as belonging to the same construct (Hill

& Flanagan, 2019). Bowlby also noted that *"attachment is (...) limited to behaviour normally directed towards someone conceived as better able to cope with the current situation"* (Bowlby, 1982, p. 377). With the exception of some older children taking on some caregiving aspects for a poorly functioning parent (Macfie et al., 2017), a reversal of roles between infants and their parents is unlikely.

Mother-child bonding can be measured during pregnancy with self-report questionnaires (e.g. Rossen et al., 2017). In pregnancy, parents develop an "internalized representation" of the fetus and bonding emerges to this representation (Condon, 1993). This maternal-fetal bond continues from prepartum to postpartum, where mothers bond to the infant (Doster et al., 2018; Figueiredo & Costa, 2009; Fijałkowska & Bielawska-Batorowicz, 2019; Ohara, Okada, Aleksic, et al., 2017; Petri et al., 2018). Mother-infant bonding has been found to be stable across the first year after birth (Rossen et al., 2019).

Relationship-related measures such as the quality of social support suggests a positive association with bonding during pregnancy (Alhusen et al., 2012; Condon & Corkindale, 1997; Honjo et al., 2003; Ohara, Okada, Aleksic, et al., 2017; Schmidt et al., 2016) and bonding after birth (Ohara et al., 2018). However, not all research has found significant associations between social support and maternal-fetal bonding (Dayton et al., 2019; White et al., 2008).

Maternal mental health seems intertwined with mother-child bonding. During pregnancy, mothers' symptoms of depression relate to poorer mother-fetus bonding (Figueiredo & Costa, 2009; Mako & Deak, 2014; Ohara, Okada, Aleksic, et al., 2017; Ohara, Okada, Kubota, et al., 2017; Ohoka et al., 2014; Rubertsson et al., 2015). Also, women with a major depression disorder have displayed weaker mother-fetus bonding (McFarland et al., 2011). However, some studies have not found a significant association between symptoms of depression and maternal-fetal bonding (Doster et al., 2018; Haedt & Keel, 2007; Hart & McMahon, 2006; Honjo et al., 2003). Further, the quality of maternal-fetal bonding is negatively associated with mothers' post-partum symptoms of depression and anxiety (Petri et al., 2018; Smorti et al., 2019). Moreover, maternal post-partum symptoms of depression and parenting stress are related to weakened mother-infant bonding (Behrendt et al., 2016; de Cock et al., 2017; Kasamatsu et al., 2019; Lehnig et al., 2019; Nakano et al., 2019; Ohara, Okada, Aleksic, et al., 2017; Ohara, Okada, Kubota, et al., 2017; Ohoka et al., 2014; Reck et al., 2016; Rossen et al., 2019). The quality of mother-infant bonding has also been found to

mediate the association between perception of the infant crying at six months after birth and parenting stress (Bailhache et al., 2019).

1.3.1.2 Parental reflective functioning

Reflective functioning refers to an operationalization of processes underlying mentalization (Fonagy et al., 2018; Fonagy et al., 1998), defined as "*attending to mental states in oneself and others*" (Allen et al., 2008, p. 1). Parental reflective functioning is thought to reflect this process within the parent-child relationship, i.e., the parents' capacity to reflect upon the mental states of their child and themselves (Luyten et al., 2017). There is a range of interviews and observational instruments for assessing parental reflective functioning in families with children 0-3 years old (Schiborr et al., 2013), but self-report questionnaires have also been developed for caregivers with small children (Luyten et al., 2017). Parental reflective functioning measured with the Parental Reflective Functioning Questionnaire (Luyten et al., 2017) is related to e.g., adult attachment style and parenting stress, child socio-emotional development, and measures of the parent-child relationship quality, including reduced sensitivity to infant distress in mothers with postpartum depression (Krink et al., 2018; Luyten et al., 2017; Moreira & Fonseca, 2022; Nijssens et al., 2018; Nijssens et al., 2020; Rostad & Whitaker, 2016).

1.3.1.3 Maternal confidence

Mothers who are uncertain about their practical parenting skills, reading the infant's signals, and knowing what makes their infant satisfied may find the postpartum period demanding. Thus, maternal confidence is negatively related to parenting stress (Liu et al., 2012), symptoms of depression (Rodrigues et al., 2018), maternal trait anxiety and infant regulatory problems (Matthies et al., 2017). Moreover, maternal attachment avoidance orientation, but not attachment anxiety, is also linked to less confidence in infant care in the first month after birth, and this relationship was mediated by parenting stress (Tognasso et al., 2022). On a positive note, a study on first-time mothers suggests that levels of maternal confidence increased in the first months postpartum (Kristensen et al., 2018). This may be due to mothers gradually getting to know their infant and settling into their new role as a mother.

Maternal confidence and parental reflective functioning are used as outcome measures in the study on NBO in paper 3, while bonding is used in all three papers.

1.4   Maternal vulnerability

Insecure adult attachment styles and early maladaptive schemas (EMSs) may be thought of as vulnerability and/or risk factors for relationship difficulties and mental health problems. Vulnerability and vulnerability models try to explain factors linking directly to difficulties. The concept of vulnerability is related to that of risk, which concerns the probability of having a difficulty or disorder; however, unlike a vulnerability factor, it does not involve a direct reference to what caused the difficulty. Following this line of thought, vulnerability could also be seen as risk, and thus risk has a wider scope which includes vulnerability (Ingram et al., 1998). Vulnerability is considered an *"endogenous process"* (Ingram et al., 2011, p. 30), separate from episodes of disorders considered as states (Zubin & Spring, 1977). Vulnerability is latent in individuals with no signs of disorders; it is not easy to observe (Ingram et al., 2011) and is activated by certain kinds of events. EMSs and attachment are psychological concepts, theorized with components of internal constructs and processes (Cassidy & Shaver, 2016; Young et al., 2003). Mothers' insecure attachment and EMSs may be vulnerability or risk factors for symptoms of depression, parenting stress and maternal-fetal/infant bonding difficulties. One may assume that the strains and changes in the pre- and postpartum period may activate or elevate the attachment system and EMSs, while active insecure attachment styles and EMSs and inadequate coping with them could underlie further distress and negative interpersonal outcomes (Simpson & Rholes, 2019; Young et al., 2003). Knowledge of vulnerability factors is important for understanding the development, maintenance, prevention and treatment of difficulties (Riskind & Alloy, 2006).

1.4.1   Attachment theory

Attachment theory was first developed to understand a child's orientations toward significant others when experiencing distress or needing support and has later also been expended to adults. According to Bowlby, such care-seeking orientations early in life are usually directed towards parents, and as the individual gradually becomes older they can be directed towards significant others, for example romantic partners (Bowlby, 1988). Attachment behaviors are theorized to have a central function for increasing survival by seeking protection. Thus, the

attachment system is postulated as not only important for the developing individual but also for the development of the human species (Cassidy & Shaver, 2016). The theory states that attachment behavior develops in the first year of life. This begins with the infant showing signs of discriminating its caregiver from other people in the early months of life. As the months go by, infants start to show clearer attachment behavior, such as when they are left alone by their caregiver and attempt to keep close by crying or crawling after the caregiver (Bowlby, 1982). Ainsworth and colleagues (Ainsworth et al., 2015) made a significant contribution to attachment theory by studying infants' reactions to environmental changes in a structured setting. Based on patterns of reactions to being left alone by the caregiver, being introduced to a stranger and reunion with their caregiver, infants were classified as secure or as having different types of insecurity.

Individuals' experiences with attachment figures from early in life and onwards are organized into internal working models (for a overview see; Pietromonaco & Barrett, 2000). These working models vary depending on the quality of caregiving experiences and constitute two elements: expectations of whether others can be depended on for care and help in situations of distress, and assumptions about oneself as worthy of care and one's ability to obtain care (Bowlby, 1982). With age, children gradually increase their understanding of their environment, such as knowing more about when their caregiver must leave, and situations that elicit attachment behaviors change. Although individuals become more independent with age, dependency on others is still assumed to be present in adulthood (Mikulincer & Shaver, 2016). Having had sensitive and available attachment figures during childhood will probably result in internal working models of the self as worthy of care and others as reliable persons to depend on in need (Bowlby, 1982).

1.4.1.1 Attachment in adulthood

Strong connections to a partner might not be necessary for survival in adulthood, but partners can still be a base for security. Compared with infant attachment, attachments in adult couples are assumed to be more symmetrical (Zeifman & Hazan, 2016). Although social experiences with significant others are thought to be important for attachment, this is probably an over-simplification as research also suggests that genetic factors partly explain some of the variability in adult attachment styles (for a review see Erkoreka et al., 2021).

In the 1980s, two research strands on adult attachment emerged (see Bartholomew & Shaver, 1998 for an historic perspective). Both strands are based on the work of Bowlby and Ainsworth but developed from different traditions. One strand was more psychodynamically oriented and applied an interview perspective when studying adults' *"states of mind with respect to attachment"* (Mikulincer & Shaver, 2016, p. 24). The best known measure from this tradition is the Adult Attachment Interview (Hesse, 1999). In parallel, researchers from personality and social psychology developed self-report instruments to measure adults' styles, orientations or types of attachment in adult relationships (mainly romantic relationships), with the most well-known instrument probably being the Experiences in Close Relationships questionnaire (ECR) (Brennan et al., 1998). However, the Adult Attachment Interview and the ECR probably measure different aspects of attachment as they do not correlate strongly (Roisman et al., 2007). Self-report measures of adult attachment styles (such as the ECR) tend to consist of two dimensions; *anxiety* for being alone and abandoned, and *avoidance*, which is about being uncomfortable with closeness and sharing feelings with partners (Brennan et al., 1998).

1.4.1.2   Insecure attachment as a vulnerability trait

Insecure attachment, such as strong anxious and/or avoidant attachment orientations, may be framed as a vulnerability factor (a diathesis) (Simpson & Rholes, 2012). Similar ideas are not new, as Bowlby wrote: *"my hypothesis is that the pathway followed by each developing individual and the extent to which he or she becomes resilient to stressful life events is determined to a very significant degree by the pattern of attachment he or she develops during the early years"* (Bowlby, 1988, pp. 172-173). Thus, in theory, attachment insecurity might make one prone to emotional and relational dificulties, triggered by the potential stressful transition to parenthood (Simpson & Rholes, 2019). Ingram and colleagues (2011) discussed how certain aspects must be present for a factor to be a vulnerability trait. One of those is that vulnerability traits are stable. Regarding attachment, the stability of disorganized attachment during childhood has been questioned (Granqvist et al., 2017). This is probably due to children being especially sensitive to their environment and the fact that changes may alter their attachment classification in either direction. There is some support for a continuity of attachment aspects from childhood to adulthood. For instance, a longitudinal study suggests that attachment insecurity in childhood is related to the type of emotion regulation strategies applied in conflict discussions with a romantic partner in adulthood (Girme et al.,

2021). Another longitudinal study found associations, although small in size, between early childhood caregiving experiences and adult attachment styles (Fraley et al., 2013). Moreover, there is support for some stability in attachment classification from infancy until early adulthood (Waters et al., 2000). In adulthood, romantic attachment styles are suggested to be relatively stable, although for some there may be fluctuations in styles (Cozzarelli et al., 2003; Zhang & Labouvie-Vief, 2004). Good stability of adult attachment styles has been found in first time-mothers over the two first years of motherhood (Stern et al., 2018).

1.4.1.3 The attachment system and distress

According to attachment theory, experiencing danger or threats, abandonment, separation, relational conflict, or negative emotions and cognitions can activate the attachment system. This in turn impacts attachment motivations, attachment behavior, perceptions of the situation, which, depending on individual attachment history, may result in a decrease in personal and relational well-being. This range of events from distress to reduced well-being is thought to be under the influence of individuals' working models. The internal working models also influence their partners' behavior towards them. In other words, individual differences in working models, and thus different adult attachment orientations, can result in dissimilar perceptions, experiences and behavior when the attachment system is triggered (Simpson & Rholes, 2019).

One can assume that there are several sources of stress in the transition to parenthood that might trigger or enhance activation of the attachment system, and the strategies of the attachment avoidance and anxiety dimension might be suboptimal for handling the stresses, when for example receiving and seeking social support is important (Young et al., 2019). Indeed, adult attachment anxiety and avoidance are associated with increased parenting stress in the transition to parenthood (Moe et al., 2018; Trillingsgaard et al., 2011). Another study found that especially attachment anxiety was related to parenting stress postpartum (Mazzeschi et al., 2015). Moreover, one study mainly focused on avoidant attachment in the transition to parenthood. The results suggest that parents with a higher avoidant attachment style reported less satisfying marriages and desire to become parents, and increased symptoms of depression and parenting stress (Rholes et al., 2006). According to another study, especially attachment anxiety was linked to depression symptoms in the postpartum period (Axfors et al., 2017). For adults in general, a meta-analysis found the attachment

representations "insecure-preoccupied" and "unresolved" to be associated with increased symptoms of depression (Dagan et al., 2018). Maternal adult attachment styles have also been suggested as mediators between maternal childhood adversity and parenting stress, alone (Moe et al., 2018) and with adult attachment style through maternal symptoms of depression (Madsen et al., 2022). Thus, mothers with more childhood adversity are more likely to experience parenting stress, and this relationship is mediated by adult attachment style and symptoms of depression. Previous research has not explored parenting stress as a mediator between adult attachment style and mother-infant bonding. We aimed to fill this gap in paper 2.

1.4.1.4 The attachment system and caregiving

In addition to the attachment system, a caregiving system has been proposed, which is important for parents' feelings, behavior, and thoughts in their caregiving role. The caregiving system may be enhanced or triggered by child behavior (e.g., infant crying), which leads to caregiving behavior. Just as a child's exploratory behavior might decrease when their attachment system is triggered, increased activation of a mothers' attachment system might compromise her caregiving system (Jones et al., 2015). Accordingly, individual differences in how the attachment system responds to triggers and threats affect caregiving behavior. Enhanced activation of the mother's attachment system decreases her capacity for caregiving, as her own attachment processes and needs come into focus. In order to function properly, the attachment system must also be continuously activated for monitoring and appraising the environment for attachment-relevant information. Its degree of activation is thought to depend on the individually perceived degree of stress or threats. The attachment system might also, according to theory, affect the way relationship-relevant information is acted upon generally, not only when under large threats or stresses (Jones et al., 2015; Simpson & Rholes, 2012). As mentioned, the stresses of the transition to parenthood might in theory elevate the attachment system. In addition, some parents have a non-secure attachment history and may have found that attachment behavior will not lead to successful regulation. For them, infant distress and infant attachment behavior might be perceived as a direct threat to their own attachment system, this having a potential negative influence on their caregiving behavior (Jones et al., 2015).

Importantly, adult attachment insecurity is related to sub-optimal parenting. Parents with high attachment avoidance seem to be less responsive to their own children, especially when their child is highly distressed (Edelstein et al., 2004). Furthermore, adult attachment avoidance, to a greater degree than adult attachment anxiety, was related to maternal insensitivity (Selcuk et al., 2010). However, in the same study, both adult attachment anxiety and avoidance were related to missing the child's signals (Selcuk et al., 2010). Another study observed that mothers with an avoidant attachment style were less sensitive to their child than secure mothers, but only when they were simultaneously distressed (Mills-Koonce et al., 2011). Moreover, adult attachment styles are also related to qualities of adult relationships. A meta-analysis (Li & Chan, 2012) on intimate relationships found that attachment anxiety orientation was more closely related to partner conflicts, while attachment avoidance showed a closer relationship with less support, connectedness, and satisfaction. In extreme cases, adult attachment insecurity might be related to outcomes of child maltreatment (Lo et al., 2019) and intimate partner violence (Spencer et al., 2021).

In general, the quality of mothers' intimate relationships is positively related to maternal-fetal bonding (Barone et al., 2014; Condon & Corkindale, 1997; Doster et al., 2018; Mako & Deak, 2014). Adult attachment anxiety, but not discomfort with closeness in intimate relationships, was found to be significantly related to poorer quality of maternal-fetal bonding (Mazzeschi et al., 2015). Adult attachment anxiety and avoidance both show a negative association with mother-infant bonding quality (Little & Sockol, 2020). One study found anxious and avoidant adult attachment orientations to be linked to poorer mother-infant bonding, but that only anxious attachment orientation mediated the relationship between parental bonding (memories of one's own parents' caregiving) and mother-infant bonding (Hakhmigari et al., 2021). Maternal attachment insecurity may moderate the relationship between the mother's childhood neglect and poorer mother-infant bonding (Julian et al., 2022). Several studies suggest that maternal mental health mediates the relationship between adult attachment style and poor mother-infant bonding (Hairston et al., 2018.; Handelzalts et al., 2020; Nonnenmacher et al., 2016). For example, the relationship between poor mother-infant bonding and adult attachment anxiety and avoidance have been suggested to be mediated by maternal symptoms of posttraumatic stress disorder and depression (Handelzalts et al., 2020). Poorer mother-infant bonding is related to current maternal major depression, lifetime depression, and maternal disorganized attachment style, and the association between attachment and bonding is partially mediated by depression (Nonnenmacher et al., 2016).

Some research has found a significant association between attachment style and maternal-fetal bonding, but did not find significant links between attachment styles and mother-infant bonding (Chrzan-Dętkoś & Łockiewicz, 2015), while others have demonstrated a weak association between maternal adult attachment and mother-infant bonding (van Bussel et al., 2010). Based on these mixed results, there is a need for more research on the relationship between adult attachment style and mother-infant bonding.

1.4.2 Early maladaptive schemas

Schema theory and therapy were developed out of the cognitive therapy tradition and in response to needs for therapeutic angles for treating personality problems (Young et al., 2003). Attachment theory had a profound influence on the development of schema theory (Edwards & Arntz, 2012; Rafaeli et al., 2010), especially for developing the abandonment schema, on the importance of early relationship experiences, and on schema theory`s understanding of borderline personality disorders (Young et al., 2003).

At the core of schema theory are early maladaptive schemas (EMSs) (Young et al., 2003). The schema concept has a long tradition in psychology, but is not easy to define unanimously (e.g. Fiske & Linville, 1980). In social psychology, schemas have been viewed as a cognitive structure containing knowledge about a specific social domain (Augoustinos & Innes, 1990), with information organized in abstract form (Moskowitz, 2005). Some schemas are therefore used to process information from the social world in an attempt to make the world predictable (Augoustinos & Innes, 1990). There is support for the idea that information is processed in agreement with schemas (Markus, 1977; Rogers et al., 1977). Schemas exist in many forms and may be adaptive or maladaptive for individuals. Schema theory (Young et al., 2003) focuses on schemas that are maladaptive, with a focus on those that might help to explain difficulties relating to oneself and others (such as personality disorders). These schemas are called *early* maladaptive schemas (EMS), based on the assumption that they develop in early childhood and adolescence. According to schema theory, an EMS is defined as: *"a broad, pervasive theme or pattern, comprised of memories, emotions, cognitions, and bodily sensations, regarding oneself and one`s relationships with others, developed during childhood or adolescence, elaborated throughout one`s lifetime and dysfunctional to a significant degree"* (Young et al., 2003, p. 7). Rafaeli and colleagues (2010) state that EMSs more readily assimilate new experiences, rather than accommodation of EMSs in response to

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new experiences. In other words, striving for a predictable world might explain why schemas are thought of as durable (Rafaeli et al., 2010).

The number of EMSs proposed has varied. In addition, they can be organized into EMS domains, which are collections of related EMSs. The present thesis uses the most recent list of 18 EMSs, organized into four EMS domains according to a recent revision (Bach et al., 2018). See Table 1 for the EMSs and the four EMS domains we have focused on in paper 1. EMS domain 1) Disconnection and Rejection concerns themes of expecting that one's needs for social belonging, secure attachment, love, nurturance, and spontaneity will not be frequently met (Young, 2014). Schemas are not always helpful in giving individuals experiences of a controllable world. For example, an individual with EMSs in the Disconnection and Rejection domain might predict that others are not to be trusted and that one eventually will be abandoned, which leaves one with a feeling of less control of one's environment and relationships (Young et al., 2003). The EMS domain 2) Impaired Autonomy and Performance involves assumptions about not being able to manage and function in daily life without support from others and failing in achievements. People with EMSs from the 3) Excessive Responsibility and Standards domain tend to be focused on following their own high standards at the cost of their own well-being or relationships and may feel guilty if occupied with more enjoyable activities. Lastly, individuals who score high on the EMS domain 4) Impaired Limits may have difficulty in directing themselves towards achieving goals, and in tolerating frustration and deficits in internal limits. These individuals may feel superior or entitled to privileges (Young, 2014).

Table 1

Brief descriptions of the 18 early maladaptive schemas proposed by Young et al. (2003) and their organization into four schema domains (Bach et al., 2018)

Schema domains and early maladaptive schemas	Brief descriptions
Disconnection and Rejection domain	
Emotional deprivation	Anticipating that one's emotional needs will not be met by other people.
Social isolation	An experience of being different from other people, not included in a group.
Emotional inhibition	The inclination to suppress the expression of positive and negative emotions, with a focus on reason and a struggle to interact freely with others.
Defectiveness/shame	The feeling that one is defect and assumptions that exposure of these flaws will lead to loss of respect or love from others.
Mistrust	An inclination not to trust other people's intentions, expecting to be hurt, humiliated, taken advantage or of manipulated.
Negativity/pessimism	The tendency to worry about the negative aspects of life and expecting catastrophes, while focusing less on life's positive aspects.
Impaired Autonomy and Performance domain	

Dependence/incompetence	The assumption that one has difficulty in handling everyday commitments without considerable support from others.
Failure to achieve	A persuasion that one is a failure or inadequate regarding achievements.
Subjugation	Surrender of control to other people to avoid negative reactions (e.g., negative emotional reactions from others, abandonment). This usually involves suppressing one's decisions, desires and/or emotions with a belief that one's own thoughts and feelings are not valid or important.
Abandonment	A feeling of unreliability in support and connection from important others.
Enmeshment	Excessive involvement with important others.
Vulnerability to harm	Fear that medical, emotional and/or external catastrophes will happen at any time without being able to stop them.
Excessive Responsibility and Standards domain	
Self-sacrifice	A focus on prioritizing others` needs at the expense of one's own needs.
Unrelenting standards	The belief that one must push oneself to reach one`s own high standards of performance and behavior.
Punitiveness	The belief that oneself and people around one should be disciplined for mistakes.

Impaired Limits domain	
Entitlement	A conviction of being superior to others.
Approval-seeking	A focus on seeking approval and attention from other individuals and being easily affected by other people's reactions.
Insufficient self-control	Difficulty with self-control and toleration of frustration.

Internal working models in attachment theory are similar to relational schemas (Baldwin, 1992). Riskind and Alloy (2006) argue that: *"Quite similar to schema models, these* [internal working models] *are thought to reflect the cognitive representation of relationships that have been generalized through interactions with key figures early in the individual`s life*" (Riskind & Alloy, 2006, p. 69). There are thus similarities, as both internal working models and EMSs are theorized to impact individuals' feelings, thinking and behavior regarding themselves and in relation to other people (Mikulincer & Shaver, 2016; Young et al., 2003).

Schema theory assumes that all individuals have emotional needs which may vary in strength between individuals, and that unmet emotional needs in childhood may result in the development of EMSs (Young et al., 2003). The needs proposed are for "secure attachments to others", to have "autonomy, competence, and sense of identity" and "freedom to express valid needs and emotions", to experience "spontaneity and play", and to have "realistic limits and self-control" (Young et al., 2003, p. 10). Examples of frustration of needs are abuse, emotional neglect, and receiving too much of a good thing. In addition to the importance of emotional needs, schema theory proposes emotional temperament of the individual as an important factor in the development of EMSs, but through interaction with childhood experiences (Young et al., 2003).

Schema theory makes a distinction between schemas and modes. EMSs are trait-like constructs assumed to be more or less dormant or active at a given time, and when the individual encounters situations similar to those that led to their development, the EMSs

become more present and the individual may experience negative emotions or altered emotional states (van Genderen et al., 2012; Young et al., 2003). Modes are transient states and refer to the *"predominant emotional state, schemas, and coping reactions that are active for an individual at a particular time"* (Rafaeli et al., 2010, p. 47). People develop different responses and coping styles to the activated schemas. In childhood these responses might be useful in helping the child cope with a situation, but these responses and coping styles are usually not adaptive in adulthood. Three types of maladaptive coping styles have been theorized: 1) surrender, 2) avoidance, and 3) overcompensation (Young et al., 2003). Recently, the first and third coping styles have been proposed to be re-labeled as resignation and inversion, respectively (Arntz et al., 2021). The coping styles are not necessarily used consistently but may vary between situations. In the first coping style, resignation (surrender), the individual accepts the schema as a truth, experiences all the pain from the triggered schema and behaves according to it. With the second coping style, avoidance, the individual attempts to live in such a way as to avoid schema-triggering situations and schema-related feelings and uses distractions when potentially schema-triggering threatening thoughts and images emerge. In the last coping style, inversion (overcompensation), individuals attempt to deal with maladaptive schemas by behaving, thinking, and feeling in the opposite direction of the schema. This is not an easy coping strategy, and individuals may seem self-confident, but within themselves they feel the schema pressing to influence them (Arntz et al., 2021; Young et al., 2003).

In support of schema theory, a meta-analysis (Pilkington et al., 2020) suggests a relationship between toxic experiences in childhood and EMSs. Research has found EMSs to be associated with mental health problems (Thimm & Chang, 2022). A recent meta-analysis suggests that there is a positive relationship (with small to large effect sizes) between EMSs and depression (Bishop et al., 2022). In line with viewing EMSs as vulnerability traits, EMSs have been found to be relatively stable over time (Wang et al., 2010), also through the major life transition of having a baby (Blissett & Farrow, 2007). Moreover, EMSs may be triggered by stressful life events, such as the transition to parenthood period may be, which could lead to symptoms of depression. Further, EMSs may be related to stress generation which in turn affects symptoms of depression (Cámara & Calvete, 2012; Eberhart et al., 2011; Zhu et al., 2016). Further, a meta-analysis found EMS`s to have a small to moderate positive relationship with interpersonal difficulties (Janovsky et al., 2020). Several of the EMSs are also positively associated with attachment styles (Karantzas et al., 2022). There is also a link between

maternal EMSs and the child's feeding problems (Blissett et al., 2005; Farrow & Blissett, 2006). In general, research on EMSs in mothers is scarce, and research on maternal EMSs in relation to maternal-fetal/infant bonding is lacking. Taken together, the association between EMSs and mental health, relationship difficulties and adult attachment styles suggests that EMSs may be of importance for maternal mental health and the maternal-fetal/infant relationship in the transition to parenthood.

1.5   The Newborn Behavioral Observation

The NBO is an intervention developed to enhance parents' understanding of their infant's temperament and capacities and has the potential to give parents a positive start early in parenthood. The intervention can be used for all families or for families with more fragile infants, such as prematurity. The NBO takes 15 to 40 minutes to administer and can be used from birth until three months after birth. The system consists of 18 reflex and behavioral elements, where the newborn's motor, state, interactive and physiological capacities are observed. Among these are observations of habituation abilities to light and sound, and of being soothed, ability to stay awake, amount of motor activity and stress responses. Thus, the infant's individuality is recognized, and the NBO describes its capacities to the parents, thereby creating a picture of the strengths and challenges of their unique infant. Clinicians administrating the NBO are sensitive to parents' perspectives and the major transition they might experience in having an baby and their potential struggles to achieve a good match with their baby. Further, the observations are adapted to the family's needs and the newborn's states; thus, the sequence of the observation items and the length of sessions may vary. The clinician and parent(s) recognize areas where the infant needs support and ways the parents can provide this. In demonstrating the infant's capacities, the NBO also aims at enhancing the mother-infant relationship by improving the bonding quality (Nugent et al., 2007). A feeling of success in reading, regulating and connection with the child will probably enhance the sense of competence as a parent and reduce stress and symptoms of depression in the parent.

The NBO evolved from the Neonatal Behavioral Assessment Scale (NBAS, Brazelton & Nugent, 1995) tradition but diverts in focusing on observation and building relationships instead of diagnostic assessment and evaluation of newborn's behaviors. Important theoretical assumptions of the NBO are that infants are born with capabilities that pave the way for responding to their environment. The acknowledgement of different behavioral states is also

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important as is the notion that regulation of states is central in the first months of life (Nugent et al., 2007). Infants need to obtain regulation in *"the physiological or automatic system… motor and state behavioral dimensions, and … the affective interactive (responsivity) behavioral dimension …"* (Nugent et al., 2008, p. 257). Behavioral states observed in infants usually involve six categories: crying, alert and active, quiet and alert, drowsy, light sleep and deep sleep (Brazelton & Nugent, 1995). Achieving regulation is important for infants to start engaging socially with their caregivers (Brazelton & Als, 1979). Thus an important task for caregivers is to aid the regulation of states (Nugent et al., 2007; Winberg, 2005) and this is an important aspect when administering the NBO. Sound caregiving promotes the infant's own capacity to self-regulate (Nugent et al., 2007). In a longer perspective, the capacity to self-regulate is important for healthy development, such as in relation to less externalizing behavior (Eisenberg et al., 2001; Gartstein et al., 2012) and higher academic achievements (Sektnan et al., 2010).

In general, research on parenting interventions for parents with infants has yielded mixed results. A meta-analysis based on seven studies testing parenting interventions against the parent-infant relationship in mothers with major depression, or with symptoms of depression above threshold on a screening instrument (Rayce et al., 2020), did not find support for an effect of the interventions on the parent-infant relationship or child development. Another meta-analysis focused on the effects of parenting interventions for at-risk parents with infants. The results suggest an effect of parenting interventions for the parent child-relationship and maternal sensitivity. However, there was no effect on child internalizing and externalizing behavior, child cognitive development, or long-term effects on child behavior (Rayce et al., 2017).

A Cochrane review from 2018 concluded that the included studies on the NBO were of low quality (Barlow et al., 2018). Among studies in the review, receiving the NBO in selected families was related to reduced symptoms of depression in mothers (Nugent et al., 2014) and factors of the parent-infant relationship (McManus & Nugent, 2014; Nugent et al., 2017). A pilot study from 2020 on at-risk infants showed that compared to usual care, receiving the NBO was associated with healthy infant development and fewer symptoms of depression in caregivers up to six months post-enrolment (McManus et al., 2020). A recent study on first-time mothers with symptoms of anxiety or depression, or with a history of mental illness, found positive effects of the NBO on maternal relationship quality and distress compared with treatment as usual (Nicolson et al., 2022). Research into the NBO is limited,

but knowledge to date might indicate greater effectiveness of the NBO in selected families (e.g., primiparous mothers or infants at risk) as opposed to its use in a universal setting. Moreover, research on other populations (children and adolescents) suggests that selective and indicated preventive interventions have larger effects on symptoms of depression than universal interventions (Horowitz & Garber, 2006). A recent study on the NBO as a universal program in Denmark did not find a significant association with self-reported increased maternal confidence, better mood, quality of the mother-infant relationship, or infant socio-emotional behavior. However, mothers in the NBO group reported greater knowledge of parenting than in the control group, e.g., about infants' communication skills and how to sooth the infant (Kristensen et al., 2020). Results from a small feasibility study in Norway also indicate that parents gained greater perceived understanding of their infant's behavior and the parent-infant relationship from the NBO intervention (Greve et al., 2018). These results are in line with a study reporting more knowledge of infant self-regulation among health workers trained in the NBO than in a comparison group (Kristensen et al., 2019). However, there is a need for more studies on the effectiveness of the NBO, also in a general population setting.

2   Research aims and objectives

The overall aim of the present thesis was to increase knowledge of mothers' well-being and relationship to their fetus/infant during pregnancy and until four months postpartum. Adult attachment style and EMSs seem to have the potential to relate to maternal symptoms of depression, parenting stress and aspects of the mother's relationship to the fetus/infant in the period of transition to parenthood. EMSs are related to symptoms of depression (Bishop et al., 2022) and relationship problems (Janovsky et al., 2020). To my knowledge, no studies have investigated EMSs with regard to maternal-fetal bonding and maternal perinatal symptoms of depression, but research has explored EMSs with regard to infant feeding difficulties (Blissett et al., 2005; Farrow & Blissett, 2006). The disconnection and rejection domain concerns assumptions that needs for security and nurturance will not be met, and a tendency to suppress emotions and find it difficult to relate freely to others. Individuals scoring high on this domain will according to theory have childhood experiences of coldness, rejection and unpredictability (Young et al., 2003). Thus, this domain involves one's view of oneself and important others in relationships and might be particularly influential in leading to poorer

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quality of maternal-fetal bonding. Adult attachment styles have previously been studied in relation to parenting stress (Moe et al., 2018; Trillingsgaard et al., 2011), maternal mental health, and mother-infant bonding in the postpartum period (Hairston et al., 2018; Handelzalts et al., 2020; Nonnenmacher et al., 2016). Further, no previous study has explored parenting stress as a mediator between adult attachment style and mother-infant bonding.

Moreover, the NBO seems to have the potential to have a positive influence on maternal symptoms of depression, parenting stress and aspects of mother's relationship to the infant. A few studies have investigated the effectiveness of the NBO on maternal symptoms of depression and aspects of the mother-infant relationship (Barlow et al., 2018; McManus et al., 2020). At the commencement of this study, no studies had investigated the effectiveness of the NBO on our range of outcome measures in a sample of relatively well-functioning mothers. Thus, there was a gap in the research literature of studies on the effectiveness of the NBO, especially in a general population setting.

In this thesis, I investigated whether mothers` EMSs would predict maternal-fetal bonding quality during pregnancy (paper 1), whether attachment style would be associated with mother-infant bonding quality after birth (paper 2), and if these relations were mediated by symptoms of depression (paper 1) and parenting stress (paper 2). EMSs and anxious and avoidant attachment styles may be thought of as vulnerability factors for these relationships. In addition, we wanted to investigate whether a short intervention, the NBO, was associated with better maternal well-being postpartum, the quality of the mother's relationship to the infant, and mothers' experiences of postpartum follow-up care. Specifically, our objectives were:

1. To examine the association between mothers` EMSs and maternal-fetal bonding during pregnancy. Further, when controlling for demographic information and mental health history, to examine EMSs as predictors of maternal-fetal bonding quality. We hypothesized that the EMS domain disconnection and dejection would show a negative association with maternal-fetal bonding. Further, as EMSs are seen as encompassing emotions and cognitions about oneself and one's relationships (Young et al., 2003), we also hypothesized that EMS domains in general relate more to the qualitative experience of bonding than to the intensity and amount of time thinking and talking about the fetus. Lastly, to explore symptoms of depression as a mediator between the relationship between EMSs and maternal-fetal bonding (paper 1).

2. To explore the association between mothers` attachment styles and the quality of mother-infant bonding around six weeks postpartum. Further, to explore parenting stress as a mediator of the association between adult attachment style and mother-infant bonding (paper 2). As in paper 1 we controlled for demographic factors and mental health history in the hierarchical regression analysis and mediation analyses.

3. To evaluate the NBO as a universal preventive intervention within regular well-baby clinic services. We investigated whether receiving the NBO was associated with maternal symptoms of depression and parenting stress, mother-infant bonding, maternal confidence, reflective functioning, and satisfaction with and benefit from postpartum follow-up care (paper 3). We hypothesized that receiving the NBO would relate to decreased maternal symptoms of depression and reduced parenting stress, in addition to stronger mother-infant bonding and higher levels of reflective functioning and maternal confidence in the parenting role. Lastly, we hypothesized that the NBO would be associated with higher satisfaction with and benefit from postpartum follow-up care.
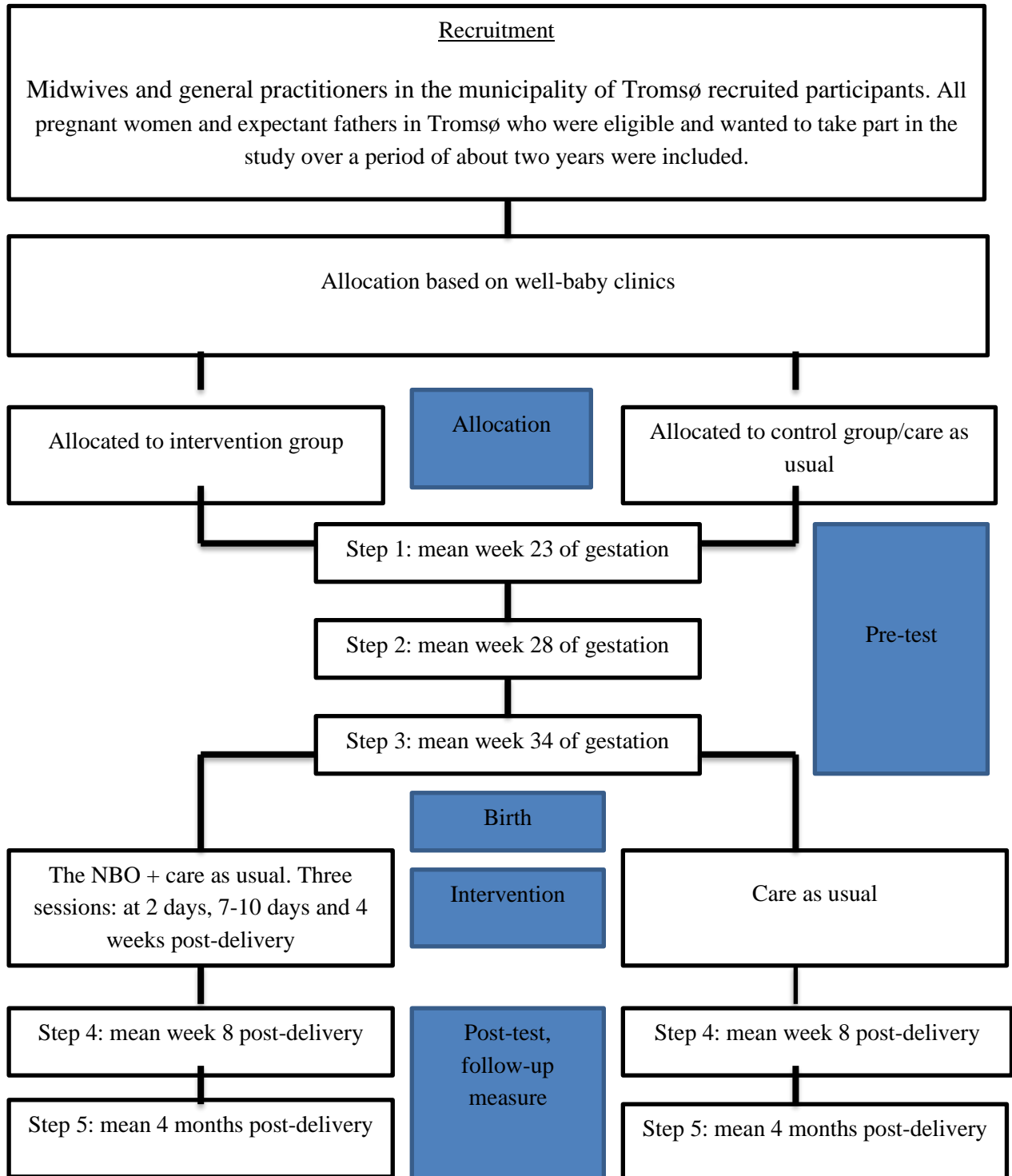
3 Methods

3.1 Design

The papers in this thesis were written based on data from the Northern Babies Longitudinal Study (NorBaby) (Høifødt et al., 2017). The NorBaby study is a longitudinal observational study with an intervention. The observational part of the study is designed as a prospective cohort study, while the intervention study has a non-randomized cluster-controlled design. Paper 1 examines the relationship between EMSs, symptoms of depression and maternal-fetal bonding, and paper 2 explores the relationship between adult attachment style, parenting stress and mother-infant bonding. Paper 3 differs from the other two papers by evaluating the association between the NBO intervention and parenting stress, symptoms of depression, mother-infant bonding, parental reflective functioning, and maternal confidence. In the intervention study, we compared a group of participants receiving up to three NBO sessions in addition to care as usual in the first four weeks after birth with a control group receiving only care as usual. The NorBaby study assessment was performed at six time points: three before birth and three after birth until around six months postpartum. In this thesis, I have only used data from the five first time points and from a subset of the NorBaby study assessments battery. See Figure 2 for flow diagram of the study until T5.

Figure 2

Flow diagram of design

Recruitment		
Midwives and general practitioners in the municipality of Tromsø recruited participants. All pregnant women and expectant fathers in Tromsø who were eligible and wanted to take part in the study over a period of about two years were included.		

Allocation based on well-baby clinics

Allocated to intervention group	**Allocation**	Allocated to control group/care as usual

Step 1: mean week 23 of gestation

Step 2: mean week 28 of gestation

Step 3: mean week 34 of gestation

Pre-test

Birth

The NBO + care as usual. Three sessions: at 2 days, 7-10 days and 4 weeks post-delivery	**Intervention**	Care as usual

Step 4: mean week 8 post-delivery	**Post-test, follow-up measure**	Step 4: mean week 8 post-delivery
Step 5: mean 4 months post-delivery		Step 5: mean 4 months post-delivery

3.2 Participants and recruitment procedure

Between October 2015 and December 2017, 220 pregnant women and 130 partners were recruited to the NorBaby study. Thus, 220 pregnant women responded to T1, while 185 responded to T2, 197 to T3, 185 to T4 and 170 to T5. All Norwegian-speaking pregnant women and their partners living in the municipality of Tromsø were eligible for inclusion in the study. We originally planned to recruit all participants in gestational week 16 (T1), but after study start we increased the span in weeks to enable T1 to include more participants. This also resulted in extension of the other measurement time points due to delayed responses from participants.

To recruit participants, we used different channels to inform the public about the study. The project was marketed on posters hung up at different locations in Tromsø. For those interested in more information or in participating in the study, contact details of the research team was available on the posters. We also contacted the surgeries of general practitioners for assistance in distributing written information and the contact details of the research team to pregnant women. It is uncertain how many surgeries actually distributed the study information. Written study information was also given to pregnant women at their ultrasound examination in the University Hospital of North-Norway around gestational week 18. Moreover, midwives in Tromsø recruited most of the participants by handing out written information about the study to pregnant women during a regular pregnancy consultation. Pregnant women at their ultrasound examination or pregnancy consultation who wanted more information about the study left their contact details in a locked box in the waiting room. A member of the research team phoned all the potential participants around a week later and gave them further information about the study. During the phone call, we encouraged the women to ask their partners if they were also interested in participating in the study. For interested participants, we agreed on a time for a face-to-face meeting where we gave further information about study participation and enrolled the pregnant women and partners who wanted to participate. For more information about the NorBaby study, see the protocol article (Høifødt et al., 2017).

3.3 Demographics

Sample demographics of the 220 participants are presented in Table 2.

Table 2

Sample demographics

Characteristics at T1	Mean (SD)	N (%)
Maternal age (years)	31.1 (4.22)	
Marital status		
Married or cohabiting		213 (96.8)
Single		7 (3.2)
Education[a]		
Upper secondary school or less		32 (14.5)
Up to 4 years of higher education		66 (30.0)
4 or more years of education		121 (55.0)
Employment status before pregnancy[a]		
Full-time		183 (83.2)
Part-time		6 (2.8)
Student		22 (10.0)
Homemaker		1 (0.5)
Unemployed		2 (0.9)
Sick leave or benefits		5 (2.3)
Family income[b]		
350,000 NOK (35,398 USD) or less		11 (5.0)
351,000-750,000 NOK (35,499-75,853 USD)		62 (28.2)
751,000 NOK (75,954 USD) or more		145 (65.9)
Pregnancy wanted[c]		

Yes	209 (95.0)
No	3 (1.4)
Do not know	4 (1.8)
Parenting experience	
First-time mother	108 (49.1)
Second-time mother	91 (41.4)
Two or more pervious children	21 (9.6)
Maternal mental health history	
History of contact with professionals for mental health issues	70 (31.8)
Previous experience with being depressed most of the day, almost every day for a period of 2 weeks	72 (32.7)
History of diminished ability to enjoy things one has usually found enjoyable for a period of two weeks	90 (40.9)

Note. N = 216-220, [a]one missing value, [b]two missing values, [c]four missing values

3.4   An overview of time points in papers 1, 2 and 3

Measures for papers 1 and 2 are described in section 3.5, while measures for paper 3 are presented in section 3.7. See Table 3 for information about when responses were provided at the different time points in papers 1-3.

Table 3

Time range for answering the time points

	T1	T2	T3	T4	T5
Paper 1	13-30 (mean week 22.3)	24-37 (mean week 28.3)	31-41 (mean week 34.2)		
Paper 2	13-34 (mean week 23.0)		31-41 (mean week 34.3)	5-15 (mean week 8.0)	
Paper 3	13-39 (mean week 23.0)			5-15 (mean week 8.1)	3-9 (mean month 4.4)

Note. T1-3 in gestational weeks, T4 in weeks after birth, and T5 in moths after birth.

3.5 Measures for papers 1 and 2

For papers 1 and 2 we collected demographic information and measured maternal symptoms of depression, parenting stress, maternal-fetal/infant bonding, adult attachment style and early maladaptive schemas (EMSs). All measures were self-reported and collected via an online survey (the NTNU Survey), either during a meeting with a member of the research team (T1) or alone from home (T2-T4).

3.5.1 Demographics and health information for papers 1 and 2

Demographic information was collected at T1 and included maternal age, educational level, employment status before pregnancy, household income, marital status, previous births and whether the pregnancy was wanted. Participants also answered three questions about their mental health. More specifically, 1) whether they had been in contact with professionals for mental health problems, 2) whether they had previously experienced felt depressed most of the day and almost every day for a period of two weeks, and 3) whether they had diminished ability to enjoy the things they usually find enjoyable for a period for two weeks. We also included data from a question at T3 about having undergone ultrasound tests during their current pregnancy (paper 1 only). We also determined the rate of premature birth, defined as being born more than three weeks before the due date, by calculating the difference between the mothers' reported due date and the day of birth (paper 2 only).

3.5.2 Maternal symptoms of depression and stress

3.5.2.1 Symptoms of depression

Symptoms of depression were measured with the Edinburgh Postnatal Depression Scale (EPDS; Cox et al., 1987). The EPDS was designed for use as a screening instrument for depression in the post-partum period but has also been used as a measure of depression during pregnancy (e.g. Alvarado et al., 2015; Rubertsson et al., 2011; Vázquez & Míguez, 2019). In addition to depression symptoms, the scale probably also measures anxiety symptoms (Brouwers et al., 2001; Swalm et al., 2010). The self-report inventory consists of ten items, where each item is scored on a four-point scale from 0 to 3. Higher scores indicate more depression symptoms. The scale has been validated on a Norwegian sample (Berle et al., 2003).

A total score of 10 (Eberhard-Gran et al., 2001) and 12 (Berle et al., 2003) has in Norwegian samples been recommended as a cut-off for probable clinical depression, whereas others recommend 13 as the cut-off for probable major depression (Cox et al., 1987; Matthey et al., 2006). A recent study on a Danish population suggests a cut-off score of 11 as optimal for detecting depression according to the criteria of DSM-5 and ICD-10 (Smith-Nielsen et al., 2018). A Swedish study suggested 13 points as cut-off for detecting depression in women during pregnancy (Rubertsson et al., 2011). The EPDS was measured at T3 in paper 1, with a Cronbach's alpha of .88.

3.5.2.2 Parenting stress

Parenting stress was measured using the Parenting Stress Index (PSI; Abidin, 1995), 3rd edition. The PSI is a self-report inventory covering stress in life and the parenting role and parents' perceptions of their child's behavior. The development of the PSI was driven by theorizing that the stressed parent's experiences are a composite of certain characteristics of both child and parent, and aspects of the situation of being a parent. The instrument consists of 101 items divided into two domains; the Child Domain (CD) (47 items), and the Parent Domain (PD) (54 items).

The PD consists of seven subscales. The subscales of Competence (PSI-CO; 13 items) and Depression (PSI-DP; 9 items) are assumed to be related to the parent's personality and

pathology and are theorized to be directly related to the Attachment subscale (parent-child bonding) (PSI-AT; 7 items). The last four subscales are assumed to be situational: Isolation (PSI-IS; 6 items), Health (PSI-HE; 5 items), Role Restriction (PSI-RO; 7 items), and (support from) Spouse (PSI-SP; 7 items) (Abidin, 1995). Since PSI-AT resembles the outcome measure of paper 2 (MPAS) and PSI-HE was not considered relevant, we created a reduced PSI-PD5 with the remaining five subscales. The remaining five subscales, PSI-DP, PSI-IS, PSI-RO, PSI-SP and PSI-CO were in addition to PSI-PD and PSI-PD5 used as measures in paper 2.

The current version of PSI was translated to Norwegian by Professor Jon Rønning. Hogrefe (Hogrefe) gave permission to use the PSI in the NorBaby study (Høifødt et al., 2017). Abidin (1995) reports a high degree of internal reliability for CD and PD, and acceptable to good internal consistency for the subscales. Studies of the Norwegian version of the PSI provide support for good internal consistency of the CD and PD (Glavin et al., 2010; Siqveland et al., 2013). Fewer studies have included the subscales, but a study from Hong Kong found good internal consistency for the CD and PD, while the internal consistencies for the subscales ranged from unacceptable to good (Tam et al., 1994). A study on the French version of the PSI provides support for the validity of the PD and CD (Bigras et al., 1996). We used the PD (T4) as a mediator in paper 2. In paper 2, Cronbach's alpha was .91 for PSI-PD, .90 for PSI-PD5, .77 for PSI-CO, .73 for PSI-IS, .64 for PSI-SP, .81 for PSI-DP and .71 for PSI-RO.

3.5.3 Maternal fetal and infant bonding

3.5.3.1 Maternal-fetal bonding

Maternal-fetal bonding was measured with the self-report inventory Maternal Antenatal Attachment Scale (MAAS; Condon, 1993). The MAAS consists of 19 items, where each item has individual response options on a five-point Likert scale. Examples are from "Very weak or non-existing" to "Very strong", or from "A real little person with special characteristics" to "A thing not really alive". Eleven items are reversed scored, and higher scores indicate higher bonding. The inventory can be used as a global scale (19 items), or as two subscales: 1) quality of maternal bonding (QMB; 10 items), and 2) intensity of preoccupation with the fetus (IPF; 8 items). One item was excluded from the subscales as this was recommended in the guidelines from the author of the scales (Condon, 2015a). QMB measures the quality of the

affective bond towards the unborn child, anticipation of meeting the child, and representations of the fetus. IPF measures the amount of time pregnant women think about and talk to the fetus, in addition to the intensity of their feelings in this period (Condon, 1993).

The MAAS total scale and subscales have been found to be valid and reliable measures of maternal-fetal bonding in studies from Belgium (Johan CH van Bussel et al., 2010) and Hungary (Mako & Deak, 2014). Although an Italian study found good and acceptable values of internal consistency for the global subscale and the IPF subscale, the QMB subscale revealed poor internal consistency (Busonera et al., 2016). Further, factor analyses mainly supported the two-factor solution suggested by Condon (Condon, 1993), but four items showed a poorer fit (Busonera et al., 2016). We did not find a Norwegian version of the MAAS. Therefore, Professor Catharina E A Wang and I translated the English version of the inventory to Norwegian and discussed the translation with a professional translator, Paul Farmer, until we were satisfied with the translation. In paper 1 only the subscales of the MAAS were used, and the MAAS was measured at T3. Cronbach's alpha was .79 for QMB and .77 for IPF.

3.5.3.2   Mother-infant bonding

Mother-infant bonding was measured with the self-report inventory Maternal Postnatal Attachment Scale (MPAS; Condon & Corkindale, 1998). The MPAS consists of 19 items, answered on Likert scales with unequal numbers of response options: 2 options (2 items), 3 options (1 item), 4 options (10 items), and 5 options (6 items). Examples are from "Feel very guilty that I am not more involved" to "I don`t have any guilty feelings regarding this", and from "I usually try to prolong the time I spend with him/her" to "I usually try to shorten the time I spend with him/her". Eight items were reversed scored, and, to ensure equal weighting, response options from all items were recoded in such a way that a score of 1 represented low bonding and 5 represented high bonding (Condon, 2015b). For example, an item with four response options was recoded to 1; 2.3; 3.6; and 5.

In addition to a global scale (19 items), the measure consists of three subscales: 1) Quality of attachment (9 items), 2) Absence of hostility (5 items), and 3) Pleasure in interaction (5 items). To limit the number of variables in the statistical tests and to simplify the papers we only used the global scale. The original study on MPAS found acceptable

internal consistency for the global scale (Condon & Corkindale, 1998), as did a study of the Italian version of the MPAS (Scopesi et al., 2004). A study from Belgium found acceptable internal consistency for the global scale 8-12 weeks postpartum, but questionable internal consistency 20-25 weeks postpartum (J. C. van Bussel et al., 2010). As with MAAS, we did not find a Norwegian version of the MPAS. The same procedure was applied for translating MPAS. MPAS was measured at T4 (paper 2), with a Cronbach's alpha of .81.

3.5.4 Maternal vulnerability

3.5.4.1 Early maladaptive schemas

Early maladaptive schemas (EMSs) were measured with the self-report instrument the Young Schema Questionnaire Short Form 3 (YSQ-S3; Young & Brown, 2005). All 90 items of the YSQ-S3 are answered on a six-point Likert scale ranging from "Completely untrue to me" (1) to "Describes me perfectly" (6). The items can be organized into schemas or schema domains. Schema domains are collections of related schemas. For paper 1 we used domains and a recent organization of four schema domains, see Table 1 (Bach et al., 2018): 1) Disconnection and Rejection (30 items), 2) Impaired Autonomy and Performance (30 items), 3) Excessive Responsibility and Standards (15 items), and 4) Impaired Limits (15 items).

The current Norwegian version of YSQ-S3 has been used in previous studies (Thimm, 2017). The YSQ-S3 is a frequently used questionnaire and has been found to be a valid and reliable instrument in studies from e.g., Denmark (Bach et al., 2015), Germany (Kriston et al., 2013), Korea (Lee et al., 2015), France (Bouvard et al., 2018), and India (Jain & Singh, 2019). YSQ-S3 was measured at T3. In paper 1, Cronbach's alpha was .94 for Disconnection and Rejection, .92 for Impaired Autonomy and Performance, .87 for Excessive Responsibility and Standards, and .83 for Impaired Limits, thus showing acceptable internal consistency.

3.5.4.2 Adult attachment style

We assessed adult attachment style with the self-report instrument Experiences in Close Relationships (ECR; Brennan et al., 1998). ECR consists of 36 items and measures individuals' experiences in close relationships during adulthood, with several questions on experiences in intimate relationships. From the items, two dimensions of attachment are calculated: attachment avoidance (18 items) and attachment anxiety (18 items). All items are

answered on a seven-point scale from "Disagree strongly" (1) to "Agree strongly" (7). Avoidance concerns the degree of discomfort with closeness and dependency, and anxiety reflects fears of rejection and a strong wish for close contact with the partner (Brennan et al., 1998).

The ECR is a well-validated instrument, with research suggesting good reliability and validity in samples from e.g., America, Spain (Alonso-Arbiol et al., 2008), and Japan (Nakao & Kato, 2004). A meta-analysis found the overall internal reliability of the ECR to be high, but the reliability could vary with the characteristics of the sample (Graham & Unterschute, 2015). The present Norwegian version of ECR has been used in previous research (Moe et al., 2018), and a population-based study in Norway found the ECR to have satisfactory psychometric properties (Olssøn et al., 2010). ECR was measured at T3 (paper 2). In paper 2, Cronbach's alpha was .90 for ECR avoidance and .91 for ECR anxiety.

3.6   The intervention: The Newborn Behavioral Observation system

The NBO (Nugent et al., 2007) intervention and research on the NBO are described in the introduction under 1.6 and will not be further described in this section. Here the procedure for using the NBO in this study will be described, including a description of the training of the midwives and public health nurses in the NBO intervention.

We wanted to administer three NBO sessions to the families in the intervention group: one in the maternity ward and two after discharge from hospital (see 3.1. for design of the intervention part of the study). In Tromsø, the area of recruitment, there are five well-baby clinics. The mothers' home address decides which well-baby clinics they belong to. Participants whose local well-baby clinic had nurses trained in the NBO were allocated to the intervention group, while the remainder were allocated to the comparison group. We were concerned about contagion effects between the nurses if only some of the nurses at a well-baby clinic were trained in the NBO, thus it was decided to train all the nurses at the clinic in the NBO. At study commencement, it was only practical to train the public health nurses at one well-baby clinic and participants belonging to that well-baby clinic were enrolled in the group receiving the NBO plus regular care. During the course of the study some of the nurses from the original NBO well-baby clinic moved to other well-baby clinics in Tromsø. We therefore decided to extend the NBO intervention and training in

the intervention to three well-baby clinics. This made it possible to increase the size of the NBO group. Participants belonging to the rest of the well-baby clinics were enrolled in the "usual care group". To inform the healthcare workers which group the mothers belonged to, the mothers' health cards were marked for those belonging to the NBO group. Moreover, we sent lists to the maternity ward and the well-baby clinics to inform about participation in the study and joining the NBO group.

For the families in the intervention group, the NBO was given as an additional component to care as usual. The first NBO session was given at the maternity ward within two days of the birth by a midwife certified in the NBO. The second session took place 7-10 days after birth at the routine home visit by a nurse certified in the NBO. The third session also took place with a certified nurse at the well-baby clinic four weeks after birth (in addition to usual care visits). Care as usual was provided to the comparison group in the maternity ward, at the home visit 7-10 days after birth and at the first regular meeting with a nurse at the well-baby clinic six weeks after birth. Thus, the NBO group received an extra consultation at four weeks postpartum with a health care worker, which the comparison group did not receive. According to the Norwegian Directorate of Health (2017) care as usual includes a focus on areas such as like social interaction, parents' life situation and mental health, feeding, sleeping, motor development, crying and caring for the baby.

The midwives and nurses filled out logs after each NBO session. The logs were important to track if the NBO had been administered to the participants and included information about who were present and which NBO observation elements were administered. Based on communication with the health care workers, we have indications that it took some time after study start before they routinely filled out the logs. Thus, it is likely that the number of NBO sessions given was greater as health care workers probably gave some NBO sessions without keeping logs. The logs show that 7.6% of the mothers in the intervention group received 1 NBO session, 33.7% received 2 NBO sessions and 43.5 % received 3 NBO sessions. Thus, at least 84.8% were given at least one NBO session. According to the logs, 15.2% of mothers in the intervention group did not have an NBO session.

The midwives and nurses who were to administer the NBO in this study received the following training. They attended a two-day introductory course on the NBO, followed by self-practice for six weeks, one day of supervision in groups with feedback on films of their

own NBO session, another six weeks of self-practice and one day of supervision with films of their own NBO practice. The NBO was thereafter practiced in daily work for approximately six months before the final supervision and experience seminar. Lastly, the participants completed five certification NBOs and a summary note and received written feedback from the parents.

3.7 Measures for paper 3

The outcome measures of interest for paper 3 were of symptoms of depression, parenting stress, parental reflective functioning, mother-infant bonding, confidence in the parenting role, and maternal experience of follow-up care after birth. Responses on the measures were given in an online survey (the NTNU Survey), either during a meeting with a member of the research team (T1) or alone from home (T4-T5).

3.7.1 Demographics and health information for paper 3

Demographic information was collected at T1 and included maternal age, educational level, household income, employment status before pregnancy, whether the pregnancy was wanted and previous births. Participants answered three questions about their mental health (see section 3.5.1 for more information). They also answered two questions on their physical health: first, whether they had pregnancy-related health problems; second, whether they had other physical health problems. In addition, participants answered four questions concerning social support. First, whether their family could help them when they needed it. Second, whether their friends could help them as needed. Third, whether they could confide in their family members. Fourthly, whether they could confide in friends.

3.7.2 Pre-intervention measures for paper 3

To aid our description of characteristics of the sample and pre-intervention group differences, we also included the following four self-report instruments in paper 3. To measure maternal-fetal bonding we included the MAAS (Condon, 1993) (see 3.5.3.1 for a description) from T3. The remaining three pre-intervention instruments we included were measured at T1 and will be described in brief here.

The ten-item Pregnancy-Related Anxiety Questionnaire-Revised (PRAQ-R; Huizink et al., 2004) measures anxiety of giving birth, one`s appearance related to pregnancy, and fears related to the child`s health.

The ten-item Adverse Childhood Experiences (ACE; Felitti et al., 1998) measures abuse (emotional, sexual and physical) and household dysfunction during the mother`s childhood and adolescence.

The 21-item Beck Depression Inventory-II (BDI-II; Beck et al., 1996) was used to measure depressive symptoms during the past two weeks.

3.7.3 Post-intervention measures for paper 3

3.7.3.1 Maternal symptoms of depression

Symptoms of depression were measured with the Edinburgh Postnatal Depression Scale (EPDS; Cox et al., 1987). See section 3.3.2.1 for a description. The EPDS was an outcome measure for paper 3 and was applied as a continuous scale, with data from the time points T1, T4 and T5. In paper 3, Cronbach's alpha for the EPDS for the NBO group and comparison group combined was 0.79 (T4) and 0.82 (T5). Cronbach's alpha for the NBO-group was 0.78 (T4) and 0.84 (T5). Cronbach's alpha for the comparison group was .80 (T4) and .80 (T5).

3.7.3.2 Maternal stress

Parenting stress was measured with the Parenting Stress Index (PSI; Abidin, 1995), $3^{rd.}$ edition. We used the CD (T5) and PD (T4 and T5) as outcome measures. The PSI and PD are described in section 3.5.2.2. The CD consists of six subscales, four of which are assumed to be related to child temperament: Distractibility/Hyperactivity (9 items), Adaptability (11 items), Demandingness (9 items), and Mood (5 items). The last two subscales Acceptability (7 items) and Reinforces Parent (6 items) are more relationship-related as they measure the degree of acceptance of the child and the parents' experience of being reinforced by interacting with their child. In paper 3, Cronbach's alpha for the PSI-PD for the NBO group and comparison group combined was .92 (T4) and .92 (T5). Cronbach's alpha for the PSI-PD for the NBO-group was .90 (T4) and .91 (T5), while for the comparison group it was .92 (T4) and .93 (T5). Cronbach's alpha for the PSI-CD for the NBO group and comparison group

combined was .89 (T5). Cronbach's alpha for the PSI-CD for the NBO group was .85 (T5), while for the comparison group it was .91 (T5). These results thus, show acceptable internal consistency.

3.7.4 Measures of the mother's relationship to the infant

3.7.4.1 Mother-infant bonding

We measured mother-infant bonding with the self-report inventory Maternal Postnatal Attachment Scale (MPAS; Condon & Corkindale, 1998) as an outcome measure at T4 and T5. See section 3.3.3.2 for a description of the MPAS. As in paper 2, we used the global scale of the MPAS, not the subscales. In paper 3, Cronbach's alpha for the MPAS for the NBO and comparison groups combined was .81 (T4) and .82 (T5). Cronbach's alpha for the MPAS for the NBO group was .81 (T4) and .81 (T5), and for the comparison group it was .82 (T4) and .83 (T5). This therefore shows acceptable internal consistency.

3.7.4.2 Maternal reflective functioning

Maternal reflective functioning was measured with the Parental Reflective Functioning Questionnaire (PRFQ; Luyten et al., 2017) at T4 and T5. The PRFQ was designed for use by parents with children up to five years old (Luyten et al., 2017). The questionnaire has 18 items, with responses on a seven-point scale from "strongly disagree" (1) to "strongly agree" (7). The PRFQ consists of three subscales: Pre-Mentalizing (PM; 6 items) (e.g., the degree of focus on the child's behavior as opposed to the child's inner life as a way of making sense of the child's actions), Certainty about Mental States (CMS; 6 items which measure parents' ability to acknowledge that the child's inner world is not always clear), and Interest and Curiosity in mental states (IC; 6 items). A preliminary study from Europe showed promising results for the internal consistency of the three subscales, as well as the validity of the instrument (Luyten et al., 2017). Results from Korea showed good internal consistency for two of the subscales, but not for the PM subscale. In addition, explorative factor analysis suggested a five-factor solution instead of the original three factors (Lee et al., 2020). A. Goksøyr and H. Braarud translated the PRFQ into Norwegian.

Cronbach's alpha for the PRFQ-PM for the NBO group and comparison group combined was 0.37 (T4) and 0.41 (T5). Cronbach's alpha for the PRFQ-PM for the NBO

group was 0.32 (T4) and 0.31 (T5), while for the comparison group was 0.39 (T4) and 0.50 (T5). Cronbach's alpha for the PRFQ-CMS for the NBO group and comparison group combined was .74 (T4) and .82 (T5). Cronbach's alpha for the PRFQ-CMS for the NBO group was .75 (T4) and .80 (T5), while it was .73 (T4) and .83 (T5) for the comparison group. Cronbach's alpha for the PRFQ-IC for the NBO group and comparison group combined was .69 (T4) and .64 (T5). Cronbach's alpha for the PRFQ-IC for the NBO group was .66 (T4) and .60 (T5), and .71 (T4) and .67 (T5) for the comparison group. The PRFQ-PM showed particularly low internal consistency.

3.7.4.3   Maternal confidence

Mothers' self-reported belief in their own parenting skills was measured with the Maternal Confidence Questionnaire (MCQ; Parker & Zahr, 1985) at T4. This instrument has 14 items, such as "When my baby is cranky, I know the reason" and "Being a parent is demanding and unrewarding". All items are answered on a five-point scale from "never" (1) to "very often" (5). The MCQ is suggested to be a reliable and valid tool (Badr, 2005) and has previously been used on a Norwegian sample (Olafsen et al., 2007). Cronbach's alpha for the MCQ for the NBO group and comparison group combined was .81. Cronbach's alpha for the MCQ for the NBO group was .69 and for the comparison group .85.

3.7.4.4   Maternal experiences of follow-up care after birth

The participants' experiences of follow-up care from the hospital and the municipality after birth were measured at T4 using three items developed by three members of the research team for the NorBaby study (Høifødt, Landsem, and Wang, 2016). The first item was made up of five sub-items: "From the follow-up care you have received after the birth from the maternity ward and the well-baby clinic, how much have you learned about the child's signals and needs in relation to: (1) "The eating situation?", (2) "Sleep/sleep patterns?", (3) "Social interaction?", (4) "Changing diapers?", and (5) "Crying/fussiness?". The second item consisted of four sub-items: "In the follow-up care you received after the birth from the maternity ward and the well-baby clinic, how much did you feel you could: (1) "Share thoughts and concerns?", (2) "Ask questions", (3) "Get practical guidance?", and (4) "Have confidence in the health care worker?". The third item was: "Overall, to what extent do you

feel that the follow-up care has supported you and your family in a satisfactory manner?" The items were answered on five-point Likert scale from 1 ("Not at all"/ "To a very small extent") to 5 ("Very much"/ "To a very large extent"). The items are treated as individual questions in this thesis and have not been used in previous research. Thus, psychometric properties are not reported.

3.8 An overview of measures in papers 1, 2 and 3

Table 3 presents an overview of the measures at the different time points.

Table 4

Measurements at different time points

Measures	T1	T2	T3	Birth		T4	T5
Demographics	1, 2, 3						
ECR			2				
EPDS			1			3	3
Follow-up						3	
MAAS			1		Routine care plus three NBO consultations vs routine care		
MCQ						3	
MPAS						2, 3	3
PRFQ						3	3
PSI							
CD							3
PD						2, 3	3

Note. _CD_ Child Domain, _ECR_ Experiences in close relationships, _EPDS_ Edinburgh Postnatal Depression Scale, _Follow-up_ The mothers' experiences of the professional follow-up after birth, _MAAS_ Maternal Antenatal Attachment Scale, _MCQ_ Maternal Confidence Questionnaire, _MPAS_ Maternal Postnatal Attachment Scale, _PRFQ_ Parental Reflective Functioning Questionnaire, _PD_ Parent Domain, Parenting Stress Index, _YSQ_ Young Schema Questionnaire, _1_ Included in paper 1, _2_ Included in paper 2, _3_ Included in paper 3.

3.9   Data analysis

3.9.1   Treatment of missing values

In paper 1, scale scores were computed if at least 80% of scores were present. In paper 2, an expectation maximization missing value analysis was applied to impute missing values for participants with valid data for a minimum of 50% of the items in the variables. In paper 3, missing data were replaced using the multiple imputation method with 50 iterations.

3.9.2   Analytical strategy

We used IBM SPSS Statistics for Windows, Version 25.0 (IBM, 2017) for data analysis in all three papers. Non-parametric approaches were used when there were indications of non-normal distributions.

For papers 1 and 2, Spearman correlations were used to measure the relationships between the study measures. Further, hierarchical regression analyses were used to explore the relationship between the adult attachment styles/EMSs (including confounding variables) and maternal-child bonding. Further, we tested symptoms of depression (paper 1) and parenting stress (paper 2) as mediators between adult attachment style/EMSs and maternal-child bonding. In the mediation analyses we included the confounding variables from the hierarchical analyses as covariates. For the mediation analyses, we used the PROCESS macro for SPSS (Hayes, 2017), Version 3.0 (paper 1) and 3.1 (paper 2). For the hierarchical regression analyses and the mediation analyses we generated confidence intervals with a bootstrap percentile approach with 10,000 samples.

In paper 3, we used a multivariate analysis of covariance (MANCOVA) to test the difference between the NBO group and the comparison group on measures of parenting stress/symptoms of depression and the mother-child relationship (PRFQ, MPAS, and MCQ), while including educational level and well-baby clinic as control variables. We performed separate analyses for T4 and T5. We generated 95% bias-corrected and accelerated confidence intervals. We used a repeated-measure analysis of covariance (ANCOVA) to test whether the scores between the groups changed from T4 to T5. The Mann-Whitney U test was used to investigate the differences between the groups on the questions about satisfaction/benefit of the follow-up care.

Results were considered statistically significant if the p-value was less than .05. For the ANOVAs we used a Bonferroni correction of the p-value.

3.9.3   Power calculations

In planning the study we calculated sample size (Høifødt et al., 2017) based on the difference between the group receiving NBO and the comparison group on the EPDS, PSI, PRFQ and the MPAS six weeks post-partum. We expected a small to medium effect size (f2=0.07), based on a pilot study by Nugent et al. (2014) in addition to some regression to the mean. We estimated that, with a group size of n=176, a MANOVA with EPDS, PSI, PRFQ and MPAS could detect group differences with a power of 0.80. We expected a dropout rate of 10% and aimed at recruiting a group size of 200 women. The calculations are based on a 0.05 α-level. This power calculation is specific for the aims of paper 3, and we did not calculate sample sizes specific to papers 1 and 2.

3.10 Ethical considerations

The Regional Committee for Medical and Health Research Ethics in Northern Norway (2015/614) approved the NorBaby study. Participants were given oral and written information about the aim of the study, study background, protection of privacy and the data collection process. Further, information was given that participation was voluntary and that participants were free to withdraw at any time without giving a reason. Participants gave written informed consent for themselves and their infant`s participation. Data were collected on a secure database (the NTNU Survey). Each participant was given a unique ID which they used

through the whole study. Names were securely stored on password protected sheets separated from the database. The study is registered at clinical trials.gov (NCT02528497).

4   Main results

4.1   Paper 1

Early maladaptive schemas as predictors of maternal bonding to the unborn child.

Aim: This paper aimed to examine the role of EMSs for maternal-fetal bonding quality, and symptoms of depression as a mediator in this relationship.

Methods: The sample for this study consisted of 165 pregnant women (mean age 30.8 years, SD 4.1 years). The participants answered the Young Schema Questionnaire Short Form 3 (YSQ-S3) at T2 (between gestational weeks 24 and 37), and the Maternal Antenatal Attachment Scale (MAAS) and the Edinburgh Postnatal Depression Scare (EPDS) at T3 (between gestational weeks 31 and 41).

Results: All EMS domains correlated significantly and negatively (*r*`s from -.28 to -.39) with the quality of maternal-fetal bonding. Only the Disconnection and Rejection domain correlated significantly with intensity of preoccupation with the fetus (*r* = -.17). There were significant positive correlations between all schema domains and scores on the Edinburgh Postnatal Depression Scale (EPDS) (r`s from .37 to .48). The results also revealed a significant negative correlation between the EPDS and the quality of maternal-fetal bonding (r = -.38), but no significant correlation with the intensity of preoccupation with the fetus. Hierarchical regression analysis, where we included the four EMS domains and seven confounding variables, revealed that the EMS domain of Disconnection and Rejection was a significant predictor of scores on the quality of the maternal-fetal bonding scale. Parenting experience but no EMS domains predicted intensity of preoccupation with the fetus. Mediation analysis was performed for the EMS domains correlating significantly with the quality of maternal-fetal bonding and the intensity of preoccupation with the fetus. The EMS domains of Disconnection and Rejection, Impaired Autonomy and Performance, and Impaired Limits showed significant direct effects on the quality of maternal-fetal bonding scale. Symptoms of depression mediated the effect of the EMSs on the quality of maternal-fetal bonding. The EMS domain of Disconnection and Rejection did not show direct or indirect effects on the intensity of preoccupation with the fetus in the mediation analysis.

Conclusion: Pregnant women's EMSs are related to maternal fetal bonding quality, and this association is mediated by their symptoms of depression. The results may have implications for the identification of pregnant women at risk of unhealthy bonding.

4.2 **Paper 2**

Adult attachment style and maternal-infant bonding: The indirect path of parenting stress.

Aim: This study aimed to explore the role of the mother's adult attachment styles for maternal infant bonding quality, and mothers' parenting stress as a mediator in this relationship.

Method: The sample for this study consisted of 158 women (mean age 31.0 years, SD 4.2 years). The participants completed the Experiences in Close Relationships questionnaire (ECR) at T3 (between gestational weeks 31 and 41), and the Parenting Stress Index-Parent Domain (PSI-PD) and the Maternal Postnatal Attachment Scale (MPAS) at T4 (between 5 and 15 weeks after birth).

Results: There were significant positive correlations between attachment-related anxiety and attachment-related avoidance and parenting stress. Correlations between adult attachment style and the Parenting Stress Index - Parent domains (PSI-PDs) ranged from $r =$ .42 to .52. Correlations between adult attachment style and the five subscales of the Parenting Stress Index ranged from r = .24 to .48. Mother-infant bonding correlated significantly and negatively with adult attachment style (r = -.40 and -.32) and with the Parent domains and subscales of the Parenting Stress Index (r`s ranged from -.42 to -.67). Through a hierarchical regression analysis, including eight confounding variables, the results revealed attachment-related avoidance as a significant predictor of mother-infant bonding. A series of mediation analyses were performed to test parenting stress as a mediator between adult attachment style and mother-infant bonding. There were no direct effects. The PSI- PDs appeared as a mediator between attachment-related avoidance and attachment-related anxiety and maternal infant bonding. Further, the PSI subscale of sense of competence in the parenting role mediated the relationship between attachment-related avoidance and maternal infant bonding. The subscales of sense of competence and role restriction mediated the relationship between attachment-related anxiety and maternal infant bonding.

Conclusion: Mothers' insecure attachment style is related to poorer mother-infant bonding, and this association is mediated by mothers' level of parenting stress. The results may have implications for identification of mothers at risk of developing bonding difficulties.

4.3   Paper 3

The association between the Newborn Behavioral Observation and maternal stress, depressive symptoms, and the mother-infant relationship: Results from the Northern Babies Longitudinal Study.

Aim: This study aimed to investigate the role of the Newborn Behavioral Observation (NBO) intervention for mothers' symptoms of depression, parenting stress, mother-infant bonding, parental reflective functioning, maternal confidence, and benefit/satisfaction with postpartum follow-up care.

Method: The sample for this study consisted of 196 women, 82 of whom were allocated to the NBO intervention group (mean age 31.0 years, SD 4.0 years) and 114 to the care as usual comparison group (mean age 31.1 years, SD 4.5 years). We administered the Edinburgh Postnatal Depression Scale (EPDS), the Parenting Stress Index (PSI), the Parental Reflective Functioning Questionnaire (PRFQ), and the Maternal Postnatal Attachment Scale (MPAS) at T4 (between 5 and 15 weeks after birth) and T5 (between 3 and 9 months after birth). The Maternal Confidence Questionnaire (MCQ) and the questions about benefit/satisfaction with postpartum follow-up care were answered at T4.

Results: The only significant difference between the NBO group and the intervention group on demographic information was for education, in that more participants in the comparison group had four or more years of education. There was no difference between the groups on the pre-intervention measures BDI-II at T1, PRAQ at T1 and T3, ACE at T1, and MAAS at T3. Therefore, education was added as a covariate in all statistical analyses to control for the potential influence of education on the effects. Well-baby clinic was also added as a covariate in the analyses due to the cluster-controlled design. Results from multivariate analyses of covariance (MANCOVA) and repeated measures ANCOVA showed no significant differences between the NBO group and the comparison group for the mother-infant relationship domain (Maternal Postnatal Attachment Scale, Maternal Confidence Questionnaire and the Parental Reflective Functioning Questionnaire) and few differences on

maternal symptoms of depression/parenting stress (Edinburgh Postnatal Depression Scale and the parent (PD) and child domain (CD) of the Parenting Stress Index (PSI)). The repeated measure ANCOVA revealed a small but significant difference between the groups on the PSI-PD, where participants in the NBO group showed slightly higher parenting stress. A Mann-Whitney U test suggested that participants in the NBO group learned significantly more from the follow-up care than the comparison group about the child`s signals in relation to social interaction, sleeping/sleep patterns and crying/fussiness.

Conclusion: Receiving the NBO was related to learning more about reading an infant's signals. The NBO group did not have lower symptoms of depression or parenting stress, nor strengthened maternal bonding, reflective functioning, or maternal confidence. In conclusion, there may be limited benefits of the NBO in a general population sample.

5   Discussion

The driving force behind this thesis and the link between papers 1-3 were to enhance knowledge of factors that may relate to maternal symptoms of depression, parenting stress and qualities of the mother's relationship to the fetus/infant.

I used self-report data to explore how EMSs (paper 1), maternal attachment style (paper 2) and the NBO (paper 3) were related to parenting stress (papers 2 and 3), symptoms of depression (papers 1 and 2) and the quality of maternal-fetal/infant bonding in the transition to parenthood (papers 1 and 2). In brief, papers 1 and 2 lend support to the model in Figure 1 in that maternal vulnerability traits (paper 1: EMSs, and paper 2: adult attachment styles) relates to symptoms of depression (paper 1), parenting stress (paper 2), maternal-fetal bonding (paper 1), and mother-infant bonding (paper 2). Further, it was found that symptoms of depression/parenting stress mediated the relationship between maternal vulnerability traits and bonding. Results from the NBO study (paper 3) do not support the model in Figure 1. Receiving the NBO plus care as usual, compared with care as usual, was not associated with lower maternal symptoms of depression, parenting stress or outcomes of mothers' relationship to the infant.

5.1   Maternal vulnerability and the maternal-fetal/infant relationship

Our results show that the maternal vulnerability traits of attachment avoidance and attachment anxiety style (paper 2), and all four EMS domains (paper 1), are associated with poorer quality of self-reported maternal bonding. However, the EMS domain of Disconnection and Rejection emerged as a significant predictor of maternal-fetal bonding quality, above and beyond the other EMS domains. Adult attachment avoidance was a significant predictor of mother-infant bonding, above and beyond attachment anxiety. Thus, the EMS domain Disconnection and Rejection (paper 1) and Attachment Avoidance (paper 2) had unique contributions to maternal bonding. Accordingly, the attachment system and EMSs, with assumed roots in early relationship experiences (Cassidy & Shaver, 2016; Young et al., 2003), and also relating to relationship difficulties in adulthood (Janovsky et al., 2020; Li & Chan, 2012), seem to be relevant factors in contributing to explain variations in maternal-child relationship qualities. Attachment avoidance concerns the degree of discomfort with closeness and dependency (Brennan et al., 1998). The EMS domain Disconnection and Rejection

includes themes of expecting that one's needs for social belonging, secure attachment, love, and nurturance will not be consistently met (Young, 2014). Accordingly, both constructs seem to measure a tendency to avoid emotional closeness or suppress warm feelings toward others, which may explain poorer quality of maternal bonding in women with attachment avoidance and/or maladaptive schemas of disconnection and rejection.

In paper 1 we used the subscales of maternal-fetal bonding and not the global scale. Our results suggest that EMS domains are mainly related to the subscale quality of maternal-fetal bonding and that only the EMS domain Disconnection and Rejection is associated with the subscale less intensity of preoccupation with the fetus, which concerns, among other things, the degree of time spent in bonding related activities. No EMS domains emerged as a significant predictor of less intensity of preoccupation with the fetus in a regression analysis with all four EMS domains and seven confounding variables. In paper 2 we investigated only the global scale of mother-infant bonding.

EMSs and attachment have theoretical similarities in that internal working models resembles the schema concept as an internal representation of relationships (John H Riskind & Lauren B Alloy, 2006), including beliefs about own worth in receiving care when in need, if one can depend on others or has to depend on oneself (Bowlby, 1982). EMSs may according to theory result in negative emotions and impact cognitions about oneself and social relationships (Young et al., 2003). Thus, both constructs are believed to influence the way one relates with others and might therefor also possibly impact thoughts and feelings in the maternal-fetal/infant relationship. Internal working models are assumed to underlie adult attachment styles and are not necessarily measured directly in research. Instead, adult attachment styles are reported as a proxy for the working models (Simpson & Rholes, 2012). In addition to theoretical similarities between EMSs and attachment styles, research also suggests that they are related (Karantzas et al., 2022). For example, there are moderate correlations (Cohen, 1988) between the Disconnection and Rejection domain and attachment anxiety ($r = .47$) and attachment avoidance ($r = .34$), measured with the ECR. These results should be treated with caution, as this study used other domain organizations and versions of the YSQ and the ECR, and items with overlap were also removed (Bosmans et al., 2010).

The caregiving system may add to the understanding of the associations between attachment styles and mother-infant bonding. This system is assumed to be central for the maternal-child relationship (Ainsworth, 1989), and it is linked to the attachment system, since

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the development of the caregiving system is thought to be influenced by parents` own attachment experiences (Mikulincer & Shaver, 2016). Further, both systems are theorized to work towards a common goal: to seek and maintain close contact between caregiver and child, especially during danger and distress, and to ensure the survival of the child (Bowlby, 1982, 1988). The attachment system and the caregiving system are also assumed to be in a reciprocal relationship, in such a way that intensification of parents' attachment system may decrease activation of the caregiver's behavioral system (Jones et al., 2015). Thus, parent-infant bonding may be related to the caregiving system and mobilization of the parent's attachment system could affect the parent-infant bond by influencing the caregiving system. In other words, experiencing pregnancy and the postpartum period as demanding might increase the mother's attachment system, thus decreasing the caregiving system and affecting the quality of mother-infant bonding.

Research on EMSs and parenting is scarce, although a relationship has been demonstrated between mothers' and their children's scores on the Disconnection and Rejection domain (Zeynel & Uzer, 2020), between EMSs and infant feeding difficulties (Farrow & Blissett, 2006), and EMSs and interpersonal problems in general (Janovsky et al., 2020). To my knowledge, this is the first study (paper 1) to investigate the relationship between EMSs and maternal-fetal bonding, thus adding valuable knowledge to the field. The role of attachment styles for parenting has received attention in research (see Jones et al., 2015, for a review). Results from this thesis (paper 2) are in line with previous research suggesting that adult attachment style is related to mother-infant bonding (Hairston et al., 2018; Handelzalts et al., 2020; Nonnenmacher et al., 2016; van Bussel et al., 2010). However, others have not found a significant relationship between attachment style and mother-infant bonding (Chrzan-Dętkoś & Łockiewicz, 2015).

5.2 Maternal vulnerability, parenting stress and symptoms of depression

Our results suggest that all four EMS domains are associated with increased symptoms of depression in pregnancy, and that adult attachment anxiety and avoidance are associated with increased levels of parenting stress. It is common to experience stress during life transitions, and having available resources mitigates stress (Miller, 2010). Attachment security may represent a resource in response to stress (Simpson & Rholes, 2012). When facing stress, individuals with secure attachment are theorized to have positive beliefs about themselves and

their environment, believing that distress is manageable and that obstacles can be overcome, and to have healthy emotion regulation strategies promoting strong relationship maintenance, thus seeking closeness when in need (Mikulincer & Shaver, 2016; Simpson & Rholes, 2019).

On the other hand, attachment insecurity and EMSs may represent a vulnerability (Simpson & Rholes, 2019; Young et al., 2003), leading to non-optimal coping strategies and thus increased stress and symptoms of depression, triggered by the stresses of the transition to parenthood. In stressful situations, individuals with an attachment avoidance style might believe that others are not to be trusted for comfort and support. They might not be fully aware of their distress and will more likely suppress negative emotions instead of seeking interpersonal interaction for emotion regulation. Although this strategy may work, it tends to collapse under prolonged or significant stressors. An attachment anxiety orientation is related to less confidence in one's ability to deal with the situation and a focus on emotions and the origin of the stress, and tends towards catastrophic thinking when the attachment system is intensified. These coping strategies also divert attention from problem solving, which prolongs activation of the attachment system. Anxious attachment-prone individuals also doubt that others will be available for support and fear rejection, but will still seek help and be motivated to reduce distress by enhancing partner closeness (Mikulincer & Shaver, 2016; Simpson & Rholes, 2019).

In parallel, EMSs are theorized to be more present in stressful situations such those that resemble the situations that led to their development, and the enhancement of EMSs results in negative emotions (van Genderen et al., 2012; Young et al., 2003). Research suggests that EMSs may be triggered by stressful life events outside of the transition to parenthood period that could lead to symptoms of depression, and that EMSs may be associated with stress generation which, in turn, could lead to symptoms of depression (Cámara & Calvete, 2012; Eberhart et al., 2011; Zhu et al., 2016). Attachment avoidance and attachment anxiety styles, perhaps especially attachment anxiety, and EMSs are also suggested to be associated with difficulty in emotion regulation (Marques et al., 2018; Mc Donnell et al., 2018; Nielsen et al., 2017). All of these relationships seem to suggest that attachment avoidance and anxiety style, and EMSs, may be related to stress and symptoms of depression in the transition to parenthood. To my knowledge, this is the first study to explore EMSs in relation to symptoms of depression in pregnancy. The results are in line with research suggesting that EMSs are related to symptoms of depression outside of pregnancy (Bishop et al., 2022) and with previous research finding adult attachment styles to be

associated with parenting stress in the postpartum period (Moe et al., 2018; Trillingsgaard et al., 2011). Moreover, some suggest that especially attachment anxiety is linked to increased parenting stress in first time mothers postpartum (Mazzeschi et al., 2015). We found that both attachment avoidance and attachment anxiety are related to parenting stress, although there were slightly higher correlations between parenting stress and attachment anxiety (e.g., r = .52) than attachment avoidance (e.g., r = .44).

5.3   Mediation by symptoms of depression and parenting stress

Mediation analyses assume that one variable has an influence on a mediator variable, which again influences an outcome. A substantial portion of psychology research aims at making assumptions about causality. This is not easy as human beings are complex and affected by many several factors. Baron and Kenny (1986) have had substantial influence on the process of conducting mediation analyses. According to them, to proceed with testing for mediation, one must first establish that there is a relationship between the predictor (x) and an outcome (y). If there is no such relationship, one should not test for mediation. A more modern approach proposed among others by Hayes (2017) is not so strict in requiring a direct relationship between x and y to test for mediation. Theoretical meaningful mediation pathways can be explored even without a direct relationship between x and y. In paper 1 we only tested for mediations effects when x and y were significantly related. Perhaps meaningful mediations pathways would have been revealed if we had tested symptoms of depression as a mediator for the relationship between all EMSs domains and MAAS IPF scores (subscale of the maternal antenatal attachment scale; maternal-fetal bonding). However, this appears unlikely as symptoms of depression were not significantly associated with MAAS IPF.

In our mediation analyses we demonstrated indirect effects of the four EMS domains (paper 1) on maternal bonding through symptoms of depression, and indirect effects of attachment avoidance and attachment anxiety style (paper 2) on maternal bonding through parenting stress. This suggests that EMSs and insecure attachment styles are associated with elevated symptoms of depression and stress, respectively, in the pre- and postpartum period, which might spill over and decrease maternal bonding quality. We did not find direct effects of attachment styles (paper 2) on maternal bonding. Thus, attachment styles only had an influence on maternal bonding through parenting stress. Moreover, the EMS domains (paper

1) of Disconnection and Rejection, Impaired Limits and Impaired Autonomy and Performance had a direct effect on maternal-fetal bonding quality, suggesting that EMS domains also have a negative influence on maternal-fetal bonding independently of the effect of symptoms of depression. Previous research suggests lifetime depression (Nonnenmacher et al., 2016), symptoms of depression and PTSD symptoms (Hairston et al., 2018; Handelzalts et al., 2020) as mediators between attachment styles and poorer mother-infant bonding. The present results concur with the literature and add to the field by suggesting parenting stress as a mediator. To my knowledge, our study on EMSs, symptoms of depression during pregnancy and maternal bonding is new to the field.

With all theories, including attachment theory and schema theory, there is a risk of expanding to areas which the theories were not meant to cover, and thus attempting to explain more than the theory is capable of explaining. Attachment theory *"makes very specific predictions—to positive expectations concerning self, other, and relationships; to a basic sense of security; to the capacity to draw support from and offer support to others; to emotion regulation; and to a well-functioning personality"* (Sroufe, 2018, p. 1003). Schema theory also predicts that EMSs have an impact on relationships and emotional well-being (Young et al., 2003). Hence, the relationships between EMSs and attachment styles, symptoms of depression and parenting stress, respectively, and maternal bonding shown in this thesis seem to be reasonable in light of the theory.

5.4   The NBO

Preventive interventions can be administered differently, ranging from a universal intervention for all individuals of target populations, to a selective intervention involving individuals at risk, or one involving people with indications of subclinical symptoms of a disorder. We investigated the NBO as a universal preventive intervention within the regular well-baby clinic service, thus all participants belonging to well-baby clinics that administered the NBO were eligible to receive the NBO. We investigated the association between receiving the NBO in the postpartum period and maternal symptoms of depression, parenting stress, measures of the mother's relationship to the infant, maternal confidence and satisfaction/benefit of follow-up care after birth. The only support we found for the benefit of the NBO was that the intervention group reported significantly more learning about reading their infants signals. In research on other populations, such as on children and adolescents,

both selective and indicated prevention interventions have been shown to be more effective than universal interventions on symptoms of depression (Horowitz & Garber, 2006).

The NBO is a program that focuses on improving the parent-infant relationship by sensitizing parents to their infants' signals and needs (Nugent et al., 2007). Our finding of no relationship between the NBO and higher levels of mother-infant bonding, parental reflective functioning and maternal confidence are in line with a Danish universal study (Kristensen et al., 2020) finding no effects of the NBO on maternal parenting confidence, and mothers' perceived quality of the mother-infant relationship. Our results contradict research suggesting a relationship between the NBO and maternal sensitivity in primiparous mothers (Nugent et al., 2017). We ran subgroup analyses on primiparous mothers but did not find that the NBO influenced our outcome measures.

The NBO was not associated with reduced parenting stress and symptoms of depression, which is in line with another study finding no effect of the NBO on symptoms of depression in a community sample (Kristensen et al., 2020). Two pilot studies (McManus et al., 2020; Nugent et al., 2014) suggest that the NBO may be associated with reduced symptoms of depression, including a small sample of mothers scoring above cut-off for symptoms of postpartum depression (Nugent et al., 2014). We also investigated the effect of the NBO on the number of participants scoring above the cut-off for probable clinical depression but did not find any effect on this subgroup either. Moreover, we found that the NBO group reported significant and slightly more parenting stress on the PSI Parent Domain then the comparison group, although this difference was numerically small.

The study sample was generally well-functioning based on their educational level, social support, pre-pregnancy income and employment status. This could possibly explain the lack of benefit of the NBO on maternal symptoms of depression, parenting stress, mother-infant bonding, parental reflective functioning, and confidence in the parenting role. Further, our sample had low mean scores on symptoms of depression, and compared to women with postpartum depression (Misri et al., 2006) our sample had low mean scores on parenting stress. Our participants in general scored high on mother-infant bonding and maternal confidence in the parenting role. Perhaps our well-functioning sample leaves little room for a significant increase on the outcome measures in our study. Moreover, our NBO logs show that 15% of participants in the intervention group did not receive any NBO session, while most received one to three sessions, but not all participants received the intended three

sessions. There might have been larger group differences if everyone in the intervention group had received the intended three sessions.

In the context of our study, the regular follow-up care received by the comparison group consists of similar themes as the NBO. Both the comparison group and the NBO group reported satisfaction with the follow-up program. Thus, in a well-functioning sample this makes it difficult to reveal any significant effects of the NBO intervention. In other words, our results demonstrated few effects of the NBO beyond what is already offered in regular follow-up care, except that the intervention group learned more than the comparison group about reading their infant's signals and sleep needs/sleep patterns, crying/fussiness, and social interaction. These issues are more closely linked to the content of the NBO than measures of mental health and the parent-infant relationship, and are in line with similar studies on the association between the NBO and parental experiences of the intervention on learning and understanding infant signals and needs (Greve et al., 2018; Kristensen et al., 2020).

Recently, the NBO has been found beneficial for mother-child interaction and maternal distress in primiparous mothers with symptoms of depression or anxiety, or with a history of mental illness (Nicolson et al., 2022). Moreover, a small study on at-risk infants suggests that NBO may be beneficial for healthy infant development and maternal mental health (McManus et al., 2020). These studies contrast with our findings and the study by Kristensen et al. (2020), which applied the NBO in a universal setting to a broader range of families in a community. Clearly there is need for more research to study the effect of the NBO and to ascertain which groups would profit the most from receiving it, which might apply more to at-risk samples. Our results indicate that maternal vulnerability (EMSs and insecure attachment styles) is important in the transition to parenthood, as EMSs and adult attachment styles were associated with increased maternal symptoms of depression/parenting stress and poorer maternal bonding. Thus, it would be interesting to explore whether mothers who score high on an anxious and/or avoidant attachment style or on EMSs would profit more from the NBO than more secure mothers.

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5.5   Strengths and limitations

This study has some limitations. First, adult attachment styles and EMSs might be conceptualized as vulnerability and/or risk factors for the outcomes in this thesis. To be

framed as a vulnerability factor, the factor must be activated by a trigger, and negatively affect an outcome while active. With regard to this thesis, the stresses of the transition to parenthood might activate or enhance the activation of the attachment system and EMSs. This will in turn impact maternal parenting stress and symptoms of depression, and negatively influence maternal bonding. Although psychological theories in general are simplifications with weaknesses, it may be meaningful to frame attachment style (i.e., internal working models) and EMSs as vulnerability factors or at least as risk factors. The term risk only reflects on the probability of a disorder or difficulty and does not draw conclusions on the mechanisms that cause difficulties (Ingram et al., 2011).

One argument for seeing EMSs as vulnerability traits for symptoms of depression and the quality of the mother's relationship to the child may be that activation of these schemas might affect maladaptive processing of information about oneself and others, thus impacting symptoms of depression and feelings and thoughts towards the fetus. The present study is a simplification of reality, and the explored relationship might possibly also be partly explained by another variable not investigated (e.g., anxiety). In this way, the assumed mechanism might turn out to be more nuanced. Further, a large number of research studies, including this one, are correlational in nature, calling for caution in making inferences about causality and effects of mechanisms. Thus, EMSs and insecure attachment style might be a vulnerability for some of the relationships explored in this thesis, but the complexity described above makes conclusions difficult. This does not mean that a theoretical discussion of the possibility that those factors could exist as a mechanism is not fruitful or could not influence future research to disentangle issues of vulnerability.

Second, the mediator and outcome variables were measured at the same timepoint (papers 1 and 2). Thus, we can only draw conclusions about relations between the variables, not causations. Third, the sample consisted mostly of well-functioning participants based on their educational level, social support, family income and employment status. This limits the generalizability to at-risk populations. We had difficulty recruiting more disadvantaged participants. Including these might have provided stronger associations between the study variables.

Fourth, there is a concern about comparing maternal-fetal and mother-infant bonding in the discussion in this thesis. Although these constructs are measured with different questionnaires consisting of different items, previous research suggests that there is a

relationship between maternal-fetal bonding and mother-infant bonding (e.g. Petri et al., 2018). This makes it reasonable to discuss maternal-fetal and mother-infant bonding together as one bonding-construct for the purpose of this thesis. A related concern for this comparison is that we used the full-scale of the MPAS (mother-infant bonding in paper 2) and subscales of the MAAS (maternal-fetal bonding in paper 1).

Fifth, the data for all three papers in this thesis come from self-report questionnaires. Applying observational measures of the parent-infant relationship and interviews regarding maternal depression and maternal attachment could have changed the results. Self-report data may also be biased. Some items, especially in the YSQ-S3 and ECR, refer to difficulties in relating to oneself and others. There is a possibility that respondents perceived these questions as socially undesirable and thus responded in a more socially desirable manner (Chan, 2010).

Moreover, there is a specific concern about measuring attachment styles and EMSs with self-report questionnaires. Self-report questionnaires for adult attachment styles have been criticized for not tapping sufficiently into unconscious processes related to attachment (see Shaver & Mikulincer, 2004 for a discussion) in the belief that unconscious processes are better accessed with interview perspectives on attachment (Jacobvitz et al., 2002). In response, others conclude that self-report measures of adult attachment style also tap into unconscious processes (Shaver & Mikulincer, 2004). This also applies to measuring mental health with self-report questionnaires. Using interviews could have provided more reliable diagnostic information.

Sixth, theoretical models of cognitive vulnerability often include protective factors in their quest to understand the development of emotional difficulties (Riskind & Alloy, 2006). Parenting stress, as measured in this thesis with the Parenting Stress Index (Abidin, 1995), might be thought of as assessing state-like dimensions (such as symptoms of depression), but also protective factors or the lack of these with a focus on e.g., perceived degree of social support. Thus, symptoms of depression measured with the EPDS may be considered as tapping into participants' state, while the PSI may also measure other aspects in addition to state.

Seventh, randomization of participants to the NBO and comparison group was not achievable in the setting of the study. Although controlling for educational level, which emerged as different between the two groups, did not change the results, there could still have

been differences between the groups belonging to the different well-baby clinics, although also controlling for this variable did not change the results. Eighth, the participants in the NBO group received one extra session (at four weeks) compared with the comparison group. This adds uncertainty as we cannot rule out whether any benefits of the NBO could be related to receiving additional consultations with health workers rather than to the effects of the intervention. Ninth, many participants did not receive all three NBO sessions.

The longitudinal design of this study is a strength as it allowed us to follow the families over time and to measure the study constructs at different timepoints.

5.6 Future research

Future studies should be conducted on samples with a higher proportion of disadvantaged families than our sample. Fathers should be included in future studies as they also are important in infants' lives. Fathers were excluded in this thesis to simplify the focus of the papers and statistical analyses. Also, the number of fathers recruited was fare lower than recruited mothers. Moreover, I encourage replication of our studies 1 and 2, as well as exploration of the relationship between EMSs and adult attachment styles, respectively, and parent-infant interaction, infant attachment classification and infant development. There is probably a bidirectional relationship between parenting stress and symptoms of depression, and maternal bonding, and this challenges the interpretation of our results. Future studies should therefore measure parenting stress and symptoms of depression at a time point before maternal bonding is measured, to gain more knowledge of the direction of the relationship.

Furthermore, studies should investigate whether therapeutic interventions for changing EMSs and attachment insecurity can enhance bonding quality. The results of our study on the effect of NBO in a generally well-functioning sample are limited, but I encourage more studies on samples of more disadvantaged parents and studies with outcome measures of child development, parent-infant interaction, and child attachment classification. Also, future research could further investigate which groups would profit most from receiving the NBO. Studies could investigate whether mothers with an anxious and/or avoidant attachment style and mothers with high EMSs scores would profit more from the NBO than more secure mothers. I would also encourage studies with a longer time frame to explore whether the effect of the NBO will be more pronounced at a later stage.

5.7 Implications

The results have clinical implications in that maternal adult attachment style and EMSs may be important for identifying mothers at risk of mental health difficulties and bonding difficulties in the transition to parenthood. Attachment insecurity and EMSs may be important factors in intergenerational transmission of risk, which calls for a focus on those factors in at-risk families. Clinicians should be aware of maternal attachment styles and EMSs to identify mothers that may need additional follow-up care regarding their mental health and mother-infant relationship in the pre- and postpartum periods. These mothers would potentially benefit from attachment-based therapy or schema therapy, although there is a need for more research on this area. Receiving the NBO leads to more knowledge about the infant. This knowledge may contribute to positive infant development in the long term.

6 Conclusion

This thesis adds to extant knowledge in that maternal vulnerability factors (EMS domains and attachment styles), theorized to be rooted in the mother' own childhood, were related to symptoms of depression and parenting stress, and maternal-fetal and mother-infant bonding. EMS domains, especially the Disconnection and Rejection domain, were associated with maternal-fetal bonding. Further, the EMS domains were more closely associated with the quality of bonding than with the intensity of fetal bonding. Maternal symptoms of depression were found to mediate the relationship between the EMS domains and maternal-fetal bonding. Maternal attachment styles were related to mother-infant bonding, and in particular, attachment avoidance style was a significant predictor of poorer bonding. Parenting stress mediated the relationship between attachment style and mother-infant bonding. Administrating the NBO in a setting with generally well-functioning participants was not associated with lower levels of maternal depressive symptoms and parenting stress, nor with increased mother-infant bonding, reflective functioning, or maternal confidence. On the contrary, the NBO group reported slightly higher parenting stress than the comparison group. Moreover, the NBO was associated with increased learning about reading infants' signals.

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Paper 1

Early maladaptive schemas as predictors of maternal bonding to the unborn child

BMC Psychology

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Early maladaptive schemas as predictors of maternal bonding to the unborn child

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Abstract

Background: The quality of an expectant mother's bonding to the fetus has been shown to be associated with important developmental outcomes. Previous studies suggest that bonding quality is predicted by, for example, social support, psychological well-being, and depression. However, little is known regarding the role of maternal cognition in maternal-fetal bonding. Early maladaptive schemas (EMSs) are negative and stable assumptions about oneself and one's relationships with others that are developed during childhood and adolescence. In the present study, we examined the associations between EMSs and the quality of the bonding to the fetus in expectant mothers.

Methods: The present investigation is part of a larger study in which 220 pregnant women (approximately 12% of the pregnant women in the region) and 130 of their partners were recruited from October 2015 until December 2017. The sample for the current study comprised 165 pregnant women (mean age 30.8 years, SD 4.1 years). The participants completed the Young Schema Questionnaire Short Form 3 (YSQ-S3) between gestational weeks 24 and 37 and the Maternal Antenatal Attachment Scale (MAAS) and the Edinburgh Postnatal Depression Scale (EPDS) between gestational weeks 31 and 41.

Results: All EMS domains correlated significantly and negatively with scores for quality of maternal-fetal bonding on the MAAS. Only the Disconnection and Rejection domain correlated significantly and negatively with MAAS scores for intensity of preoccupation with the fetus. The Disconnection and Rejection domain was a significant independent predictor of the quality of maternal-fetal bonding. Symptoms of depression mediated the effect of the EMS domains on the quality of maternal-fetal bonding. The EMS domains Disconnection and Rejection, Impaired Autonomy and Performance, and Impaired Limits showed significant direct effects on bonding quality.

Conclusions: EMSs are related to expectant mothers' self-reported bonding to their fetuses. This association was mediated by the mothers' symptoms of depression. The results may have implications for the early identification of pregnant women at risk of bonding difficulties and encourage more studies on cognitive schemas and mechanisms for maternal-fetal bonding.

Keywords: Early maladaptive schemas, Maternal cognitions, Mediation, Maternal-fetal bonding, Maternal-fetal attachment, Antenatal depression

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Background

Introduction

Maternal bonding is described as an emotional tie or bond from a mother towards her child [1]. Maternal bonding starts developing during pregnancy [2], and this development continues after birth [3–7]. Bonding is clearly related to the concept of attachment, and these two terms are sometimes used interchangeably. However, there is an important distinction between bonding and attachment. In Bowlby's attachment theory [8], the attachment system has the purpose of eliciting caregiving behavior from important others, which pregnant women do not seek from their fetus. Hence, some have argued that attachment is an inappropriate term for a mother's emotional tie to her fetus [9, 10] and use other labels, such as bonding. One way to measure bonding during pregnancy is through the mother's descriptions of the qualities of the affective experience towards the fetus, thoughts about the fetus and reactions to experiences of loss. Additionally, one can measure the mother's intensity of preoccupation with the fetus [1]. Bonding as early as during pregnancy has been shown to be related to a variety of infant outcomes, including colic, infant temperament difficulties, and delayed developmental milestones [11]. In addition, maternal-fetal bonding predicts the quality of mother-infant interaction after birth [12, 13], which has been shown to be important for the child's development [14–17]. Therefore, research on factors that contribute to explaining different qualities of maternal bonding is warranted. Knowledge of predictors of maternal bonding during pregnancy may aid in the development of interventions to enhance bonding for at-risk mothers before the child is born, interaction difficulties become established and developmental difficulties are manifested.

A number of predictors of maternal-fetal bonding have been examined and reviewed by Cannella [18] and Alhusen [19]. However, the findings were inconsistent for most variables. Among variables with some findings of positive relationships with maternal-fetal bonding were social support [18], family support [19], psychological well-being, having an ultrasound test performed [19], and attitude towards childbearing [18]. Variables with some indications of a negative relationship with maternal-fetal bonding included substance abuse [19], anxiety [19], maternal age [18], being married [18], and experience with motherhood [18]. Other studies have shown a positive association between the quality of the relationship with one's own mother in childhood and bonding to the fetus during pregnancy [20, 21]. In addition, pregnant women's attachment style in romantic relationships relates to maternal-fetal bonding [22–24]. For example, securely attached women reported a higher quality of maternal-fetal bonding than insecurely attached women [24]. In line with the findings on adult attachment styles, personality traits in the mother such as agreeableness, extroversion and conscientiousness also relate positively to maternal-fetal bonding during pregnancy [2]. It has also been observed that mothers' level of rumination predicts maternal-fetal bonding [25]. Another important factor for maternal bonding is maternal depression. Depressed mood is prevalent in pregnancy, affecting approximately 10% of pregnant women [26]. A meta-analysis from 2009 found that depressive symptoms have a small effect on maternal-fetal bonding [27]. However, more recent studies have shown that maternal depressive symptoms in early pregnancy have a negative impact on maternal-fetal bonding in late pregnancy [28]. In two studies, one of first-time mothers and the other of low-income women, depressive symptoms were associated with the quality of maternal feelings towards the fetus [29, 30]. Furthermore, pregnant women with clinical depression have been shown to have reduced levels of maternal-fetal bonding compared to those without depression [31]. Despite the variety of potential predictors of maternal-fetal bonding that have been investigated, there has been a paucity of studies on the role of the mother's cognitions about herself and her relationship with others regarding her bonding to the fetus.

Early maladaptive schemas, attachment theory, and bonding

The present study explored how mothers' early maladaptive schemas (EMSs), which can be described as negative emotional and cognitive patterns regarding oneself and one's relationships with others [32], are associated with bonding towards the fetus. According to Young et al. [32], EMSs develop during childhood and adolescence from an interplay between the child's temperament and adverse experiences with parents and peers. The theory states that EMSs result from unmet core emotional needs in the areas of secure attachments, independence, competence, sense of identity, autonomy to express needs and emotions, naturalness and play, and reasonable limits and self-mastery [32]. EMSs are elaborated throughout life, are dysfunctional, and guide the view of one self and one's relationship with others [32]. The most recent list of EMSs includes 18 EMSs organized into four EMS domains according to a recent revision [33] (see Table 1). Individuals with EMSs from the domain of 1) Disconnection and Rejection expect that their needs for secure attachments, social belonging, nurturance, love, and spontaneity will not be consistently met. People who score high on the EMS domain 2) Impaired Autonomy and Performance have negative assumptions about their own capability to function independently in daily life and inadequacy in regard to areas of

Table 1 Short descriptions of the 18 early maladaptive schemas proposed by Young et al. [32] and their organization into four schema domains [33]

Schema domains and early maladaptive schemas	Short descriptions
Disconnection and Rejection domain	
Emotional deprivation	The assumption that others will not meet one's emotional needs.
Social isolation	A sense that one is set apart/different from other people.
Emotional inhibition	The tendency to suppress the expression of emotions and to have difficulties relating freely to others.
Defectiveness/shame	The assumption that one is full of flaws, and if these are exposed, one would lose the respect or love of others.
Mistrust	Distrust in others' intentions or expected abuse.
Negativity/pessimism	The inclination to focus on the negative areas in life, with an expectation that things will end badly.
Impaired Autonomy and Performance domain	
Dependence/ incompetence	The assumption that one is incapable of handling everyday obligations without substantial assistance from others.
Failure to achieve	A conviction that one is a failure in regard to achievements.
Subjugation	Surrender of control to other people, due to the fear of negative reactions, usually implying a belief that one's thoughts and feelings are not important.
Abandonment	A feeling of instability in support from significant others.
Enmeshment	Over involvement with significant others.
Vulnerability to harm	Fear of medical, mental and/or external catastrophes.
Excessive Responsibility and Standards domain	
Self-sacrifice	The tendency to prioritize others' needs ahead of one own needs.
Unrelenting standards	The assumption that one must meet one's own high standards of achievement and behavior.
Punitiveness	The assumption that one and others should be disciplined for mistakes.
Impaired Limits domain	
Entitlement	A conviction of superiority.
Approval-seeking	The tendency to seek approval and connection with other people and to be sensitive to the reactions of other.
Insufficient self-control	Challenges with frustration tolerance and self-control.

achievement. The EMS domain 3) Excessive Responsibility and Standards involves a strong focus on following rigid internalized rules and expectations with regard to many aspects of life, such as obligations, good behavior

and orderliness, at the expense of one's own well-being, health, or interpersonal relationships. Individuals high in this domain may also feel egoistic or guilty if they occupy themselves with positive activities. Finally, the EMS domain 4) Impaired Limits refers to difficulties in self-directed behavior towards goal achievement, lack of frustration tolerance, and deficits in internal limits, which may be manifested as feelings of superiority or feelings of being entitled to privileges [34].

Essentially, EMSs resemble the internal working model in attachment theory [35], as both are assumed to develop during childhood from interpersonal experiences with important others and to have a complex influence on how one relates to oneself and to other people [32]. For example, the quality of parental relations and rearing in childhood has been found to be associated with EMSs [36–39] and attachment style [40, 41] in adolescence and adulthood. Moreover, insecure attachment early in life has been shown to be related to increased signs of EMSs 15 years later [42], and attachment style in adulthood is found to be related to EMSs [43]. EMSs are suggested to mediate between adverse childhood experiences with parents and adult interpersonal functioning [36]; they relate to interpersonal problems [44], and they may also play a role in parent-infant relationships, such as infant feeding difficulties [45, 46]. Hence, EMSs are related to attachment theory, are tightly intertwined with social functioning and relationships, and may therefore contribute to the understanding of the mechanisms underlying maternal-fetal bonding.

Finally, EMSs are assumed to play a central role in the development of later psychopathology [32]. Several EMSs have been found to be related to depressive symptom severity [47–52]. This includes defectiveness/shame, failure, and self-sacrifice [48] as well as defectiveness/shame, insufficient self-control, vulnerability, and incompetence/inferiority [49]. As depression is associated with weakened bonding, it is conceivable that the relationship between EMS and bonding is mediated by depressive symptoms.

Objectives and aims of the present study
The main objective of the present study is to examine the relationship between mothers' EMSs and two aspects of maternal-fetal bonding: the intensity of preoccupation with the fetus and the quality of the affective bond [1]. The EMS domain Disconnection and Rejection is theorized to impact the development of close relationships [32]. Hence, we hypothesize that this domain in particular will relate negatively to maternal bonding. Furthermore, as EMSs can be seen as emotional and cognitive scripts impacting experiences of oneself and one's relationships [32], we hypothesize that EMS domains relate more to the qualitative experiences of bonding (quality)

than to the amount of time mothers are consumed with thinking or talking about the fetus (intensity of preoccupation) [1]. Previous research [47] has demonstrated that a) EMSs are related to depression and b) that depression predicts maternal bonding [27, 28]. Accordingly, we also sought to explore whether the EMS domains have a direct effect on maternal bonding or whether this relationship is mediated by depressive symptoms.

Method

Participants and procedure

The present study is part of the Northern Babies longitudinal study on parental and infant prenatal risk factors, parent-infant interaction and infant development [53]. All Norwegian-speaking pregnant women and partners thereof who lived in the municipality of Tromsø were eligible for inclusion. The recruitment period lasted from October 2015 until December 2017. Participants were recruited by midwives who informed pregnant women and their families about the study. Potential participants who agreed to be contacted were later telephoned by a member of the research team for more information about the study and to plan a meeting for inclusion in the study. In this phone call, the researcher encouraged the participation of both parents, and partners were invited to the meeting for further information about the study and inclusion. A total of 430 pregnant women agreed to be contacted by phone. Two hundred and twenty pregnant women (equivalent to approximately 12% of the pregnant women in the region) and 130 partners consented to be included in the study. The reasons for exclusion included failure to respond to the phone call and refusal to participate in the study due to time considerations. The families were followed longitudinally at six measurement points (T1-T6), including three time points during pregnancy (T1-T3) and three postpartum until the infant was 6 months old (T4-T6).

In the present study, all pregnant women who had completed measures of EMSs and bonding to the fetus (administered at T2 and T3, respectively) were included ($n = 165$). Reasons for exclusion were omission of the T2 measurement due to late inclusion ($n = 13$), omission of the T3 measurement due to closeness in time to T2 ($n = 1$), withdrawing from the study or not answering all or relevant parts of T2 or T3 ($n = 30$), answering T2 and T3 successively on the same day ($n = 3$), premature birth ($n = 3$), and answering T3 after giving birth ($n = 3$). Furthermore, data from two participants could not be identified and were excluded from the sample. T1 ranged from gestational week 13 to week 30 (mean week 22.3). T2 measures were administered between gestational weeks 24 and 37 (mean week 28.3). T3 measures were administered between gestational weeks 31 to 41 (mean week 34.2). The overlap in timing between the steps in this study is largely due to

variations in gestational week at inclusion (T1) and late responses to later steps for some participants. The time between T1 and T2 ranged from 1 to 17 weeks (mean 6 weeks, SD 2.14). The time between T2 and T3 ranged from 1 to 13 weeks (mean 5.9 weeks, SD 2.14). At T2 and T3, participants completed questionnaires using an online survey tool. Further details about the design and procedure have been published previously [53].

Measures

Demographic information was collected at T1 and included questions about maternal age, whether pregnancy was wanted, number of children, education, income and marital status, as well as questions about previous mental health status and help sought for mental health issues. In addition, at T3, participants answered a question about having undergone ultrasound tests during their current pregnancy.

EMSs were measured using the Young Schema Questionnaire Short Form 3 (YSQ-S3; [54]) at T2. The YSQ-S3 is a self-reported measure consisting of 90 items. The items are rated on a 6-point Likert scale ranging from [1] "Completely untrue of me" to [6] "Describes me perfectly". The 18 EMSs constituting the YSQ-S3, their organization into four domains according to recent research [33] and short descriptions of the schemas are shown in Table 1. We used the following four domains in the present study: Disconnection and Rejection (30 items), Impaired Autonomy and Performance (30 items), Excessive Responsibility and Standards (15 items), and Impaired Limits (15 items). The present Norwegian version of the YSQ-S3 has been used in earlier research [55]. In the present study, the four domains of the YSQ-S3 had adequate internal consistency (see Table 3).

Bonding felt by the mother towards her baby during pregnancy was measured with the Maternal Antenatal Attachment Scale (MAAS; [1]) at T3. This self-report measure consists of 19 statements. The statements are followed by individual response options rated on 5-point Likert scales, for example, ranging from "Very emotionally distant from my baby" to "Very close emotionally to my baby". Higher values indicate higher bonding. In addition to a global scale (19 items), the measure consists of two subscales: [1] quality of maternal bonding (QMB; 10 items) and [2] intensity of preoccupation with the fetus (IPF; 8 items). Following guidelines from the author of the scale, one item was excluded from the subscales [56]. QMB assesses emotions towards the unborn child. The time spent in bonding mode with the unborn child is measured with the IPF. The present study focuses on the two subscales. Members of the research group translated the original version of MAAS to

Norwegian, and a professional translator checked the translation and provided suggestions for improvement. In the present sample, the two subscales had adequate internal consistency (see Table 3).

Maternal symptoms of depression were measured with the Edinburgh Postnatal Depression Scale (EPDS; [57]) at T3. The EPDS is a self-report inventory consisting of 10 items and used as a screening instrument for depression during pregnancy and after birth [58]. The EPDS includes items concerning sadness, anxiety, sleep and thoughts of harming oneself. Each item is scored on a 4-point scale with individual response options across items. The maximum score is 30. Higher scores indicate more symptoms of depression, and the cut-off for probable clinical depression is a score of 13 or more [57, 59]. The current study applied the measure as a continuous scale. The Norwegian translation of the EPDS has been used in previous research [60]. In the present sample, EPDS had adequate internal consistency (see Table 3).

Approach to data analysis and missing data

Skewness and/or kurtosis were above 1 for all scales except MAAS IPF and the YSQ-S3 domain Impaired Limits. As this indicates non-normal distributions, non-parametric approaches were used. Spearman correlations were conducted, and for regression and mediation analysis, a bootstrapping percentile approach with 10,000 samples was used to generate confidence intervals. Hierarchical regression analyses were employed to test whether the four EMS domains predicted maternal bonding. In block one, we controlled for seven potentially confounding variables (e.g., maternal age, education, parenting experience and mental health history). These variables are listed in Table 2. The variables of maternal education and gross annual household income were dummy coded. Parenting experience was recoded to indicate first-time mothers and those with one or more previous children. The variables of marital status and wanting the pregnancy contained little variability in scores and were therefore excluded from the analysis. The four EMS domains were added in block two. Mediation analysis was carried out to explore whether symptoms of depression mediated the relationship between EMS domains and maternal bonding, controlled for potential confounding variables. Only significant EMS domains in the correlation analysis between EMS domains and bonding were tested in the mediation analysis.

Descriptive statistics, correlations and regression analysis were conducted with SPSS 25, and PROCESS version 3.0 [61] was used for mediation analysis.

To compute scale scores, we required more than 80% of the values to be present. No values were missing from the YSQ-S3 or the EPDS. Only 0.3% of the values from

Table 2 Sample demographics

Characteristics at T1	Mean (SD)	N (%)
Maternal age (years)[a]	30.8 (4.10)	
Pregnancy wanted[b]		
Yes		156 (94.5)
No		2 (1.2)
Do not know		3 (1.8)
Parenting experience		
First-time mother		84 (50.9)
Second-time mother		68 (41.2)
Two or more previous children		13 (7.9)
Maternal education		
Upper secondary school or lower		22 (13.3)
Up to 4 years of higher education		50 (30.3)
4 or more years of higher education		93 (56.4)
Gross annual household income		
350,000 NOK (44,980 USD) or less		6 (3.6)
351,000–750,000 NOK (45108–96,386 USD)		46 (27.9)
751,000 NOK (96,515 USD) or more		113 (68.5)
Marital status		
Married or cohabiting		162 (98.1)
Single		3 (1.8)
Maternal mental health history		
History of contact with professionals for mental health issues		50 (30.3)
Previous experience with being depressed most of the day, almost every day for a period of 2 weeks		55 (33.3)
History of a diminished ability to enjoy things one has usually found enjoyable for a period of 2 weeks		70 (42.4)

N = 161–165
[a]one missing value
[b]four missing values

the MAAS QMB and IPF were missing. We decided not to replace the missing values.

Results

Table 2 reports the demographic data. The mean age for the sample was 30.8 years. A large proportion of the women reported wanting the pregnancy (94.5%), currently living with a partner (98.1%) and having a gross annual household income above 751,000 NOK (96,515 USD) (68.5%). In addition, 162 (98.2%) participants (missing: n = 3) reported having at least one ultrasound test performed during the current pregnancy. Approximately half of the participants in the sample were first-time mothers (50.9%) and had four or more years of higher education (56.4%). A substantial number of participants reported that they had previously been

depressed (33.3%) or were a diminished ability to enjoy things they usually find enjoyable (42.4%) for a period of 2 weeks. Furthermore, 30.3% had been in contact with professionals for mental health issues at some point during their life.

Table 3 reports the means, standard deviations and correlations for the study variables. With regard to maternal bonding, only MAAS QMB was significantly related ($p < .001$) to the total EPDS score, with a correlation of −.38. All EMS domains were significantly related ($p < .001$) to MAAS QMB. These correlations were negative and ranged from −.26 (Impaired Limits) to −.39 (Disconnection and Rejection). Only the EMS domain Disconnection and Rejection was significantly related ($p < .05$) to MAAS IPF ($r_s = −.17$). All EMS domains were significantly related ($p < .001$) to the total EPDS score. These correlations were positive and ranged from .37 (Impaired Limits) to .50 (Impaired Autonomy and Performance).

Table 4 presents the results of the regression model with the MAAS QMB as the outcome. Prior to the regression analysis, indices of possible multicollinearity were examined due to high intercorrelations between the EMS domains ($r_s = .58–.82$). Variance inflation factors (1.97–4.90) and tolerance (0.20–0.51) indicate possible multicollinearity, although not at a level that would raise serious concern [62–64]. In the first block, potentially confounding variables were included as predictors. The regression model with only the confounding variables was significant ($p = .002$), explaining 15% of the variance of the MAAS QMB subscale. In the second block, the four EMS domains were included as predictors. The regression model was significant ($p < .001$), explaining 32% of the variance of the MAAS QMB subscale. The increase in explained variance from model

one to model two was significant ($p < .001$). The EMS domain Disconnection and Rejection was a significant individual predictor ($p = .045$).

Table 5 presents the result of the regression model with the MAAS IPF as the outcome. The first block with the potentially confounding variables as predictors was significant ($p < .001$), explaining 21% of the variance of the MAAS IPF subscale. In the second block, the four EMS domains were included as predictors. The regression model was significant ($p < .001$), explaining 25% of the variance of the MAAS IPF subscale. The increase in explained variance from model one to model two was not significant ($p = .117$). No EMS domain was significant as an individual predictor.

Mediation analysis testing depressive symptoms as a mediator between EMS domains and maternal bonding was performed only for the EMS domains that correlated significantly with MAAS QMB and MAAS IPF scores. All potentially confounding variables from the hierarchical regression analysis were included as covariates in the mediation analysis. Confidence intervals for the direct and indirect effects were based on 10,000 bootstrap samples generated in PROCESS. Confidence intervals for the total effects were based on approximately 10,000 bootstrap samples generated in a series of regression analyses in SPSS. One participant was missing a value on the covariate maternal age, and the analyses are based on data from 164 participants. There were significant total effects of the EMS domains Disconnection and Rejection, $b = −3.150$, 95% CI [−4.898, −1.482]; Impaired Autonomy and Performance, $b = −3.749$, 95% CI [−5.858, −1.802]; Excessive Responsibility and Standards, $b = −1.471$, 95% CI [−2.496, −0.357]; and Impaired Limits, $b = −2.426$, 95% CI [−4.022, −0.951] on MAAS QMB. There was a significant direct effect of Disconnection and Rejection, $b = −1.789$, 95% CI [−3.315, −0.523]; Impaired Autonomy and Performance, $b = −1.776$, 95% CI [−3.344, −0.251]; and Impaired Limits, $b = −1.142$, 95% CI [−2.354, −0.061] on the MAAS QMB subscale. There was no significant direct effect of Excessive Responsibility and Standards, $b = −0.333$, 95% CI [−1.337, 0.637], on the MAAS QMB. The EMS domains Disconnection and Rejection, $b = −1.361$, 95% CI [−2.503, −0.448]; Impaired Autonomy and Performance, $b = −1.974$, 95% CI [−3.607, −0.673]; Excessive Responsibility and Standards, $b = −1.138$, 95% CI [−2.009, −0.404]; and Impaired Limits, $b = −1.285$, 95% CI [−2.471, −0.392] had significant indirect effects on MAAS QMB scores through EPDS scores. The EMS domain Disconnection and Rejection showed a significant total effect on MAAS IPF scores, $b = −1.749$, 95%, CI [−3.320, −0.292]. The EMS domain Disconnection and Rejection did not show a significant direct effect on MAAS IPF scores, $b = −1.146$, 95%, CI

Table 3 Descriptive statistics, Cronbach's alpha and Spearman correlations between the study measures

	Cronbach's alpha	Mean	SD	Correlation		
				MAAS QMB	MAAS IPF	EPDS
YSQ-S3 DR	.94	1.62	0.56	−.39***	−.17*	.48***
YSQ-S3 IAP	.92	1.49	0.45	−.36***	−.11	.50***
YSQ-S3 ERS	.87	2.54	0.67	−.28**	−.09	.43***
YSQ-S3 IL	.83	1.99	0.52	−.26**	−.02	.37***
MAAS QMB	.79	44.94	4.13	–	.54***	−.38***
MAAS IPF	.77	27.15	4.69		–	−.13
EPDS	.88	4.19	4.33			–

$N = 165$; *YSQ-S3* Young Schema Questionnaire-Short Form 3, *DR* Disconnection and Rejection, *IAP* Impaired Autonomy and Performance, *ERS* Excessive Responsibility and Standards, *IL* Impaired Limits, *MAAS* Maternal Antenatal Attachment Scale, *QMB* quality of maternal bonding, *IPF* intensity of preoccupation with the fetus, *EPDS* Edinburgh Postnatal Depression Scale; *$p < .05$, **$p < .001$, ***$p < .0001$

Table 4 Hierarchical regression analysis testing EMS domains as predictors of MAAS QMB

Block	Predictors	b (95% CI)	SE B	β	p	R²
1	Maternal age	0.11 (− 0.06, 0.29)	0.09	.11	.230	.15
	Parenting experience	0.03 (− 1.25, 1.27)	0.64	.00	.958	
	Maternal education[a]					
	Upper secondary school or lower	1.98 (−0.40, 4.43)	1.23	.16	.105	
	Up to 4 years of higher education	1.07 (−0.46, 2.55)	0.77	.12	.167	
	Gross annual household income[b]					
	351,000–750,000 (45,108–96,386 USD)	−0.76 (−4.25, 3.01)	1.83	−.08	.663	
	750,000 or more (96,515 USD or more)	0.28 (− 2.89, 3.92)	1.72	.03	.866	
	Mental health help seeking	0.48 (− 1.37, 2.16)	0.90	.05	.598	
	Previous experience with being depressed	−2.11 (−3.88, −0.38)	0.89	−.24	.020	
	Previous lack of joy	−1.56 (−3.18, −0.08)	0.79	−.19	.052	
2	Maternal age	0.12 (−0.06, 0.29)	0.09	.12	.193	.32
	Parenting experience	−0.29 (−1.48, 0.86)	0.59	−.04	.625	
	Maternal education[a]					
	Upper secondary school or lower	1.59 (−0.45, 3.53)	1.02	.13	.123	
	Up to 4 years of higher education	0.96 (−0.50, 2.32)	0.72	.11	.192	
	Gross annual household income[b]					
	351,000–750,000 (45,108–96,386 USD)	−1.08 (−4.95, 2.96)	2.00	−.12	.571	
	750,000 or more (96,515 USD or more)	−0.49 (− 4.18, 3.44)	1.93	−.06	.785	
	Mental health help seeking	1.12 (−0.47, 2.67)	0.79	.12	.163	
	Previous experience with being depressed	−1.55 (−3.19, 0.03)	0.81	−.18	.063	
	Previous lack of joy	−0.89 (−2.49, 0.64)	0.79	−.11	.260	
	Disconnection and Rejection	−2.66 (−5.34, −0.23)	1.29	−.36	.045	
	Impaired Autonomy and Performance	−0.71 (−3.52, 1.70)	1.33	−.08	.593	
	Excessive Responsibility and Standards	0.67 (−0.79, 2.24)	0.76	.11	.386	
	Impaired Limits	−1.12 (−2.97, 0.54)	0.89	−.14	.213	

EMS early maladaptive schemas, *MAAS* Maternal Antenatal Attachment Scale, *QMB* quality of maternal bonding, *IPF* intensity of preoccupation with the fetus; [a]variables were dummy coded with four or more years of higher education as a reference; [b]variables were dummy coded with 350,000 NOK (44,980 USD) or less as reference; "Mental health help seeking" = having been in contact with professionals for mental health issues; "Previous experience with being depressed" = Previous experience with being depressed most of the day, almost every day for a period of 2 weeks; "Previous lack of joy" = Having previously had a 2-week period of diminished ability to enjoy things one has usually found enjoyable; confidence intervals and standard errors were based on 9986 bootstrap samples, as SPSS did not manage to generate the requested 10,000 samples; *N* = 163

[− 2.868, 0.275], or a significant indirect effect on MAAS IPF scores through EPDS scores, $b = − 0.603$, 95% CI [− 1.535, 0.201].

Discussion

Earlier research has revealed a range of predictors of maternal-fetal bonding [18, 19], illustrating the complexity in explaining different qualities of bonding. Few studies have included cognitions [25], and no study so far has examined the role of mothers' cognitive schemas regarding herself and her relationships with others. These schemas are thought to have roots in the mothers' own relationship experiences with important others in childhood [32, 36–39] and are linked to attachment style [42, 43]. Thus, by focusing on EMSs, our findings may contribute to an enhanced understanding of the mechanisms underlying maternal bonding.

The present study investigated the relationship between mothers' EMSs and the quality of maternal-fetal bonding as measured with MAAS. To the best of our knowledge, the present study is the first to explore these associations. Furthermore, as symptoms of depression are related to EMSs outside of pregnancy [47–50] and to maternal-fetal bonding [27–30], we also explored the mediating effects of symptoms of depression between EMS domains and maternal-fetal bonding. Our explorations revealed that all four EMS domains correlated significantly with bonding quality. Regression analyses showed that the four EMS domains and seven potentially confounding variables (e.g., maternal age, education, parenting experience and mental health history)

Table 5 Hierarchical regression analysis testing EMS domains as predictors of MAAS IPF

Block	Predictors	b (95% CI)	SE B	β	p	R^2
1	Maternal age	−0.24 (− 0.44, − 0.04)	0.10	−.21	.019	.21
	Parenting experience	−2.65 (−4.02, − 1.32)	0.69	−.28	.001	
	Maternal education[a]					
	Upper secondary school or lower	1.19 (− 1.22, 3.66)	1.24	.09	.333	
	Up to 4 years of higher education	0.69 (−0.87, 2.17)	0.77	.07	.372	
	Gross annual household income[b]					
	351,000–750,000 (45,108–96,386 USD)	2.48 (−2.88, 9.04)	3.05	.24	.379.	
	750,000 or more (96,515 USD or more)	3.67 (−1.72, 10.26)	3.04	.36	.187	
	Mental health help seeking	0.63 (−1.44, 2.46)	1.00	.06	.532	
	Previous experience with being depressed	−1.32 (−3.26, 0.44)	0.94	−.13	.162	
	Previous lack of joy	−0.92 (−2.78, 0.89)	0.93	−.10	.323	
2	Maternal age	−0.24 (− 0.44, − 0.03)	0.10	−.21	.026	.25
	Parenting experience	−2.75 (−4.11, −1.43)	0.68	−.29	.000	
	Maternal education[a]					
	Upper secondary school or lower	1.13 (−1.14, 3.41)	1.16	.08	.319	
	Up to 4 years of higher education	0.66 (−0.94, 2.18)	0.79	.06	.406	
	Gross annual household income[b]					
	351,000–750,000 (45,108–96,386 USD)	2.54 (−2.76, 9.13)	3.05	.24	.379	
	750,000 or more (96,515 USD or more)	3.55 (−1.85, 10.17)	3.07	.35	.210	
	Mental health help seeking	0.79 (−1.21, 2.61)	0.97	.08	.423	
	Previous experience with being depressed	−1.01 (−2.93, 0.76)	0.94	−.10	.276	
	Previous lack of joy	−0.54 (−2.29, 1.21)	0.90	−.06	.550	
	Disconnection and Rejection	−2.02 (−4.81, 0.62)	1.37	−.24	.143	
	Impaired Autonomy and Performance	0.46 (−3.11, 3.63)	1.71	.04	.785	
	Excessive Responsibility and Standards	−0.02 (−1.69, 1.67)	0.86	.00	.980	
	Impaired Limits	0.00 (−1.84, 1.83)	0.93	.00	.997	

EMS early maladaptive schemas, *MAAS* Maternal Antenatal Attachment Scale, *QMB* quality of maternal bonding, *IPF* intensity of preoccupation with the fetus; [a]variables were dummy coded with four or more years of higher education as a reference; [b]variables were dummy coded with 350,000 NOK (44,980 USD) or less as a reference; "Mental health help seeking" = having been in contact with professionals for mental health issues; "Previous experience with being depressed" = Previous experience with being depressed most of the day, almost every day for a period of 2 weeks; "Previous lack of joy" = Having previously had a 2-week period of diminished ability to enjoy things one has usually found enjoyable; confidence intervals and standard errors were based on 9979 bootstrap samples, as SPSS did not manage to generate the requested 10,000 samples; *N* = 163

explained a substantial part of the variance of bonding quality (32%). The EMS domain Disconnection and Rejection predicted the quality of maternal bonding above and beyond the other EMS domains. This finding supports our hypothesis that especially the EMS domain Disconnection and Rejection relates to maternal bonding. Mediation analyses revealed that the relations between all EMS domains and quality of bonding were mediated by symptoms of depression. Additionally, all EMS domains except Excessive Responsibility and Standards showed significant direct effects on bonding quality. This means that the domains had unique contributions to bonding quality when we controlled for symptoms of depression and the seven potentially confounding variables.

In line with our hypothesis, we found only a few links between EMS domains and the MAAS subscale measuring intensity of preoccupation with the fetus. Only the EMS domain Disconnection and Rejection correlated significantly with intensity of preoccupation, and no EMS domains emerged as significant unique predictors of scores on this subscale in the hierarchical regression model. Additionally, symptoms of depression did not emerge as a mediator between the EMS domain Disconnection and Rejection and intensity of preoccupation. In line with earlier research [29], the preoccupation subscale was not correlated with symptoms of depression. Thus, our findings suggest that mothers engage in bonding-related activities regardless of depressed mood and more or less regardless of the extent of EMSs. Bonding quality connects more strongly than quantity of bonding activities to the mood of the mother and her level of EMSs.

In theory [32], the EMS domain Disconnection and Rejection addresses negative assumptions regarding not having one's emotional needs met by others, being different, distrusting others, pessimism, suppression of emotional expressions and fear of being exposed. Our results show that higher scores on this EMS domain are associated with a poorer quality of maternal-fetal bonding. This may be understood as a tendency to avoid emotional closeness with or to suppress warm feelings towards the fetus, thus affecting maternal bonding. The results correspond to research showing a relationship between several of the EMSs from the Disconnection and Rejection domain and the quality of interpersonal relationships (e.g., attachment style in adulthood; 43).

Overall, the results are in line with research supporting the link between EMSs and social relationships. The schema model is related to adult social functioning [44] and infant feeding difficulties [45, 46]. Earlier research has mainly looked to relationships in the past, suggesting that EMSs are developed from social experiences in childhood with important others [36, 37]. In contrast, we measured emerging relationships by exploring the mothers' thoughts and feelings about their children before birth and the influence of infant temperament on the relationship.

The present study shed further light on the role of depressive symptoms in the associations between EMSs and maternal-fetal bonding. In line with previous research [48, 49], significant correlations between EMSs and depressive symptoms were found. The results of the mediation analyses showed indirect effects of the four EMS domains on bonding quality through depressive symptoms. However, significant direct effects of the EMS domains Disconnection and Rejection, Impaired Autonomy and Performance, and Impaired Limits were also found, suggesting that these EMS domains also affect maternal-fetal bonding independently of the effects of depression.

The results may have implications both for clinical practice and for research. Assessing EMSs may help clinicians identify pregnant women at risk for bonding difficulties. This may be important not only for preventing the development of a potentially unhealthy mother-child relationship but also for the treatment of women at risk. As this is the first study establishing a relationship between EMS domains and bonding quality, more studies are warranted. We encourage replication of our study as well as follow up studies with other measures of maternal-fetal bonding and with measures of bonding after birth. In addition, potential relationships between EMS domains and parent-infant interaction, infant attachment classification, and early child development should be explored. Preferably, the samples should include a higher proportion of disadvantaged families than the current sample. Clinical studies should investigate whether psychological interventions aimed at modifying EMSs can contribute to reducing bonding difficulties.

Strengths and limitations

The longitudinal design of the study is a strength. The present study also has some limitations. First, only approximately 12% of all the pregnant women in the municipality of Tromsø were included in the study. The participation rate may partly be explained by failure to reach out to all pregnant women. In addition, the extensive data collection may have been perceived as demanding and time consuming by potential participants. Second, the present study sample consisted mostly of healthy and resourceful women. Although participants were recruited from a region with generally high socioeconomic status, their educational level and gross annual household income also indicate that the sample is quite resourceful. There is a possibility that a clinical or at-risk sample may have had less favorable scores on the study measures (MAAS, YSQ-S3, and EPDS) than our sample had. Due to the well-functioning sample, caution should be exercised in generalizing the findings to other populations. However, despite the resourcefulness and generally low levels of depressive symptoms in the study sample, it is worth mentioning that approximately one-third of participants reported having experienced depression in the past, possibly indicating some mental health vulnerability in the participants. Third, the predictors and maternal bonding were measured entirely by self-report questionnaires, which may have led to response bias. Measuring these variables with interviews may have given different results. Fourth, there were indications of possible multicollinearity for the EMS domains (although not at a level that raises serious concern), which may have affected the results of the hierarchical regression models. This means that the results from the hierarchical regression models should be interpreted with some caution. Fifth, given the large number of predictors in the regression analysis, an increased sample size would have been preferable.

Conclusions

The present study has demonstrated that a mother's EMSs are relevant to the quality of her bonding towards her fetus. After we controlled for confounding variables and the three other EMS domains, Disconnection and Rejection was a significant predictor of the quality of maternal-fetal bonding. Mothers' symptoms of depression mediated the relationship between bonding quality and the EMS domains Disconnection

and Rejection, Impaired Autonomy and Performance, Excessive Responsibility and Standards, and Impaired Limits. This is one of very few studies exploring cognitions and maternal-fetal bonding, and it is also the first study exploring the EMSs and maternal-fetal bonding. Our results are promising and call for more studies on cognition and bonding during pregnancy. In the future, assessing EMSs may enable improved identification of pregnant women at risk for bonding difficulties.

Abbreviations
EMS: Early maladaptive schemas; EPDS: Edinburgh Postnatal Depression Scale; IPF: Intensity of preoccupation with the fetus; MAAS: Maternal Antenatal Attachment Scale; QMB: Quality of maternal bonding; YSQ: Young Schema Questionnaire

Availability of data and materials
The dataset used during the study is available from the corresponding author on request.

Authors' contributions
Study concept and design: DN, RSH, IPL, JCT and CEAW. Data acquisition: DN, RSH, AB, IPL and CEAW. Analysis: DN. Drafting the manuscript: DN, CEAW and JCT. Critical revision for important intellectual content: DN, RSH, AB, IPL, CEAW and JCT. Approval of the submitted version: DN, RSH, AB, IPL, CEAW and JCT. All authors read and approved the final manuscript.

Ethics approval and consent to participate
Ethics approval for this study was obtained from the Regional Committee for Medical and Health Ethics in Northern Norway (2015/614). All participants gave written informed consent.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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Paper 2

Nordahl. D., Rognmo, K., Bohne, A., Landsem, I.P., Moe, V., Wang, C.E.A & Høifødt, R.S. (2020).

Adult attachment style and maternal-infant bonding: the indirect path of parenting stress

RESEARCH ARTICLE

Adult attachment style and maternal-infant bonding: the indirect path of parenting stress

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Abstract

Background: The quality of maternal-infant bonding is related to important child outcomes. The literature has assumed that the ability to form relationships is a relatively stable trait, and research studies have suggested that a mother's attachment style in close adult relationships is related to mother-infant bonding. The transition to parenthood is also often stressful, and the adult attachment style may relate to parenting stress in the first year after birth. Such stress could possibly have a negative relationship with the mother-infant bond. In the present study, we examined the associations between maternal adult attachment styles and the quality of mother-infant bonding and whether this relationship is mediated by parenting stress.

Methods: The present study sample comprised 168 women (mean age 31.0 years, SD 4.23 years). Between weeks 31 and 41 of gestation, the anxious and avoidant adult attachment dimensions were measured with the Experiences in Close Relationships questionnaire (ECR). Between 5 and 15 weeks after birth mother-infant bonding and parenting stress were measured with the Maternal Postnatal Attachment Scale (MPAS) and the Parenting Stress Index-Parent Domain (PSI-PD), respectively.

Results: Both attachment-related avoidance and attachment-related anxiety correlated significantly and negatively with mother-infant bonding. However, a regression analysis showed that only attachment-related avoidance was a significant predictor of mother-infant bonding when controlling for demographic variables and maternal mental health history. The relationship between the adult attachment style and bonding was mediated by parenting stress. Higher scores on attachment avoidance and anxiety were related to increased stress, which was related to decreased quality of bonding. The overall parent domain and the subscale of competence in the parent-related stress dimension mediated between attachment avoidance and bonding, and the overall parent domain and the subscales of competence and role restriction mediated between attachment anxiety and bonding. There was no direct relationship between the adult attachment style and mother-infant bonding when parenting stress was included as a mediator.

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Conclusions: This study illustrates that maternal adult attachment style relates to mother-infant bonding. This relationship was mediated by parenting stress. The results may have implications for the early identification of mothers at risk of having bonding difficulties.

Keywords: Parenting stress, Attachment style, Bonding, Maternal-infant bonding, Mother-infant relationship, Mediation

Background

Maternal bonding, defined as an emotional tie [1] from the mother towards her child, develops already during pregnancy [2–4]. The quality of maternal-infant bonding is important, as it is predictive of maternal sensitivity [5] and is related to child developmental outcomes [6, 7]. Thus, research on factors related to the quality of mother-infant bonding is important.

Bonding is related to the concept of attachment. It has been argued that while attachment encompasses care seeking, bonding might be more related to caregiving [8]. Thus, these two concepts might tap into different aspects of the parent-child relationship. Attachment theory states that establishing close bonds/relations to others is of central importance to all humans, irrespective of age [9]. This is further elaborated with the construct of internal working models, which are assumed to develop during early childhood from experiences with important caregivers, and to have an impact throughout life on the way we relate to ourselves and other people [10]. Hence, it is reasonable to assume that a mother's attachment style will affect her bonding with the infant. Additionally, adults are theorized to form attachments to each other, and adult attachment styles are often defined by feelings and behaviors in close relationships, often romantic relationships, during adulthood [10]. Adult attachment can be conceptualized as a two-dimensional model of attachment-related anxiety and attachment-related avoidance (described in [11, 12]). Attachment anxiety is about, e.g., fear of not being loved by a partner or that a partner may leave you. Attachment avoidance concerns unease with dependency and intimacy [12, 13].

Adult attachment styles have been studied in relation to diverse aspects of parenting (for a review see: [14]), and the relationship between adult attachment styles and maternal bonding has received some attention [15–18]. Van Bussel, Spitz and Demuttenaere [15] found weak associations between adult attachment patterns and maternal bonding. Chrzan-Detkos and Lockiewics [16] found a relationship between adult attachment and maternal bonding during pregnancy, but not with maternal bonding after birth. However, two studies [17, 18] found a relationship between adult attachment style and maternal bonding postpartum, and this relationship was mediated by depression. The variability in the results of the studies investigating the association between adult attachment style and maternal bonding makes evident the need for more research on this relationship and on the potential mediators of this link.

The transition to parenthood is considered stressful [19], inducing changes in many areas of life. Such stress may impact the mother-infant relationship [20, 21]. Parenting stress typically occurs when parenting demands exceed the parents' sense of accessible resources [22]. Parenting stress is often thought to arise from perceived challenges with the child's behavior, the relationship between the parent and child, and aspects related to the parent's health, life situation and perception of the parental role [22]. There is support for a negative relationship between parenting stress and maternal-infant bonding [6, 23]. Parenting stress is suggested related with decreased sensitivity in parents, and increased intrusiveness and hostility towards the child [24]. Individuals with difficulties in close relationships due to insecure attachment styles may experience increased stress as parents, feeling frustrated and overwhelmed, which may spill over to the quality of the mother-infant bond. Maternal-infant bonding is also negatively affected by mothers' depressive symptoms during pregnancy [3] and after birth [4, 25–27], depressive symptoms in both spouses [25], and symptoms of post-traumatic stress disorder [28].

As with maternal-infant bonding, the relationship between adult attachment and parenting stress has also been investigated in some studies. Adult attachment style has been found to relate to parenting stress, measured in the first year after birth [29–32]. Studies have found that attachment anxiety and attachment avoidance is related to increased parenting stress [14]. A recent study indicates that this effect is most prominent in mothers with high level on the attachment anxiety dimension. This includes mothers' sense of competence in parenting, partner support, isolation and the degree of feeling restricted by the parenting role [33]. The relationship between attachment style and parenting stress may be understood within attachment theory. In this theory, internal working models are thought to influence the perception of and coping with stressful experiences [34]. Thus, people with secure or insecure attachment patterns may have different ways of experiencing and coping with stressful events [34]. Hence, individuals with anxious or avoidant attachment styles may experience more relational distress and may also tend to cope with this distress in non-optimal ways [35]. This

group may therefore be more prone to experiencing higher levels of parenting stress.

Study aims

Mothers' adult attachment styles, parenting stress and maternal-infant bonding seem to be related. Parenting stress in the first year after birth has been related both to the parent's adult attachment style [29–32] and to maternal-infant bonding [6, 23]. The aim of the present study is twofold. First, we will explore associations between mothers' adult attachment styles and their bonding with their infants. Second, we will investigate parenting stress as a potential mediator between adult attachment style and maternal bonding postpartum. Parenting stress will be explored as a domain, but with a main focus on the subscales.

Method

Participants and procedure

The present study is part of the Northern Babies Longitudinal Study (NorBaby) [36] on risk factors of parental mental health problems, poor parent-infant interaction and infant development. Midwives recruited Norwegian speaking participants from the municipality of Tromsø during pregnancy. One week later, a member of the research team called the participants and planned a meeting for enrollment in the study. Between October 2015 and December 2017, 220 women and 130 partners were included in the study. From pregnancy to 6 months postpartum participants completed 6 measurement points: T1–T3 during pregnancy and T4–T6 after birth.

For the present study, only female participants who completed questionnaires relevant for the present study at T1 (between gestational weeks 13 and 34, mean 23.0, SD 3.61, median 23.0), T3 (between gestational weeks 31 and 41, mean 34.3, SD 2.18, median 34.0) and T4 (between 5 and 15 weeks after birth, mean 8.0, SD 1.74, median 8.0) were included. The reason for the time span for each measurement point are recruitment at different weeks of gestation (impacting responses at T1 and T3), and late responses from the participants (impacting responses at T3 and T4). Data were collected using an Internet-based survey during a meeting with a member of the research team (T1) and at home (T3 and T4).

Within 4 weeks of postdelivery, a subset of the families in the study ($n = 92$) completed up to three sessions with the Newborn Behavioral Observation program (NBO: [37]). In the present study sample, 71 (42.3%) of the participants were in the group participating in the NBO. The NBO is assumed to have the potential to enhance the relationship between the parent and infant, although it showed few effects on parenting stress and bonding in an earlier study based on the NorBaby study sample [38]. An investigation of the effects of the NBO is not part of the present study, but group membership will serve as a control variable.

Measures

Demographic and health information

Demographic information was collected at T1 and included maternal age, education, gross annual household income, marital status, whether the pregnancy was wanted and whether this was the parents' first child. Further, participants answered three questions concerning their mental health: first, whether they have been in contact with professionals for mental health issues; second, whether they have previously experienced being depressed most of the day and almost every day for a period of 2 weeks; third, whether they have previously had a two-week period of diminished ability to enjoy the things that they usually find enjoyable. In addition, the rate of premature births was calculated by determining the difference between the mothers' reported due date and the actual day of birth. Premature birth was defined as being born more than 3 weeks before the due date.

Adult attachment style

Adult attachment style was measured with the Experiences in Close Relationships questionnaire (ECR: 12) at T3. The ECR consists of 36 items, all of which are answered on a 7-point scale, from strongly disagree (1) to strongly agree (7). The 36 items are divided into the two dimensions of avoidance (18 items) and anxiety (18 items). The ECR mainly addresses attachment in romantic relationships. For example, the avoidance scale includes a focus on the degree of discomfort with being close to a romantic partner and the anxiety scale measures, among other things, the participants' worries about being abandoned and not being close enough to romantic partners. In the present study, Cronbach's alpha was 0.90 for ECR avoidance and 0.91 for ECR anxiety.

Parenting stress

Parenting stress was measured with the Parenting Stress Index – Parent Domain (PSI-PD: [39]) at T4. The PSI-PD is part of the PSI and is designed to measure stress in the parenting role and the relationship between parent and child. The PSI-PD consists of 7 subscales: competence in the parenting role (PSI-CO; 13 items), social isolation (PSI-IS; 6 items), support from spouse (PSI-SP; 7 items), depression (PSI-DP; 9 items), role restriction by the parenting role (PSI-RO; 7 items), attachment (PSI-AT; 7 items), and health (PSI-HE; 5 items). All items are answered using 4 or 5 response options. For the present study, the PSI-PD, a shortened version of the PSI-PD (PSI-PD5) and 5 of the subscales were used (PSI-CO, PSI-IS, PSI-SP, PSI-DP, and PSI-RO). The PSI-HE subscale was not considered theoretically relevant, and the PSI-AT subscale had a too close a

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thematic resemblance to the outcome measure. For the PSI-PD5, we therefore removed PSI-AT and PSI-HE from the composite score and did not include them when we tested the subscales as individual mediators. The Norwegian version of PSI has been translated by J. A. Rønning and has been used in earlier research [40]. In the present sample, Cronbach's alpha was 0.91 for PSI-PD, 0.90 for PSI-PD5, 0.77 for PSI-CO, 0.73 for PSI-IS, 0.64 for PSI-SP, 0.81 for PSI-DP and 0.71 for PSI-RO.

Parental bonding

Maternal bonding with the infant was measured with the Maternal Postnatal Attachment Scale (MPAS: [41]) at T4. The MPAS measures the emotional quality of bonding, hostility towards the child and the degree of pleasure in interacting with the child. The scale consists of 19 items. The items have varying response options, ranging from 2 to 5 response options. Eight items were reversed, and all response options were recoded, such that a score of 1 represented low bonding and 5 represented high bonding. The MPAS was translated to Norwegian by members of the research team in consultation with a professional translator. In the current study, Cronbach's alpha was 0.81 for the MPAS.

Statistical analysis

There were indications of challenges with normality, as skewness and/or kurtosis were above 1 for the MPAS, PSI-DP and ECR avoidance. Hence, a nonparametric approach was applied with Spearman's correlations and bootstrapping generated confidence intervals using 10,000 samples for the hierarchical regression analysis and mediation analyses. A hierarchical regression approach was applied to explore the effects of eight confounders (see Table 1) and the two ECR dimensions of anxiety and avoidance on the MPAS. In the first block, we included ECR anxiety and avoidance as predictors. In the second block, demographic information (maternal age, parenting experience, education, and family income) and allocation to the NBO or the control group were added. The mental health variables of mental health help seeking, previous experience with depression and previous lack of joy were added in the third block. Whether the pregnancy was wanted, marital status and prematurity were excluded due

Table 1 Sample demographics

Characteristics at T1	Mean (SD)	N (%)
Maternal age (years)	31.0 (4.23)	
Pregnancy wanted[a]		
Yes		161 (95.8)
Do not know		3 (1.8)
Parenting experience		
First-time mother		83 (49.4)
Second-time mother		67 (39.9)
Two or more previous children		18 (10.7)
Maternal education		
Upper secondary school or lower		20 (11.9)
Up to 4 years higher education		51 (30.4)
4 or more years higher education		97 (57.7)
Gross annual household income[b]		
350,000 NOK (39,672 USD) or less		7 (4.2)
351,000–750,000 NOK (39,785–85,011 USD)		41 (24.4)
751,000 NOK (85,125 USD) or more		119 (70.8)
Marital status		
Married or cohabiting		166 (98.8)
Single		2 (1.2)
Maternal mental health history		
Have been in contact with professionals for mental health issues		51 (30.4)
Previous experience with being depressed most of the day, almost every day for a period of two weeks		55 (32.7)
Having previously had a two-week period of diminished ability to enjoy things one has usually found enjoyably		68 (40.5)
Premature birth (more than 3 weeks before due date)[a]		6 (3.6)

N = 164–168; [a]Four missing values; [b]One missing value

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to little variability in the scores. The variables of gross annual household income and education were dummy coded, and parenting experience was recoded as "first-time parent" and "one or more previous children". A mediation analysis was conducted to investigate the indirect effect of ECR avoidance and anxiety on the MPAS through the PSI and to investigate their direct effect on the MPAS, while controlling for the PSI. First, we conducted mediation analyses with PSI-PD as a mediator. Second, we removed the subscales PSI-AT and PSI-HE from the PSI-PD and conducted mediation analyses with a composite of the remaining five subscales (PSI-PD5) as a mediator. Third, we conducted mediation analyses with the five subscales PSI-CO, PSI-IS, PSI-SP, PSI-DP, and PSI-RO as mediators. The eight potentially confounding variables used in the hierarchical regression analysis were all included as covariates in the mediation analyses. SPSS version 25 was used for the hierarchical regression analysis and descriptive statistics, and PROCESS version 3.1 [42] was used for the mediation analyses.

Missing values

Data from one participant were not included due to completion of T3 after birth. In addition, one participant withdrew from the study before completing T1. In addition, we did not include data from participants who did not respond at T3 or T4. This resulted in a sample of 168, participants from which we imputed missing values. There were no missing values for the variables ECR anxiety and ECR avoidance. SPSS expectation maximization (EM) missing value analysis (MVA) were used to impute missing values for respondents with valid data for a minimum of 50% of the items of the PSI-CO variable, PSI-IS variable, PSI-SP variable, PSI-DP variable, PSI-RO variable, PSI-AT, PSI-HE, and the MPAS variable. Imputations were conducted for respondents participating in both T3 and T4. For the imputed variables, missing values were reduced by between 8.0 and 0.4%. EM was chosen as the manner of imputation, because PROCESS [42] was not able to analyze multiple imputed datasets.

Results
Descriptive statistics

Table 1 reports the demographic data. The mean age for the sample was 31.0 years. A large proportion of the participants reported wanting this pregnancy (95.8%), currently living with a partner (98.8%), having a gross annual household income above 751,000 NOK (85,125 USD; 70.8%), and having higher education (88.1%). Approximately half of the study sample were first-time mothers (49.4%). A substantial number of participants reported that they had previously felt depressed (32.7%) or were less able to enjoy the things they usually find enjoyable (40.5%) for a period of 2 weeks. Furthermore,

30.4% had been in contact with professionals for mental health issues at some point during their life. A small portion (3.6%) of mothers gave birth prematurely.

Table 2 reports the means, standard deviations, potential range and correlations for the study variables. The PSI-PD, PSI-PD5, and all included subscales of the PSI were significantly related to the ECR anxiety and avoidance. These correlations were positive and ranged from .24 (PSI-RO) to .52 (PSI-PD and PSI-PD5). The PSI-PD, PSI-PD5, and all included subscales of the PSI were significantly related to the MPAS. These correlations were negative and ranged from −.42 (PSI-SP) to −.67 (PSI-PD). The MPAS correlated significantly with ECR anxiety (−.40) and ECR avoidance (−.32).

Hierarchical regression model with attachment style as a predictor of maternal infant bonding

Table 3 reports the hierarchical regression model that tested ECR anxiety and avoidance as predictors of scores on the MPAS. For the ECR subscales, variance inflation factors (anxiety 1.52 and avoidance 1.42) and tolerance (anxiety 0.66 and avoidance 0.70) did not indicate a serious problem with multicollinearity [43–45]. The first block with ECR anxiety and ECR avoidance was significant ($p < .001$), explaining 16% of the variance in the MPAS. In the second block, demographic information and allocation to the NBO or control group were added as predictors. The regression model was significant ($p < .001$), explaining 23% of the total variance in the MPAS. The third block that included the mental health-related variables was also significant ($p < .001$), explaining 25% of the total variance in the MPAS. The increase in explained variance between models one and two ($p = .054$) and models two and three ($p = .162$) was not significant. The ECR anxiety subscale was a significant individual predictor in the first two blocks ($p < .05$) but did not reach significance in the third block ($p = .097$). ECR avoidance was a significant predictor in all blocks ($p < .05$), with $p = .009$ in the third block.

Mediation analyses with parenting stress as a mediator

Mediation analyses testing PSI as a mediator between ECR and MPAS were performed in steps. First, we tested the full PSI-PD as a mediator. Then, we tested a reduced PSI-PD5 as a mediator. Finally, we tested the 5 subscales of the PSI-PD5 as mediators in the association between the ECR and MPAS. All potentially confounding variables from the last block of the hierarchical regression model were included as covariates in the mediation analyses. Confidence intervals for the direct and indirect effects were based on 10,000 bootstrap samples generated in the PROCESS. As there is no option for this in PROCESS, percentile bootstrap confidence intervals for the total effects were generated in separate regression

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Table 2 Descriptive statistics and Spearman's correlations between study variables

	Mean	SD	Potential range	ECR Anxiety	ECR Avoidance	MPAS
ECR Anxiety	47.26	18.17	18–126			
ECR Avoidance	30.13	12.05	18–126	.48**		
MPAS	82.02	7.98	19–95	−.40**	−.32**	
PSI-PD	114.28	21.69	54–270	.52**	.42**	−.67**
PSI-PD5	89.87	18.41	42–210	.52**	.44**	−.65**
PSI-CO	23.07	5.49	13–65	.40**	.38**	−.56**
PSI-SP	16.61	4.26	7–35	.33**	.34**	−.42**
PSI-IS	12.55	3.83	6–30	.39**	.37**	−.45**
PSI-DP	17.07	5.42	9–45	.48**	.38**	−.54**
PSI-RO	20.58	4.38	7–35	.38**	.24*	−.54**

ECR Experiences in Close Relationships, *MPAS* Maternal Postnatal Attachment Scale, *PSI-PD* Parenting Stress Index – Parent Domain, *PSI-PD5* Parenting Stress Index – Parent Domain with 5 subscales, *CO* Competence, *SP* Spouse, *IS* Isolation, *DP* Depression, *RO* Role Restriction; N = 168; *p < .01, **p < .0001

Table 3 Hierarchical regression analysis testing ECR Anxiety and Avoidance as predictors of MPAS

Block	Predictors	b (95% CI)	SE B	β	p	R²
1	ECR Anxiety	−0.10 (− 0.18, − 0.03)	0.04	−.23	.005	.16
	ECR Avoidance	−0.16 (− 0.29, − 0.04)	0.06	−.23	.010	
2	ECR Anxiety	−0.08 (− 0.15, − 0.01)	0.04	−.18	.030	.23
	ECR Avoidance	−0.19 (− 0.34, − 0.07)	0.07	−.28	.005	
	NBO Group	0.01 (−2.35, 2.33)	1.19	.00	.992	
	Maternal age	0.07 (−0.23, 0.38)	0.16	.04	.664	
	Parenting experience	3.08 (0.61, 5.48)	1.25	.19	.014	
	Maternal education[a]					
	Upper secondary school or lower	3.52 (−1.01, 7.83)	2.25	.14	.110	
	Up to 4 years of higher education	1.30 (−1.20, 3.89)	1.30	.07	.327	
	Gross annual household income[b]					
	351,000–750,000 NOK (39,785–85,011 USD)	−4.95 (−11.40, 0.50)	3.01	−.27	.085	
	751,000 NOK (85,125 USD) or more	−3.90 (−9.99, 1.40)	2.88	−.22	.153	
3	ECR Anxiety	−0.07 (−0.14, 0.01)	0.04	−.15	.097	.25
	ECR Avoidance	−0.19 (− 0.33, − 0.06)	0.07	−.27	.009	
	NBO Group	0.04 (−2.28, 2.31)	1.16	.00	.967	
	Maternal age	0.15 (−0.16, 0.46)	0.16	.08	.358	
	Parenting experience	3.35 (0.89, 5.74)	1.25	.21	.009	
	Maternal education[a]					
	Upper secondary school or lower	3.98 (−0.66, 8.35)	2.30	.16	.078	
	Up to 4 years of higher education	1.49 (−1.07, 4.16)	1.33	.09	.266	
	Gross annual household income[b]					
	351,000–750,000 NOK (39,785–85,011 USD)	−4.87 (−12.12, 1.04)	3.33	−.26	.124	
	751,000 NOK (85,125 USD) or more	−4.42 (−11.31, 1.34)	3.20	−.25	.142	
	Mental health help seeking	0.86 (−2.28, 3.84)	1.57	.05	.588	
	Previous experience with being depressed	−3.02 (−6.59, 0.37)	1.79	−.18	.093	
	Previous lack of joy	−0.14 (− 3.23, 3.16)	1.62	−.01	.930	

ECR Experiences in Close Relationships, *NBO* Newborn Behavioral Observation; [a]dummy coded variables with four or more years of higher education serve as a reference; [b]dummy coded variables with 350,000 NOK (39,259 USD) or less serve as a reference; "Mental health help seeking" = having been in contact with professionals for mental health issues; "Previous experience with being depressed" = Previous experience with being depressed most of the day, almost every day for a period of 2 weeks; "Previous lack of joy" = Having previously had a 2-week period of diminished ability to enjoy things one has usually found enjoyable; standard errors and confidence intervals were based on 9992 percentile bootstrap samples as SPSS did not generate the requested 10,000 samples; N = 166

analyses in SPSS. Approximately 10,000 bootstrap samples were generated for the total effects since the SPSS did not generate the requested 10,000 samples.

For all mediation models, there was a significant total effect of the ECR avoidance domain, $b = -0.230$, 95% [-0.360, -0.107 CI], and the ECR anxiety domain, $b = -0.123$, 95% CI [-0.203, -0.048], on the MPAS. There was no significant direct effect of the ECR avoidance domain on the MPAS when the PSI-PD, $b = -0.052$, 95% CI [-0.132, 0.033] or the PSI-PD5, $b = -0.063$, 95% CI [-0.150, 0.030], were included as a mediator. In the two separate mediation analyses, the ECR avoidance domain had significant indirect effects on the MPAS through PSI-PD, $b = -0.178$, 95% CI [-0.277, -0.100] and PSI-PD 5, $b = -0.168$, 95% CI [-0.258, -0.094]. There was also no significant direct effect of the ECR anxiety domain on the MPAS when the PSI-PD, $b = -0.006$, 95% CI [-0.055, 0.069], or the PSI-PD5, $b = -0.005$, 95% CI [-0.063, 0.054], were included as a mediator. In the two separate mediation analyses, the ECR anxiety domain had significant indirect effects on the MPAS through PSI-PD, $b = -0.128$, 95% CI [-0.188, -0.080], and PSI-PD 5, $b = -0.118$, 95% CI [-0.176, -0.073].

Figure 1 illustrates the two mediation analyses testing the 5 PSI subscales as mediators between the two ECR domains avoidance (Fig. 1a) and anxiety (Fig. 1b) and the MPAS. Regarding the ECR avoidance domain, there was no significant direct effect, $b = -0.071$, 95% CI [-0.152, 0.025], on the MPAS. The ECR avoidance had a significant indirect effect on the MPAS through the PSI CO, $b = -0.096$, 95% CI [-0.183, -0.038]. See Fig. 1 for the estimates. Regarding the ECR anxiety domain, there was no significant direct effect, $b = -0.016$ [-0.077, 0.051] on the MPAS. The ECR anxiety had significant indirect effects on the MPAS through the PSI CO, $b = -0.053$, 95% CI [-0.107, -0.018], and the PSI RO, $b = -0.029$, 95% CI [-0.066, -0.005]. See Fig. 1 for the estimates.

Discussion

The present study investigated the relationship between mothers' adult attachment styles and mother-infant bonding, in addition to exploring the mediating effects of parenting stress. To the best of our knowledge, we are the first to explore parenting stress as a mediator between mothers' attachment styles and mother-infant bonding. Our results show that a mother's attachment style, especially an avoidant style, relates to poorer mother-infant bonding 8 weeks after birth. In addition, the relationship between both attachment dimensions and bonding was mediated by parenting stress. The stress variable sense of competence in the parenting role mediated the relationship between attachment avoidance and bonding, and

sense of competence and role restriction mediated the relationship between attachment anxiety and bonding. Increased attachment avoidance and anxiety were related to increased stress, which was again related to decreased quality of bonding with the infant. Neither attachment-related avoidance nor attachment-related anxiety was directly related to mother-infant bonding when the parenting stress domains or subscales were included as mediators.

Our findings show that attachment avoidance and anxiety correlated negatively and significantly with maternal-infant bonding and positively with overall parenting stress and the stress subscales experience of competence in the parenting role, relationship with spouse, isolation, symptoms of depression and role restriction. This is in line with some previous studies that showed a relationship between adult attachment and different aspects of parenting [14], including parenting stress [32] and maternal-infant bonding [18], but contrary to one study that failed to find a significant association between adult attachment and maternal-infant bonding [16]. Further, in the hierarchical regression analysis, attachment anxiety and avoidance alone explained 16% of the variance in mother-infant bonding. Attachment anxiety did not reach significance in the last hierarchical regression model that included both adult attachment dimensions and that controlled for mental health history and demographic variables, but attachment anxiety was significant in the total effect of the mediation analysis when attachment avoidance was left out as a predictor. Attachment-related avoidance style addresses the degree to which one feels uncomfortable with closeness. In contrast, attachment-related anxiety concerns the extent of confidence one has in the availability and responsiveness of partners [12]. Normally, the mother-infant relationship is characterized by closeness, and the infant depends on his or her mother being psychologically available, interpreting his or her signals, giving comfort and taking care of his or her needs. Mothers high on the attachment avoidance dimension might feel uneasy and want to pull away from this new close relationship, thus impacting the quality of the mother-infant bond.

Separate mediation analyses for each adult attachment domain showed that the relationship with maternal-infant bonding was mediated by parenting stress, suggesting that parenting stress is important for the quality of maternal-infant bonding and that a mothers's adult attachment style is associated with parenting stress in the postpartum period. Depression [17, 18] and childbirth-related posttraumatic stress disorder [18] have previously been suggested as mediators between the aforementioned variables, and our results suggest that parenting stress is a mediator that closely falls in line with these studies. Parenting stress was a significant
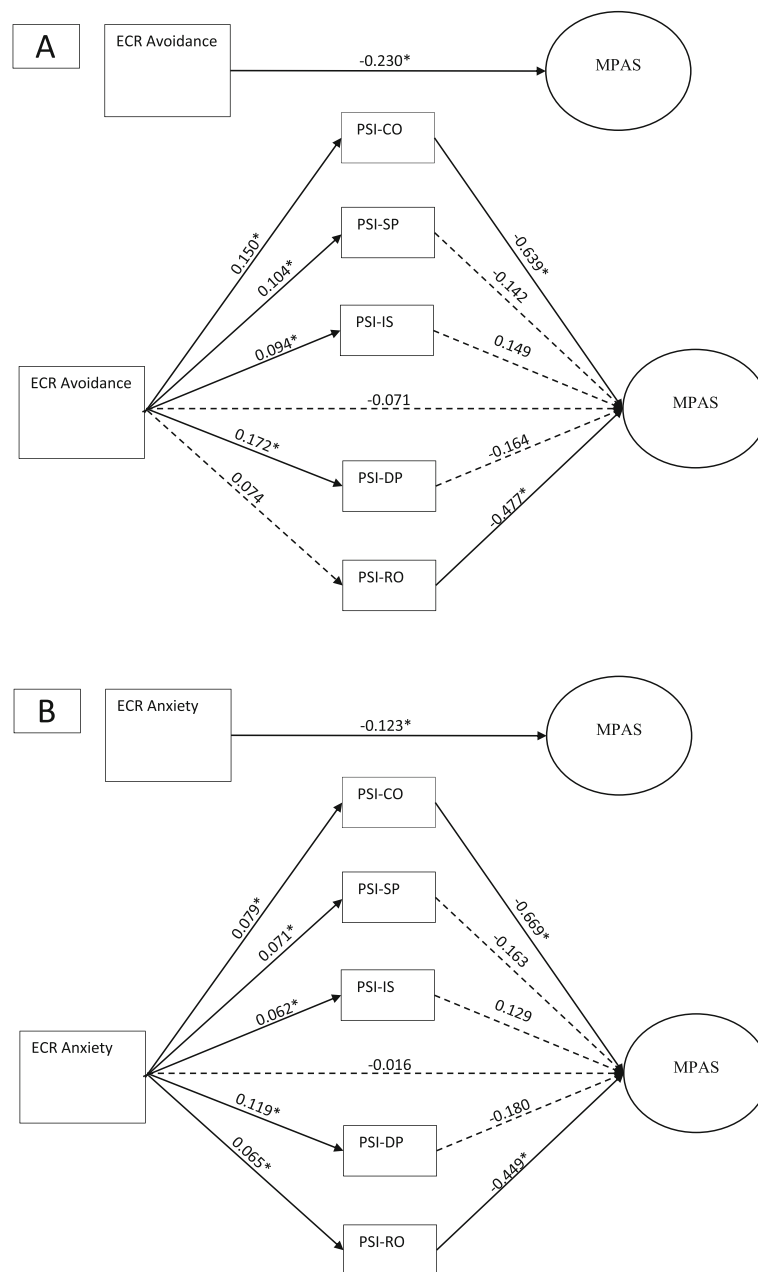
Fig. 1 Mediation analyses testing the PSI subscales as mediators between the ECR subscales and the MPAS. *ECR* Experiences in Close Relationships, *MPAS* Maternal Postnatal Attachment Scale, *PSI* Parenting Stress Index, *CO* Competence, *SP* Spouse, *IS* Isolation, *DP* Depression, *RO* Role Restriction; The covariates from the hierarchical regression analysis are included in the mediation analyses: maternal age, parenting experience, education, gross annual household income, mental health help seeking, previous experience with being depressed, previous lack of joy, and NBO–/control group allocation; coefficients represent unstandardized coefficients; non-significant relationships are in dashed lines and significant relationships are in solid lines and are also highlighted with an asterix; significance level based on 95% percent CI from 10,000 bootstrap samples; $N = 167$

mediator between adult attachment style and mother-infant bonding even when all confounding variables from the hierarchical regression analyses (e.g., demographics and mental health history) were included as co-variates. Both versions of the domains of parenting stress were significant mediators in the relation between

attachment dimensions and mother-infant bonding. For the included subscales of parenting stress, only mothers' sense of competence in the parenting role was significant as a mediator between the avoidance attachment style and maternal-infant bonding. Competence concerns beliefs about the ability to take care of a child and

make decisions as well as the ability to enjoy being a parent. For the anxiety attachment style, sense of competence and role restriction were significant as mediating variables in the relationship with maternal-infant bonding. Role restriction addresses the degree that a person experiences the parenting role as restricting, with a large focus on the child's needs and limited room to care for oneself. For both dimensions of adult attachment, higher scores on these variables were related to increased parenting stress, which was again related to decreased quality of maternal-infant bonding. According to theory, attachment avoidance mirror the tendency to deactivate the attachment system and to avoid closeness with others [46]. Thus, one explanation for our finding may be that mothers with higher scores on attachment avoidance may, to a lower degree, experience the close relationship with their children as reinforcing. The same mediating path emerged for the anxiety attachment style. It could be that mothers with higher scores on this domain worry about not being competent enough to care for their baby and that this has a negative impact on the emotional bond with the baby. The mediating effect of role restriction between attachment anxiety and mother-infant bonding was surprising. Mothers high on attachment anxiety are thought to cling to their partners. A possible interpretation may be that becoming a mother might increase anxiety in mothers high on this dimension and thereby increase their feeling of being restricted in their new role. Further, having a baby might influence the family system by reducing the experience of closeness with one's partner, and this may contribute to an experience of being restricted by the new baby and being less satisfied in the new role. Neither of the adult attachment dimensions showed a direct effect on maternal-infant bonding, meaning that the significant direct relationship between the attachment dimensions and bonding disappeared when parenting stress was taken into account. Mothers' bond with their infants are under development in the postpartum period, and our results show that the stress that mothers experience, and thus how they experience handling this life transition, is an important factor in the bonding process.

Implications

The results may have implications for research and clinical practice. There is a need for more studies on the relationship between adult attachment styles and maternal-infant bonding, including explorations of mental health-related variables as mediators. The association between mother-infant bonding and parenting stress is probably bidirectional, making the interpretation of our results difficult. Future studies should therefore also explore the mediating effect of parenting stress measured weeks before the assessment of mother-infant bonding

to better grasp the direction of this relationship. In addition to conducting such mediation studies with adult attachment styles, this could also be investigated with attachment-related concepts such as mothers' personality traits. Fathers are also important caregivers for children and should be included in future studies. Furthermore, future studies should also include a more disadvantaged sample than that included in the current study, as such a sample may have more problems in the areas of adult attachment style and mother-infant bonding and may reveal stronger results on the relationships between the study measures. In addition, a more at risk sample may reveal higher scores on the parenting stress variables than in the current study [47]. There is a possibility that variables such as stress related to isolation and support could have a higher impact as mediators in a more disadvantaged sample.

Exploring attachment-related mechanisms for the quality of mother-infant bonding may have clinical implications for the early identification of mothers at risk of having bonding difficulties. For example, as suggested by the results that the adult attachment style relates to parenting stress and that stress relates to bonding, reducing parenting stress in mothers of newborns with adult attachment difficulties may be an important intervention to increase mother-infant bonding. It may be beneficial to assess and aid in reducing parenting stress as early as before hospital discharge after childbirth in addition to follow up of highly stressed families after discharge. Parenting stress may have a range of sources as illustrated in this study. Thus, in addition to measuring an overall level of parenting stress, assessing subdomains of parenting stress might be of value as different profiles of parenting stress might benefit from different interventions. For example a mother high on stress related to sense of competence might find parental education and emotional support helpful, while high stress associated with the partner relationship will probably benefit from help in the direction of couple counseling (as suggested in [39]). Additionally, the effect of attachment based interventions for enhancing the quality of mother-infant bonding should be further investigated.

Strengths and limitations

The main strengths of the present study are the longitudinal design and the use of well-established measures. In addition, participants answered comprehensive questionnaires on demographic information. The study also has some limitations. First, the sample mostly consists of well-educated, economically sound participants living with a partner. The sample was generally low on attachment anxiety and avoidance and reported mostly good quality of mother-infant bonding, which can indicate that the participants were generally well functioning.

However, approximately one third of the participants reported experience of depression in the past, which might indicate some level of vulnerability. Second, parenting stress and mother-infant bonding were measured at the same time point. This means that even though the relationship between the variables was presented as stress mediating the relationship between attachment style and maternal-infant bonding, we cannot rule out a bi-directional relationship between these variables. Thus, the results of this study must be considered explorative. Exploring parenting stress as a mediator seems theoretically reasonable, and some argue that this justifies the use of mediation analyses of cross-sectional data [42]. Future studies should further explore the causal relationship between these variables. Third, the regression models are a clear simplification of reality, and the inclusion of other potentially relevant variables (e.g., infant temperament and mothers' temperament) might have changed our results. Fourth, all data were collected using self-reported measures. There is a possibility that an interview-based perspective on adult attachment might have given different results. In addition, assessing the parent-infant relationship with observational measures might have also given more information. Fifth, a larger sample size would have been preferable, given the large numbers of predictors in the regression analyses. Sixth, participants answered the measurement points at a span in weeks of gestation and weeks after birth. For exemple were the range of responding to T4 from 5 to 15 weeks after birth. The mother-infant bond may be different at 5 weeks after birth compared with 15 weeks after birth, and this might have impacted the results of the study.

Conclusion

Our results show that a mother's adult attachment style relates to her bonding with her infant. The avoidant adult attachment style was a significant individual predictor of maternal-infant bonding even when including a number of relevant confounding variables. Mediation analyses revealed that parenting stress is a mediator in this relationship. The overall parenting stress domain and the subscale of competence in the parenting role mediated the relationship between adult attachment avoidance and bonding. The overall parenting stress domain and the subscales of competence and role restriction mediated between attachment anxiety and bonding. The results may have implications for the early identification of mothers at risk of having bonding difficulties. We encourage more studies on attachment-based mechanisms for the quality of mother-infant bonding and on disentangling the relationships between attachment style, parenting stress and mother-infant boding.

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Paper 3

Høifødt, R.S., Nordahl. D., Landsem, I.P., Csifcsak, G., Bohne, A., Pfuhl, G., Rognmo, C., Braarud, H.C., Goksøyr, A., Moe, V., Slinning, K. & Wang, C.E.A. (2020).

Newborn Behavioral Observation, maternal stress, depressive symptoms, and the mother-infant relationship: results from the Northern Babies Longitudinal Study (NorBaby)

BMC Psychiatry, 20, 300.

RESEARCH ARTICLE

Newborn Behavioral Observation, maternal stress, depressive symptoms and the mother-infant relationship: results from the Northern Babies Longitudinal Study (NorBaby)

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Abstract

Background: Families can experience the postpartum period as overwhelming and many report a special need for support. The Newborn Behavioral Observation (NBO) aims to promote a positive parent-infant relationship by sensitising parents to the infant's signals. This article evaluates the NBO as a universal preventive intervention within the regular well-baby clinic service on measures of maternal depressive symptoms, parental stress, the mother-infant relationship and satisfaction/benefit of the postpartum follow-up.

Methods: This investigation is part of a larger longitudinal study comprising 220 women and 130 of their partners recruited between 2015 and 2017. The study had a non-randomised cluster-controlled design with 6 measurement points. This article is based on a sample of 196 women using data from T1 (gestational weeks 13–39), T4 (5–15 weeks postpartum) and T5 (3–9 months postpartum). Participants were allocated to a group receiving the NBO ($n = 82$) and a care as usual comparison group ($n = 114$). We measured maternal depressive symptoms and parental stress using the Edinburgh Postnatal Depression Scale (EPDS) and the Parenting Stress Index (PSI). The mother-infant relationship was assessed with the Parental Reflective Functioning Questionnaire (PRFQ), the Maternal Postnatal Attachment Scale (MPAS) and the Maternal Confidence Questionnaire (MCQ). Participants also answered questions about satisfaction/benefit of the postpartum follow-up.

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Results: A Mann-Whitney *U* test indicated that participants in the NBO-group learned significantly more than the comparison group from the follow-up about the baby's signals in relation to sleep/sleep patterns, social interaction and crying/fuzziness. Multivariate analyses of covariance (MANCOVA) and repeated measures ANCOVA found no significant differences between the groups for the mother-infant relationship domain and few differences in depressive symptoms and parental stress. The repeated measures ANCOVA found that participants in the NBO-group scored slightly higher on parental stress, although the difference was small.

Conclusions: The results indicate that the NBO-group learned more than the comparison group about reading their child's signals in important everyday situations. However, the benefits of the NBO were limited for depressive symptoms, parental stress and self-reported mother-infant relationship. The study sample was generally well-functioning, and the results indicate that the benefits of the NBO may be limited within a well-functioning sample.

Trial registration: ClinicalTrials, NCT02538497, Registered 2 September 2015.

Keywords: Newborn behavioral observation, Intervention, Parenting stress, Postpartum depression, Mother-infant relationship

Background

Becoming a parent is a major life transition, and the postpartum period is characterized by large biological and psychosocial changes [1]. Within these first weeks and months, parents start to know their infant, manage child-care tasks and the majority develop confidence and satisfaction in their new roles [2, 3]. However, families can experience the transition as overwhelming and many report a special need for support and care from their social network and professionals [4]. This increased vulnerability of the postpartum period points to the necessity of health care workers to empower families to reduce stress and strain, and to increase their ability to cope with their new circumstances. In addition, since these first months is a period of rapid development for the infant, the parents and the parent-infant relationship, this period serves as a "window of opportunity" during which intervention may contribute significantly in enhancing a positive transition [5].

Development of the parent-infant relationship

The newborn period entails an important transition for the parent-infant relationship. Newborns are predisposed to interact socially using their gaze, gestures, vocalisations and emotional expressions [6, 7]. Positive parent-infant interactions depend on the caregiver's ability to respond sensitively to these individually expressed signals [8]. The development of a healthy parent-child relationship and positive parenting is influenced by several factors, including parental well-being and their sense of competence and self-efficacy in caring for the infant [9, 10]. A central concept is parental reflective functioning (mentalization), i.e. the parents' capacity to understand and reflect upon one's own and the child's behaviours as expressions of underlying mental states [11]. Higher maternal reflective functioning is related to more positive maternal caregiving behaviours, especially

affective communication [12], and is intrinsically linked to sensitive caregiving [13]. Another important aspect is the emotional bond experienced by the parent towards the child, which can be seen as an affective and cognitive dimension of the parent-child relationship [14]. This bond develops during pregnancy, is fairly stable from pregnancy until toddlerhood [15], and is predictive of maternal sensitivity [16].

Through attuned, sensitive and responsive interactions parents give support and co-regulate the infant's physiological, motoric and emotional arousal and activation. Through this process parents have a central role in supporting the infant's development of self-regulation [17–19]. These patterns of early social interactions lay the foundation for the infant's emotional attachment to their caregiver, with more optimal interactional patterns being predictive of a more secure attachment in the child [20, 21]. Furthermore, the quality of the parent-infant relationship and attachment is related to the child's socio-emotional, cognitive and behavioural development [19, 22–25].

The impact of parental stress and depression on the parent-infant relationship

Several studies have pointed to the close and complex relations between parenting stress, depression and maternal-infant bonding, and these factors have an important impact on the well-being of parents, infants and the parent-infant relationship [26–29]. Some level of stress or insecurity related to managing the new circumstances and the daily parental responsibilities in the postpartum period is common [2, 30]. Parenting stress is a broad term describing distress related to the demands of the parental role, and is the consequence of perceiving these demands as exceeding the available resources for coping [31]. Parenting stress can be negatively related to parental bonding [27], the quality of parenting

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and parent-child interactions [31, 32] and child developmental outcomes [32, 33].

Some mothers develop serious emotional distress during the postpartum period, and the prevalence rates for postpartum depression range from 10 to 15% [1, 34, 35]. Postpartum depression may negatively affect the parent-infant bond [28, 36] and interaction [37, 38]. It may also increase the risk for psychological or developmental difficulties in the child, including insecure attachment, internalising and externalising problems, and impaired social competence and language development [26, 37, 39].

The newborn behavioral observation

The Newborn Behavioral Observation (NBO) is a relationship-based intervention delivered by NBO-trained health practitioners aiming to sensitise parents to the infant's capacities, uniqueness and behavioural communication cues [5]. By increasing parental competence and confidence the intervention may contribute to more sensitive parenting and a positive parent-infant relationship. Previous studies have included first time mothers of healthy infants in the US [40–42] and Norway (qualitative study [43];), as well as mothers in risk of depression (Norwegian feasibility study [44];). The NBO has been delivered between 1 and 3 times in hospital and/or home settings. These studies suggest that the NBO can increase maternal engagement [40], sensitivity [41] and understanding of the child's capacities and behavioural cues [40, 43, 44]. This may contribute to feeling more confident as a mother [43]. Results from a pilot-study indicated that receiving the NBO was associated with a reduced risk for depressive symptoms in first-time mothers [42].

Aims

The present study reports data from mothers included in the Northern Babies Longitudinal Study (NorBaby [45, 46];). The aim was to evaluate the NBO as a universal preventive intervention within the regular well-baby clinic service by investigating the association between receiving the NBO and measures of depressive symptoms/parental stress and the mother-infant relationship in the first 4 months postpartum. We had three main hypotheses. First, based on the pilot-study by Nugent et al. [42], we hypothesised that receiving the NBO would be associated with lower levels of maternal depressive symptoms and parenting stress. Second, we hypothesised that the NBO would be associated with a stronger mother-infant relationship, measured as maternal-infant bonding, reflective functioning and confidence in the parenting role. Third, we hypothesised that the NBO would be associated with higher satisfaction/benefit of the postpartum follow-up.

Methods

Study design

The present study is part of a longitudinal study that had a non-randomised cluster-controlled design. Participants completed 6 measurement points (T) as follows: during gestational weeks 16–22 (T1), 24–30 (T2) and 31(T3), and at 6 weeks (T4), 4 months (T5) and 6 months (T6) after birth. However, after study commencement the interval for T1 was extended to increase recruitment, and the intervals for the other measurement points were extended due to delayed responses from participants. This article is based on data from T1, T4 and T5 (see Table 1 for study design). Participants completed T1 between gestational weeks 13 and 39 (median 23.0, mean 23.0, SD 3.62), T4 between 5 and 15 weeks after birth (median 7.6, mean 8.1, SD 1.94), and T5 between 3 and 9 months after birth (median 4.0, mean 4.4, SD 0.83). The time between completing T4 and T5 ranged between 5 and 28 weeks (median 13.0, mean 13.1, SD 3.62). The study design and procedure have been described in more detail earlier [45].

Participants were allocated to the NBO intervention group or to care as usual based on their home address, which determined at which of five well-baby clinics they would receive their postpartum follow-up. Cluster randomisation of the well-baby clinics to learning the NBO was not feasible in this routine practice setting. Families belonging to one specific well-baby clinic received follow-up with the NBO plus care as usual. The NBO intervention was extended to three clinics during the study to increase the size of the NBO-group. Families at the remaining well-baby clinics received care as usual.

Participants and procedure

All Norwegian-speaking pregnant women and their partners from Tromsø municipality in Northern-Norway were eligible for inclusion. The recruitment period was between October 2015 and December 2017. Pregnant women and partners attending the antenatal clinic were recruited by midwives who gave information about the study. Potential participants agreeing to be contacted were later telephoned by a member of the research team for more information about the study and to plan a meeting for inclusion. The final sample recruited was 220 women (approximately 12% of pregnant women in the region) and 130 of their partners. All participants gave written informed consent. Data was collected by means of online questionnaires answered during a meeting with a member of the research team (T1), or from home (T4, T5).

The intervention

The NBO consists of 18 neurobehavioural observations focusing on the infant's behavioural repertoire within

Table 1 Study design and outcome measures

Outcomes	T1 Pregnancy	Care as usual plus NBO vs care as usual	T4 ~ 6 weeks postpartum	T5 ~ 4 months postpartum	Description of outcomes
Depression/stress					
EPDS	•		•	•	Symptoms of depression
PSI[a]			•	•	Stress in the parenting role and parent-child relationship
Mother-infant relationship					
MPAS			•	•	The emotional bond from a mother towards her child
PRFQ			•	•	Mothers' capacity to understand and reflect upon the child's behaviours as expressions of underlying mental states
MCQ			•		Sense of competence in the parenting role
Satisfaction/benefit with the postpartum follow-up			•		How much mothers learned about the child's signals and needs during follow-up. Satisfaction with the support and guidance received.

[a]The PSI-Parent domain was measured at T4, whereas both the PSI-Parent domain and the PSI-Child domain were measured at T5, *EPDS* Edinburgh Postnatal Depression Scale, *PSI* Parenting Stress Index, *PRFQ* Parental Reflective Functioning Questionnaire, *MPAS* Maternal Postnatal Attachment Scale, *MCQ* Maternal Confidence Questionnaire

the attentional-interactional, autonomic, motor and organisation of states domains [5]. This includes observations of responsivity to visual and auditory stimulation, capacity for habituation or sleep protection, amount of crying and ease of consoling, stress responses, reflexes, muscle tone and motor activity. Based on the observations, care giving strategies such as handling, sleep protection, comforting and regulation of social interaction are discussed [41]. The NBO takes 15 to 40 min to administer and can be used from birth until the infant is 3 months old. The observations are not performed as a checklist, but tailored to the needs of the individual family and the awake and sleep states of the infant [5]. Parents are encouraged to participate actively in the observation of their infant and to share their experiences, and the clinician meets them with a non-didactic and non-judgemental attitude. The overall aim is to provide tailored information and supervision related to parenting strategies based on the individual infant's signals.

In this study, the NBO-group received three NBOs as an additional component to care as usual: 1. At the maternity ward with a midwife within 2 days post-delivery, 2. At the routine home visit with a public health nurse at 7–10 days post-delivery, and 3. NBO consultation at the well-baby clinic at 4 weeks post-delivery (additional to usual care visits). The comparison group received care as usual at the maternity ward, a home visit with a public health nurse at 7–10 days post-delivery, and had their first meeting at the well-baby clinic at 6 weeks post-delivery. Care as usual also included guidance on topics such as feeding, early social interaction, sleeping patterns, motor development, safe environment, crying, handling and caring for the baby, and the parents' life situation and mental health [47]. In addition, the baby's weight gain was evaluated. The NBO was integrated as

part of the public health nurses' regular practice. However, a distinction is that in the NBO the guidance is given as part of the observation of the baby and tailored to the unique baby's state and behavioural communication cues, whereas care as usual may include more general guidance delivered as part of a conversation with the parents. The NBO was administered by certified midwives and public health nurses. They were instructed to keep logs after each NBO session to register the date of the NBO, who were present and which observation elements were performed.

Research measures
Demographic information was collected at T1 and included questions about mental health history, physical health, education, work status before pregnancy, gross annual household income, marital status, number of previous children, social support from family and friends, and whether the pregnancy was wanted. The following four self-report questionnaires have been included for a description of sample characteristics and pre-intervention group differences. Pregnancy related anxiety (fear of giving birth, concerns about one's appearance related to pregnancy, and fear of bearing a handicapped child) was measured with the 10-item Pregnancy-Related Anxiety Questionnaire-Revised (PRAQ-R [48];) at T1. Emotional, physical and sexual abuse, and household dysfunction during the parent's own childhood and adolescence was measured with the 10-item questionnaire Adverse Childhood Experiences (ACE [49];) at T1. Depressive symptoms during the last 2 weeks was assessed with the 21-item Beck Depression Inventory-II (BDI-II [50];) at T1. The mother's bonding towards her baby during pregnancy was measured with the 19-item Maternal Antenatal Attachment Scale (MAAS [51];) at T3

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(between gestational weeks 31 and 41, median 34.0, mean 34.4, SD 2.23). For more information about these instruments see the study protocol [45]. See Table 1 for study design and a short description of the outcome measures.

Depression/stress measures

Symptoms of depression were assessed with the Edinburgh Postnatal Depression Scale (EPDS [52];). The EPDS is a 10-item self-report inventory using a 4-point Likert scale. The inventory assesses sadness, anxiousness, lack of enjoyment, self-blame and thoughts about self-harm. The 10 items yield a total score, and a study on a Norwegian sample suggests ≥10 as a cut off score for possible clinical depression [53]. The EPDS was included at both T1, T4 and T5. In the present study, EPDS had an acceptable to good internal consistency (Table 2).

Parenting stress was assessed with the Parenting Stress Index (PSI [54];). The PSI is a self-report inventory designed to assess stress in the parenting role, in the relationship between the parent and child and related to the perception of the child. The instrument consists of two domains: Parent domain (PD) and Child domain (CD). The PD was measured at T4 and T5, whereas the CD was measured only at T5. The PSI-PD consists of 54

Table 2 Cronbach's alpha for the outcome measures

Outcomes	Cronbach's alpha		
	Total	NBO-group	Comparison group
Timepoint 4			
EDPS	.79	.78	.80
PSI – PD	.92	.90	.92
PRFQ			
PM	.37	.32	.39
CMS	.74	.75	.73
IC	.69	.66	.71
MPAS	.81	.81	.82
MCQ	.81	.69	.85
Timepoint 5			
EPDS	.82	.84	.80
PSI – PD	.92	.91	.93
PSI – CD	.89	.85	.91
PRFQ			
PM	.41	.31	.50
CMS	.82	.80	.83
IC	.64	.60	.67
MPAS	.82	.81	.83

EPDS Edinburgh Postnatal Depression Scale, *PSI* Parenting Stress Index, *PD* Parent domain, *PRFQ* Parental Reflective Functioning Questionnaire, *PM* Pre-Mentalizing, *CMS* Certainty about Mental States, *IC* Interest and Curiosity, *MPAS* Maternal Postnatal Attachment Scale, *MCQ* Maternal Confidence Questionnaire, *CD* Child domain

items, divided into seven subdomains: competence, parent-infant bonding/attachment, isolation (e.g., social isolation and lack of social support), health (e.g., parental physical health), spouse (e.g., support from spouse), depression and role restriction. The PSI-CD consists of 47 items, divided into six subdomains: distractibility/hyperactivity, adaptability (e.g., the child's ability to adapt to changes), parent reinforcement (e.g., experience of being liked by the child), demandingness, mood and acceptability (e.g., parental acceptance of the child). For the present study, we used the total scores from the PSI-PD and the PSI-CD. The Norwegian version of the PSI has been used in earlier research [55]. In the present sample, PSI had excellent internal consistency (Table 2).

Mother-infant relationship measures

Maternal bonding to the infant was measured at T4 and T5 with the Maternal Postnatal Attachment Scale (MPAS [14];). The MPAS is a self-report inventory consisting of 19 items, each with 2 to 5 response options, e.g., from "Very incompetent and lacking in confidence" to "Very competent and confident". All items have a minimum and maximum score of 1 and 5, respective, and some items are reversed. The MPAS measures the mother's pleasure in interacting with her baby, the mother's level of irritation towards the baby, and the quality of the maternal bonding, e.g., feeling proud of the baby. The 19 items yield a total score, with higher scores indicating healthier bonding. The current version of MPAS was translated to Norwegian by members of the research team, under the consultation of a professional translator. In the present study, MPAS had good internal consistency (Table 2).

Maternal reflective functioning was assessed with the Parental Reflective Functioning Questionnaire (PRFQ [56];) at T4 and T5. PRFQ consists of 18 items, with response options on a 7-point Likert scale from "strongly disagree" (1) to "strongly agree" (7). The 18 items are equally divided into 3 subscales. The subscales measure different aspects of parental reflective functioning and are analysed separately in previous studies and not summed up to a total score [56]. The subscales are: Pre-Mentalizing (PM) modes (e.g., attributing negative intentions to the child and a lack of focus on the child's inner life as a way of making sense of the child's behaviour), Certainty about Mental States (CMS; parents' ability to recognize that the child's inner experiences are not always apparent), and Interest and Curiosity (IC) in mental states. Higher scores on all scales signals higher capacity for reflective functioning, whereas on the CMS subscale both high and low scores may be less optimal, indicating overconfidence or a too high degree of uncertainty in understanding the child's states, respectively. The current version of the PRFQ was translated to

Norwegian by A. Goksøyr and H. Braarud. In the present study, the PRFQ subscales had low to good internal consistency (Table 2).

Maternal confidence in parenting skills and the mother's self-reported ability to perceive her child's needs was assessed with the Maternal Confidence Questionnaire (MCQ [57];) at T4. The MCQ consists of 14 items, with response options on a 5-point Likert scale from "never" (1) to "very often" (5). Examples of items are: "I have all the skills need to be a good parent" and "When my baby is cranky, I know the reason". Higher scores on the scale indicate a higher sense of competence. The Norwegian version of MCQ was used in earlier research [58]. In the present sample, MCQ had good internal consistency (Table 2).

Satisfaction/benefit of the postpartum follow-up measure

The mothers' experiences of the professional follow-up after birth were assessed at T4 using questions developed for the present study. The first domain which consisted of five questions was: "Through the follow-up you have received after birth from the maternity ward and the well-baby clinic, how much have you learned about the child's signals and needs in relation to:" (1) "the eating situation?", (2) "Sleep/sleep patterns?", (3) "Social interaction?", (4) "Nappy change?", and (5) "Crying/fuzziness?". The second domain which consisted of four questions was: "In the follow-up you received after birth from the maternity ward and the well-baby clinic, how much did you feel you could:" (1) "Share thoughts and concerns?", (2)"Ask questions", (3) "Get practical guidance?", and (4) "Have trust in the health care worker?". The last domain was: "Overall, to what extent do you feel that the follow-up has supported you and your family in a satisfactory manner?" Participants answered the questions on 5-point Likert scales from 1 ("Nothing"/"To a very small extent") to 5 ("Very much"/"To a very large extent"). These questions are treated as single items and Cronbach's alphas are therefore not reported.

Statistical analysis

All statistical analyses were carried out using IBM SPSS Statistics for Windows, Version 25.0 [59]. Analysis of missing values revealed that all dependent variables contained missing data with a total missing value frequency of 22.1% and with 97 participants providing data for all measures at each meeting. The majority of participants (40 cases, 18.2%) had only one missing value, whereas 24 cases (10.9%) missed at least 80% of our dependent variables. By excluding these 24 participants, the final analysis sample consisted of 196 participants (NBO-group: $N = 82$; comparison group: $N = 114$), with all providing data for each questionnaire on at least one of the post-NBO meetings. In our final sample, 8 participants

missed data collection at T4 (NBO-group: $N = 6$), while data from T5 was missing in 26 cases (NBO-group: $N = 9$). That is, 82.7% participated on both T4 and T5, even though some did not complete all scales or items. Moreover, data from the PSI was missing in most participants (PSI-PD: $N = 52$, PSI-CD: $N = 46$), but even here, the proportion of missing data from both groups were comparable (PSI-PD: NBO-group: $N = 22$ (26.8%), comparison group: $N = 30$ (26.3%); PSI-CD: NBO-group: $N = 18$ (21.9%), comparison group: $N = 28$ (24.5%)). Finally, data from the EPDS-T4, MCQ-T4 and PRFQ-T4 was collected in most cases ($N = 184$, NBO-group: $N = 76$ (92.6%), comparison group: $N = 108$ (94.7%)). We replaced missing data using the multiple imputation method with 50 iterations, by including data available from all scales and questionnaires as both predictors and predicted variables. Comparisons of participants missing the dependent variables ($N = 24$) with the final sample ($N = 196$) showed significant differences with regard to age, education, work status before pregnancy and annual household income. Missing participants were younger ($p = .007$, 29.0 vs 31.6 years), had a lower level of education ($p < .001$), lower income ($p = .018$) and were less often in full-time work before pregnancy and more often students ($p = .003$). There were no significant differences between the final sample and the excluded group on any other demographic or clinical variables.

By comparing basic demographic variables (e.g., age, well-baby clinic, level of education, gross annual household income, number of previous children, whether the current pregnancy was wanted, presence of any physical health problems, and previous occurrence of depressive symptoms, see Table 3 for all variables), a significant effect of group membership (comparison group vs. NBO) was found for the level of education only ($Z = -2.19$, $p = .028$), since the number of participants with 4 or more years spent in higher education was nearly twice in the comparison relative to the NBO group (74 vs. 41 participants, respectively). All other demographic parameters were comparable between the two groups ($p's > .08$ for all). Similarly, potential group differences in any of our baseline measures (BDI-II at T1, PRAQ at T1 and T3, ACE at T1, MAAS at T3) collected prior to the intervention were assessed using independent-samples t-tests, revealing no significant effect of group ($p's > .19$). Therefore, we added the level of education (3 levels: upper secondary school or lower, < 4 years or ≥ 4 years in higher education) as a covariate for all statistical analyses to control for the potential contribution of education to the observed effects. Given the cluster-controlled design of our study [45], we also included well-baby clinic as another covariate, coded as a dummy variable.

To assess the differences between the NBO-group and the comparison group, the sample size for our study was

Table 3 Description of demographic and clinical variables at inclusion for the groups receiving the Newborn Behavioral Observation (NBO) and care as usual ($n = 196$)

Variable	NBO ($n = 82$)	Comparison group ($n = 114$)	Test statistic (t or χ^2)	p-value	Effect size (Cohen's D or Cramer's V)
Mean age in years (SD)[a]	31.00 (3.96)	31.14 (4.46)	0.23	.82	.033
Marital status, n (%)					
Married or cohabiting	81 (98.8)	109 (95.6)	1.61	.20	.233
Education, n (%)[a]			4.84	.08	.701
Upper secondary school or less	12 (14.6)	10 (8.8)			
< 4 years higher education	29 (35.4)	29 (25.4)			
≥ 4 years higher education	41 (50.0)	74 (64.9)			
Work status before pregnancy[a]			5.04	.41	
Full-time	70 (85.4)	99 (86.8)			
Part-time	3 (3.7)	0			
Student	7 (8.5)	10 (8.8)			
Homemaker	0	1 (0.9)			
Unemployed	1 (1.2)	1 (0.9)			
Sick leave or disability benefits	1 (1.2)	2 (1.8)			
Family income, n (%)[b]			2.32	.31	
≤ 350,000 NOK (38,799 USD)	6 (7.3)	3 (2.6)			
351,000–750,000 NOK (38,910–83,141 USD)	21 (25.6)	29 (25.4)			
≥ 751,000 NOK (83,252 USD)	55 (67.1)	80 (70.2)			
Wanted pregnancy, n (%)[d]	79 (96.3)	108 (94.7)	0.28	.59	
Parenting experience, n (%)			0.45	.80	
First-time mother	38 (46.3)	57 (50.0)			
Second-time mother	37 (45.1)	46 (40.4)			
Two or more previous children	7 (8.5)	11 (9.6)			
Mental health, n (%)					
Lifetime mental health problems	28 (34.1)	40 (35.1)	0.02	.89	.003
Previous depressive symptoms[e]	28 (34.1)	36 (31.6)	0.14	.70	.02
Contact with mental health services	24 (29.3)	36 (31.6)	0.12	.73	.017
Physical health, n (%)			1.10	.58	
Pregnancy-related physical health problems[a]	25 (30.5)	37 (32.5)	0.08	.77	
Other physical health problems[c]	8 (9.8)	16 (14.0)	0.81	.37	
Social support, n (%)					
Family can help when in need	74 (90.2)	109 (95.6)	2.22	.14	.322
Friends can help when in need	72 (87.8)	104 (91.2)	0.61	.43	.088
Can confide in family	73 (89.0)	95 (83.3)	1.26	.26	.182
Can confide in friends	75 (91.5)	109 (95.6)	1.43	.23	.207
Clinical questionnaires, M (SD)					
Edinburgh Postnatal Depression Scale	4.30 (3.09)	4.66 (3.81)	0.50	.61	.072
Beck Depression Inventory-II	7.79 (4.15)	7.98 (5.89)	0.20	.84	.029
Pregnancy-Related Anxiety Questionnaire	23.26 (7.55)	23.55 (8.34)	0.25	.80	.036
Adverse Childhood Experiences	0.79 (1.37)	0.98 (1.67)	0.75	.45	.109
Maternal Antenatal Attachment Scale	73.63 (7.67)	74.86 (6.88)	0.56	.57	.081

Missing data: [a]$n = 1$, [b]$n = 2$, [c]$n = 3$, [d]$n = 4$, [e]Previous experience with being depressed most of the day, almost each day for a period of two weeks

Table 4 Means, standard deviations and range for all outcome measures for the NBO-group ($n = 82$) and comparison group ($n = 114$). For the PRFQ means, standard deviations and range is calculated per item

Outcomes	NBO ($n = 82$)		Comparison group ($n = 114$)		*t*-value	*p*-value	Effect size
	M (SD)	Range	M (SD)	Range			
Timepoint 4							
EDPS	3.61 (3.12)	0–14.00	3.55 (3.19)	0–13.00	0.41	.68	.059
PSI – PD	115.91 (18.56)	73.00–158.00	113.56 (21.89)	71.46–193.00	0.67	.50	.097
PRFQ							
PM	6.66 (0.39)	5.17–7.12	6.54 (0.49)	5.17–7.00	1.72	.09	.249
CMS	4.11 (0.88)	1.83–6.33	4.03 (0.91)	1.67–6.00	0.81	.42	.117
IC	5.88 (0.80)	2.67–7.00	6.02 (0.83)	2.67–7.00	−0.97	.33	−.14
MPAS	82.26 (7.27)	58.50–94.00	82.18 (7.68)	46.40–95.00	0.04	.97	−.006
MCQ	59.19 (4.03)	47.00–67.00	59.33 (5.75)	36.00–70.00	−0.08	.93	.012
Timepoint 5							
EPDS	3.15 (3.41)	−0.14 - 15.00	3.60 (3.44)	−0.82 - 14.00	−1.23	.22	−.178
PSI – PD	114.04 (20.87)	73.45–164.00	113.90 (23.52)	68.92–189.00	0.05	.96	.007
PSI – CD	84.00 (12.63)	57.00–123.00	86.51 (16.75)	53.00–159.00	− 0.41	.68	−.059
PRFQ							
PM	6.66 (0.37)	5.50–7.00	6.71 (0.38)	4.67–7.09	−0.83	.41	−.12
CMS	4.26 (0.97)	1.33–6.00	4.36 (1.01)	1.50–6.67	−0.72	.47	−.104
IC	6.19 (0.64)	4.00–7.00	6.08 (0.73)	3.17–7.00	0.84	.40	.122
MPAS	84.21 (6.46)	64.70–93.60	83.04 (7.67)	42.30–95.41	0.88	.38	.127

EPDS Edinburgh Postnatal Depression Scale, *PSI* Parenting Stress Index, *PD* Parent domain, *PRFQ* Parental Reflective Functioning Questionnaire, *PM* Pre-Mentalizing, *CMS* Certainty about Mental States, *IC* Interest and Curiosity, *MPAS* Maternal Postnatal Attachment Scale, *MCQ* Maternal Confidence Questionnaire, *CD* Child domain

based on a priori power analysis using multivariate analysis of variance (MANOVA) with an estimated effect size of $f^2 = 0.07$, a power of 0.8 and an alpha level of .05 [45]. This approach enables evaluating the joint effect of the intervention on psychometric scales sensitive to overlapping psychological constructs, accounting for possible covariations between them. We conducted separate MANCOVAs (Multivariate analysis of covariance) for testing the differences between the two groups on our two domains of interest: depressive symptoms/parental stress and mother-infant relationship, while controlling for the level of education and well-baby clinic. Separate analyses were performed at time points T4 and T5 (at ~week 6 and ~months 4 postpartum, respectively). We used scores from the EPDS, PSI-PD and PSI-CD for estimating maternal depression/stress (with PSI-CD being available at T5 only), whereas subscales from the PRFQ (PRFQ-PM, PRFQ-CMS, PRFQ-IC), the MPAS and the MCQ were used to assess the mother-infant relationship. Even though some variables showed signs of skewness and/or kurtosis (i.e., values > 1 or $< −1$) indicative of non-normal distributions, given the relatively large sample size of the current study and that assumptions of homogeneity of variances and covariance matrices were not violated (with the only exception of

the PRFQ-PM score collected at T4 with a significant Levene's test of $F(1,193) = 7.45$, $p = .007$), we decided to proceed with our original multivariate approach with reporting Pillai's trace statistics (V) and calculating 95% bias-corrected and accelerated (BCa) bootstrapped confidence intervals for the contribution of NBO status to each outcome variable [60]. For both domains of interest, separate analyses were performed at time points T4 and T5, with scores from the MCQ being available at T4 only. In order to investigate if the differences between the two groups were changing from T4 to T5, scores for the two domains were entered into repeated-measures ANCOVAs (Analysis of covariance) with Time (T4, T5) and Questionnaire (maternal depression/stress: EPDS, PSI; mother-infant relationship: PRFQ, MPAS) as within-subject variables, NBO-group as the between-subject variable, and Education and well-baby clinic as covariates.

Finally, responses to the questions regarding satisfaction with the follow-up from both groups were compared using Mann-Whitney U test. Potential variations in follow-up responses across the six well-baby clinics of intervention were assessed separately for the NBO and comparison groups with Kruskal-Wallis test. All statistical analyses were performed with an alpha value of .05,

with Bonferroni correction applied for follow-up ANO-VAs evaluating the contribution of each dependent variable to the joint effects revealed by the MANCOVA approach. Effect size is reported using Cohen's f^2.

Results

Demographic and clinical data for the two groups at inclusion/pre-intervention is reported in Table 3. Mothers in both groups had a mean age of approximately 31 years and above 95% were married or cohabiting. About half of the women in both groups were first-time mothers and a vast majority reported wanting this pregnancy. A substantial proportion of both groups had more than 4 years of higher education and reported having a gross annual family income above 750,000 NOK (~ 83,252 $), and above 85% in both groups were working full-time before pregnancy. About one third in both groups reported lifetime mental health problems, previous depressive symptoms and having been in contact with mental health services at some point during their life. However, participants in both groups scored well below the clinical threshold on the EPDS at inclusion (Table 3). For a description of the full sample ($n = 220$) see Supplementary Table 1. Scores on all outcome measures for both groups can be found in Table 4.

Exposure to the intervention

The NBO-logs filled out by midwives and public health nurses after each NBO session indicated that NBO was delivered to 64.1% of mothers in the NBO group at the maternity ward, 71.7% at the home visit, and 69.6% at the well-baby clinic at 4 weeks after birth. Thus, 7.6% of mothers in the intervention group received 1 session with NBO, 33.7% received 2 sessions, and 43.5% received 3 sessions. This means that at least 84.8% of the mothers in the intervention group received at least one NBO session, and thus, were exposed to the intervention content. The logs indicated that 15.2% did not receive the intervention at all. However, communication with the maternity ward and well-baby clinics delivering the NBO indicated that it took some time before filling out the logs became part of the routine. Therefore, the reported numbers should be interpreted as conservative estimates, as it is likely that NBO sessions were performed without the health care worker keeping a log.

Maternal depressive symptoms/parental stress

Testing for the difference between the NBO- and the comparison group on depressive symptoms/parental stress, we did not find significant differences at any time point in the multivariate analysis (at T4: $V = 0.015$, $F(2,186) = 1.41$, $p = .246$, $f^2 = .015$; at T5: $V = 0.027$, $F(3,185) = 1.69$, $p = .170$, $f^2 = .027$). Moreover, we found no significant effects of group membership

for any questionnaire score when tested separately at each time point (EPDS-T4: $F(1,187) = 1.48$, $p = .225$, $f^2 = .008$; PSI-PD-T4: $F(1,187) = 2.78$, $p = .094$, $f^2 = .015$; EPDS-T5: $F(1,187) < 0.01$, $p = .985$, $f^2 < .001$; PSI-PD-T5: $F(1,187) = 2.34$, $p = .128$, $f^2 = .012$; PSI-CD-T5: $F(1,187) = 0.11$, $p = .736$, $f^2 = .001$). However, we found a significant main effect of Education (at T4: $V = 0.06$, $F(2,186) = 5.56$, $p = .004$, $f^2 = .06$; at T5: $V = 0.08$, $F(3,185) = 5.37$, $p = .001$, $f^2 = .09$), such that participants with the highest education level (≥ 4 years in higher education) scored lower on the EPDS but not on the PSI at T4 and T5 (EPDS-T4: $F(1,187) = 10.84$, $p = .001$, $f^2 = .06$, $b = -1.06$, BCa 95% CI [-1.70, -0.42]; EPDS-T5: $F(1,187) = 11.27$, $p = .001$, $f^2 = .06$, $b = -1.20$, BCa 95% CI [-2.00, -0.39]; PSI-PD-T4: $F(1,187) = 2.44$, $p = .120$, $f^2 = .01$, $b = -3.41$, BCa 95% CI [-7.44, 0.78]; PSI-PD-T5: $F(1,187) = 1.23$, $p = .269$, $f^2 = .01$, $b = -2.58$, BCa 95% CI [-7.26, 1.86]; PSI-CD-T5: $F(1,187) = 0.74$, $p = .390$, $f^2 = .004$, $b = 1.31$, BCa 95% CI [-1.72, 4.16]).

We also performed a repeated-measures ANCOVA with EPDS and PSI scores collected at T4 and T5 as predictors. We did not observe a significant main effect or interactions for group-allocation (NBO vs. comparison group; F's < 2.92, p's > .088, f^2's < .016). However, after controlling for EPDS scores collected at baseline (T1), both the main effect for NBO group ($F(1,186) = 4.61$, $p = .033$, $f^2 = .02$) and the interaction between NBO and Questionnaire were significant ($F(1,186) = 4.49$, $p = .035$, $f^2 = .02$), with the latter indicating comparable EPDS values between the two groups ($p = .172$), but higher PSI scores in the NBO group ($p = .033$, Bonferroni-corrected). However, these effects were not significant when including only first-time mothers in the analysis (F's < 3.61, p's > .060, f^2's < .041).

Finally, we investigated the proportion of participants in the two groups who scored above a cutoff of 10 on the EPDS, indicating possible clinical depression [53]. At T4, this included 4.9% ($n = 4$) and 6.1% ($n = 7$) of the NBO- and comparison group, respectively. The numbers at T5 were 4.9% ($n = 4$) and 4.4% ($n = 5$), respectively. The differences between the groups were not significant at either time point (T4: Fisher's exact: $p = .76$, T5: Fisher's exact: $p = 1.00$).

Mother-infant relationship measures

As for the mother-infant relationship domain (PRFQ-PM, PRFQ-CMS, PRFQ-IC, MPAS and MCQ), there was no significant main effect for NBO at any time point (at T4: $V = 0.04$, $F(5,183) = 1.56$, $p = .171$, $f^2 = .04$; at T5: $V = 0.03$, $F(4,184) = 1.25$, $p = .289$, $f^2 = .03$). Testing the effect of NBO separately for each questionnaire and each time point did not yield significant results either (PRFQ-PM-T4: $F(1,187) = 0.43$, $p = .513$, $f^2 = .002$; PRFQ-CMS-T4: $F(1,187) = 1.58$, $p = .210$, $f^2 = .008$; PRFQ-IC-T4: $F(1,$

187) = 0.46, p = .500, f^2 = .002; MPAS-T4: $F(1,187)$ = 2.11, p = .148, f^2 = .011; MCQ-T4: $F(1,187)$ = 0.17, p = .681, f^2 = .001; PRFQ-PM-T5: $F(1,187)$ = 1.52, p = .219, f^2 = .008; PRFQ-CMS-T5: $F(1,187)$ = 0.36, p = .550, f^2 = .002; PRFQ-IC-T5: $F(1,187)$ = 1.19, p = .276, f^2 = .006; MPAS-T5: $F(1,187)$ = 0.97, p = .325, f^2 = .005). Repeated-measures ANCOVA investigating between-group differences in changes in PRFQ and MPAS scores over time (from T4 to T5) indicated no significant main effect for the NBO group ($F(1,187)$ = 0.28, p = .598, f^2 = 0.001), but a significant three-way Time x NBO x Questionnaire interaction ($F(3,561)$ = 3.92, Greenhouse-Geisser ε = .9, p = .011, f^2 = .02). However, Bonferroni-corrected post hoc comparisons revealed no significant differences between the two groups for any questionnaire score at any time point (p's > .147).

Satisfaction/benefit of the postpartum follow-up

Finally, we compared responses to our follow-up questions at T4 (mean 8.1 weeks postpartum) asking either about how much they learned during the previous consultations with the healthcare professionals about the child's signals and needs in everyday situations (i.e. eating, sleep/sleep patterns, social interaction, nappy change, crying/fuzziness) or inquiring about their feelings related to the interaction with healthcare professionals and their satisfaction with the meetings. Here we found significantly higher scores indicative of more efficient interventions for the NBO group for questions related to sleep/sleep patterns (Z = -2.98, p = .003), social interaction (Z = -2.79, p = .005) and crying/fuzziness (Z = -3.93, p < .001). We did not find differences in the distribution of responses between the well-baby clinics for either group of participants (NBO: H(2) < 4.3, p > .11; comparison group: H(2) < 5.12, p > .27).

Exploratory analysis including only first-time mothers

As an exploratory analysis, we conducted the above tests by including only first-time mothers, as we considered the possibility that NBO would lead to more beneficial outcomes for this group (due to the lack of previous experience with being a mother). This subsample consisted of 59 participants without NBO and 36 participants allocated to the intervention-group. However, this did not change the above results. The only exception was that these analyses failed to find significant group differences for any of the questions regarding satisfaction/benefit of the follow-up, with the item asking about social interaction showing a trend only (Z = -1.90, p = .057). This was possibly due to the highly reduced power of these exploratory analyses.

Discussion

The present study evaluated the association between postpartum follow-up with the NBO and a broad range of measures related to maternal depressive symptoms, stress, the mother-infant relationship and satisfaction/benefit of the postpartum follow-up. The results confirmed only one of our original hypothesis as they indicated that the NBO-group reported significantly higher benefit of the postpartum follow-up compared to the comparison group. Specifically, they learned significantly more from the follow-up about the baby's signals and needs in relation to sleep/sleep patterns, social interaction and crying/fuzziness. Our hypothesis that the NBO would be associated with lower levels of depressive symptoms and parenting stress and higher scores on assessments related to the mother-infant relationship were not confirmed. For the mother-infant relationship domain neither the MANCOVAs, nor the repeated measures ANCOVA did show significant benefit for the NBO-group for either time point. Also, on the depressive symptoms/parental stress domain there were few differences between the groups. However, in the repeated measures ANCOVA we found a numerically small, but significant difference between the groups on the PSI Parent Domain, with the participants in the NBO-group indicating slightly higher parental stress.

The most clear-cut differences between the groups were found for questions regarding the participants' experience of the postpartum follow-up, specifically, how much they learned about the baby's signals and needs. These questions most directly tap into how participants experienced the NBO. The significant differences between the groups for the areas of sleep/sleep patterns, social interaction and crying/fussiness correspond well with the content of the intervention [5]. Social interaction is an overarching focus of the NBO and several observational elements focus on this. In addition, the intervention also includes specific elements concerning sleep/sleep protection and strategies for supporting and comforting the baby. These results correspond well with the results from another Norwegian study of the feasibility and acceptability of the NBO showing that parents rated the intervention as highly useful with regard to understanding the behavioural cues of their infants [44]. It should be mentioned that the comparison group also received follow-up by skilled health care professionals and provided as high ratings as the NBO-group on general satisfaction with the follow-up, the practical guidance and the relationship with the health care worker. Despite this strong comparator, the NBO-group rated important parts of the follow-up significantly higher. Compared to general guidance a key feature of the NBO is that it provides guidance that is tailored to the observations of the unique baby's state and communication cues. The

present result emphasizes that using the NBO clearly provides parents with a better grasp of the baby's signals and needs in important everyday situations. This could over time, potentially have extended effects on other important parental outcomes such as sensitivity, and child developmental outcomes. However, although parents rated the intervention as useful, we do not have information about the actual sleep patterns of the infants or observational measures of parental behaviours and parent-infant interaction.

The results from the mother-infant relationship domain did not support our hypothesis that the NBO would be associated with higher levels of maternal bonding, reflective functioning and confidence. Thus, our results were not in line with earlier research indicating that the NBO can significantly increase maternal engagement [40], confidence [43] and maternal sensitivity [41]. However, the present study did not include any observational measures of actual mother-infant interaction, which could possibly have shed additional light on this issue.

Also, the lack of differences between the groups on the depressive symptoms/parental stress domain was contrary to our hypothesis. We found no main effect of the NBO when looking at the overall depressive symptoms/parental stress domain comprising of both the EPDS and the PSI– Parent domain at T4 and T5 using MANCOVAs. Nor did we find an effect of the NBO when investigating potential differences between groups in number of participants scoring above cut-off for probable clinical depression. Hence, our findings contradicts the results of a previous pilot-study [42] which indicated that the use of NBO may be associated with a substantial reduction in the risk of major depression. In the repeated-measures ANCOVA we found significantly higher PSI Parent Domain scores for the NBO-group. However, the mean difference between the groups was numerically very small (< 2.5 points) and difficult to interpret as both groups scored low on parenting stress compared to women with postpartum depression [61]. Further studies are needed to evaluate if this is a reliable effect of the NBO or a spurious finding.

Overall, the present study found limited benefits for the NBO for both the mother-infant relationship domain and the depressive symptoms/parental stress domain. This could possibly be due to the generally well-functioning sample, based on their educational level, social support, pre-pregnancy work status and income. The mean level of depressive symptoms was low at all measurement points, and the level of maternal stress was low compared to women with postpartum depression [61]. Scores on the MPAS and MCQ were also high for both groups indicating high levels of mother-infant bonding and maternal confidence. There is a possibility

that the high functioning of this sample did not give much room for significant enhancement by receiving the NBO, neither on the depressive symptoms/parental stress domain nor on the mother-infant relationship domain. Two previous studies of NBO conducted in the US with a more limited sample size have indicated that the intervention may have beneficial effects by reducing the odds of depression in first-time mothers [42] and increasing sensitivity in mother- infant interactions [41]. Contrary to this, our results suggest that the benefits of the NBO on depressive symptoms, parenting stress and measures related to the mother-infant relationship may be limited within a general population sample with particularly well-functioning participants. Similar results were found in a meta-analysis showing that interventions to enhance parental sensitivity were in general more effective in clinical samples compared to non-clinical samples [62]. Furthermore, a recent study of a video-based intervention to improve the parent-infant relationship did not find significant effects of the intervention for well-functioning parent-child dyads [63], despite positive effects for similar interventions within risk families [64]. In line with this, the NBO may possibly have more significant effects on depressive symptoms, parenting stress and mother-infant relationship measures within a risk population. In addition, as previously mentioned, also the comparison group received close follow-up focus in on similar topics as the NBO from well-trained health professionals. The high quality of the usual care is also supported by the high satisfaction with postpartum follow-up reported by the comparison group. This makes it even more challenging to reveal significant intervention effects in a largely well-functioning sample. Lastly, as shown by the intervention logs, although the majority of participants in the NBO-group received one or more sessions, not all participants received the full 3-session intervention and 15% did not receive any sessions. This may have reduced group differences.

Strengths and limitations

The present study has some strengths. The study is a longitudinal study following participants from pregnancy until the baby was 6 months old. Participants completed comprehensive measures on important demographic and clinical variables, as well as important variables related to the parent-child relationship and parental functioning. The outcomes were assessed using standardised, reliable and validated measures developed for use with the current population [14, 54, 56, 65–67]. Another strength is that the intervention was delivered within regular practice as part of the routine postpartum follow. The study also has several limitations. Unfortunately, individual or cluster randomisation of participants to the NBO

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and comparison group was not feasible within this routine practice setting. However, the only group difference at inclusion was on educational level, where the intervention group had a slightly lower educational level than the control group. Controlling for this variable in the analyses did not make any difference to the results. Potentially there could be differences between participants belonging to different well-baby clinics. However, controlling for this variable did not affect the results. Another limitation is that far from all families received all three NBO sessions. An additional limitation with the design is that the NBO-group received one additional follow-up session compared to the comparison group (NBO at 4 weeks postpartum). This adds some uncertainty to the results as it cannot be ruled out a dose-response effect of the NBO or that any benefits of the NBO could be related to receiving more follow-up from a health professional rather than to features of the intervention itself. Other limitations concern the measurements. Although well-validated questionnaires were chosen all variables included in this study were measured using self-reports. Including interviews could have provided for instance more reliable diagnostic information. In addition, it was impossible to collect pre-measures filled-out before the intervention for several of the outcome variables. This is due to the fact that these measures focus on the experience of being a parent, and thus cannot be answered before the baby is born. As the first NBO-session was delivered already within 2 days post-delivery, there was no time to include pre-measures for the parental questionnaires. However, for the EPDS we did control for depressive symptoms before birth. Another limitation concerns the low internal consistency of the PRFQ subscale pre-mentalizing for both time points. Earlier research has found acceptable internal consistency for this subscale [56], but also internal consistency in the low range [68]. One possibility for the low reliability in our data may be that some of the questions were difficult for parents to answer at this early stage of infancy since the scale is designed for parents of children up to several years old [56]. Additionally, for some of the PRFQ-items the socially acceptable answers might be quite easy to pick up by the participants. Lastly, the sample was generally well-functioning. Most participants were married or cohabiting with high levels of perceived social support and a large proportion had higher education, were working full-time before pregnancy and had a quite high family income. The mean level of depressive symptoms was low at all time points, despite about a third of the sample reporting previous mental health problems. Due to the generally high socioeconomic status of the sample, the generalisability of the results to other less advantaged populations is uncertain.

Conclusion

Although, the associations between the NBO, maternal mental health and relationship measures were scarce, the results imply that participants from the NBO-group learned more than the comparison group about reading their infant's signals in important everyday situations related to social interaction, sleep/sleep patterns and crying/fuzzyness. Our results suggest that the benefits of the NBO may be limited within a general population sample of particularly well-functioning participants. However, more research is needed to investigate if the effects of the NBO could be stronger on other outcome measures, such as measures of child development, parent-infant interaction and child attachment classification, or with more disadvantaged populations. There is also a possibility that the effects from the NBO could be more evident later on, as is evident from other studies using different interventions [69]. We therefore encourage future studies to explore the effects of the NBO within a longer time frame.

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Availability of data and materials
The dataset used during the study is available from the corresponding author on request.

Ethics approval and consent to participate
Ethics approval for the study was obtained from the Regional Committee for Medical and Health Ethics in Northern Norway (2015/614). All participants gave written informed consent.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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