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Prenatal bonding to the fetus: its associated factors in mothers and fathers and its predictive relevance for the postpartum dissatisfaction with motherhood

Dissertation

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Synopsis

This synopsis presents the work of my dissertation, which I conducted in the PAULINE research project at the Department of Child and Adolescent Psychiatry, Psychotherapy and Psychosomatics at the University Medical Center Hamburg-Eppendorf (UKE). My dissertation focuses on the emotional bond parents develop to the fetus during pregnancy as one important aspect of the adjustment process to parenthood. Research on parental-fetal bonding has gained increased attention in recent years due to its hypothesized relevance for the postnatal parent-child relationship and the transgenerational transmission of attachment patterns. However, prior research has led to mixed results and many factors influencing parental-fetal bonding remain unknown. In particular, the paternal perspective on bonding to the fetus and couple dynamics, and the role of parental-fetal bonding for the postnatal adjustment to parenthood is still not fully understood.

My research aims were i) to gain insight into the reported heterogeneity for associations of maternal-fetal bonding with prenatal anxiety, and the relevance of adult attachment styles, ii) to broaden the scope in the research field by assessing both maternal and paternal bonding to the fetus and investigating associations of parental-fetal bonding with prenatal hostility and partners anxiety and hostility, and iii) to shift the focus to the postnatal period by investigating the predictive relevance of maternal-fetal bonding for the postnatal dissatisfaction with motherhood. Further, for the purpose of this study, two questionnaires assessing parental-fetal bonding and pregnancy-related anxiety were translated into German and their psychometric properties investigated. Five research articles focus on these aims individually. At the time of handing in this dissertation for my defense, four of these articles were published in international, peer-reviewed journals. One article had been submitted to *Midwifery*. Thus, this current synopsis is an updated document including the published version of the last article.

Chapter 1 of this dissertation introduces the theoretical and empirical background on parental-fetal bonding in the context of the adjustment to parenthood in the peripartum period, on the associated factors investigated, and on expected associations with postnatal dissatisfaction with motherhood. Finally, the main research questions are summarized. In chapter 2, the study design and samples, procedure and materials are described. Chapter 3 summarizes the results of the five studies forming the main body of this dissertation. In chapter 4, the main results and their implications for future research and clinical practice are discussed, as well as strengths and limitations of this dissertation.

1. Introduction

Being a parent is a lifelong experience starting already before the child is born. As the pregnancy progresses, expectant parents develop an emotional bond to their child (Rubin, 1967). This parental-fetal bond is one part of the prenatal adaptation process, along with cognitive processes of preparing for the postpartum period and parental role. Having a child affects many aspects of the parents' life, which might lead to insecurities and increased distress in the peripartum period. This can manifest in anxiety or hostility and might interfere with committing to pregnancy and with the developing parental-child bond (Raphael-Leff, 2005). Evidence indicates that the parental-fetal bond is associated with prenatal pregnancy-related health behavior, postnatal parent-child bonding, the quality of the mother-child interaction, and the infant's attachment security, which has the potential of a long-lasting effect on the child's socioemotional development (Grossmann et al., 2008). Thus, it is of clinical relevance to understand which factors influence the development of parental-fetal bonding.

However, in the current literature, divergent results on associations of parental-fetal bonding with forms of prenatal anxiety have been reported (Yarcheski et al., 2009), and little research on the association of parental-fetal bonding with parental hostility has been conducted. Further, little is known about the emotional bonding to the fetus in expectant fathers and about the influence of the partner's anxiety and hostility on parent's own bonding. Finally, only few studies (Field et al., 2003; Graham et al., 2002) have investigated the relevance of maternal-fetal bonding for the experience of motherhood in the postpartum period. Understanding influencing factors on parental-fetal bonding and its predictive relevance for a dissatisfying postnatal maternal experience is crucial to gain more insight into the complex dynamics during the transition to parenthood and to offer optimal support for struggling parents.

1.1 Parental-fetal bonding

Developing an emotional bond to the fetus is one of the central tasks in the prenatal adjustment process (Mercer, 2004; Rubin, 1976). Parental-fetal bonding has gained growing attention in the literature in recent years (Yarcheski et al., 2009). This might be due to the unique quality of this bond, since it develops without a reciprocity in direct interaction with another person (Müller, 1993). It is thus understood as the emotional disposition for the postnatal parent-child bond

(Condon, 1993) and is discussed as one mechanism relevant for the transmission of attachment patterns across generations.

The term attachment is by researchers often used synonymously to bonding (Brandon et al., 2009; Walsh et al., 2014). However, it is important to differentiate the parental-fetal relationship from the understanding of attachment shaped by John Bowlby's attachment theory, which focuses on the child's experience in the parent-child relationship. In case of dangerous or stressful situations, the attachment behavioral system of the child is activated to increase proximity to the caregiver with the goal to receive security, protection and care (Bowlby, 1969). Therefore, the term attachment is often associated with the perspective of the child seeking care, and not with the perspective of the parent as a caregiver. Thus, in this work the label parental-fetal bonding is used.

In the literature, a huge variety in terminology, conceptualization and assessment of parental-fetal bonding exists (Brandon et al., 2009; van den Bergh and Simons, 2009). Three main concept definitions and their corresponding questionnaires are briefly summarized. Cranley (1981, p. 282) defined the developing bond as "the extent to which pregnant women engage in behaviors that represent an affiliation and interaction with their unborn child", including not only perceptions of the affective relationship, but also maternal identity and caregiving preparation behavior. She developed the Maternal Fetal Attachment Scale as the first questionnaire systematically assessing the construct (MFAS; Cranley, 1979). Contrary, Müller (1993) understood the construct excluding maternal behavior and attitudes towards the maternal role or pregnancy. Müller focused on the affective relationship towards the unborn and developed the Prenatal Attachment Inventory to assess the construct with one global factor (PAI; Müller, 1993). In line with Müller (1993), Condon understood the parental-fetal bond as the "emotional tie or bond normally developing between a pregnant parent and the child" (Condon and Corkindale, 1997, p. 359). He further differentiates between the *quality* of the emotional bond and the *intensity* of mental preoccupation with the fetus Condon, 1993). Based on these assumptions, he developed the maternal and paternal versions of the Antenatal Attachment Scale (MAAS, PAAS; Condon, 1993).

Despite these variations in conceptualization and assessment, research has repeatedly shown that parental-fetal bonding intensifies over the course of pregnancy, is positively influenced by prenatal screening (Yarcheski et al., 2009) and predicts postnatal bonding independently of symptoms of anxiety or depression (Dubber et al., 2015; Müller, 1993). Further, higher maternal-fetal bonding

predicted more maternal involvement and higher maternal sensitivity directed towards the infant during dyadic interaction (Alvarenga et al., 2013; Siddiqui and Hägglöf, 2000) and infant attachment security (Le Bas et al., 2019). This supports the relevance of the bond to the child in the prenatal period for the postnatal emotional relationship and highlights the importance of understanding factors influencing its development. An investigation of these factors in multivariate models seems promising to better understand the complex adjustment process (Bouchard, 2011). To the knowledge of the author, there was only little research on paternal-fetal bonding at the beginning of this dissertation, making this the first study to investigate parental-fetal bonding and associated factors in German mothers *and* fathers.

1.2 Emotional distress in the perinatal period

Parenthood goes along with profound changes in family and social constellations, and a shift in the personal identity and social roles. Thus, the prenatal period can be accompanied not only by joy and excitement, but also by feelings of loss of the former life, role conflicts and feelings of resentment, guilt and overall negative affect (Nyström and Öhrling, 2004; Raphael-Leff, 2005). Especially in Western societies, parental roles have been changing and become more diverse, along with high expectations in the private and professional sphere (Cabrera et al., 2000; Saisto and Halmesmaki, 2003). Fathers are naturally in a more distant position from the fetus and pregnancy. They might perceive the time of pregnancy as more abstract (Nyström and Öhrling, 2004) and feel less encouraged to address own needs and emotions in social and prenatal care contexts (Raphael-Leff, 2005; Steen et al., 2012). Strain and insecurities often go along with increased distress, manifesting in forms of negative affect. Generally, low mental health in one partner can be an additional stressor negatively influencing own prenatal mental health (Paulson et al., 2016; Philpott et al., 2017; Wee et al., 2011). Previous findings indicate that the last trimester of pregnancy might be the most stressful phase during the transition to parenthood (Condon et al., 2013; Nyström and Öhrling, 2004). While there has been focus in the literature on depressive symptoms in the peripartum period, research on anxiety or hostility as manifestations of prenatal distress need further investigation. Up to 27% of women (Heron et al., 2004) and 16% of men (Leach et al., 2017) experience high levels of general anxiety during pregnancy. Specifically, for individuals with a general tendency for excessive worry, the transition to parenthood might cause increased distress and anxiety. Additionally, pregnancy-related anxiety centering around birth, health of mother and child, or bodily changes forms an own entity with a distinct impact on maternal and

child outcomes (Haines et al., 2012). Evidence indicates that up to 23% of prospective mothers and 13% of fathers experience intense levels of fear of childbirth (Eriksson et al., 2006; Eriksson et al., 2007).

Prenatal distress can further manifest in other forms of negative affect, like irritability, hostility and anger, potentially directed towards others or oneself (Durkin et al., 2001; Parfitt and Ayers, 2014). Researchers discuss that in men, distress more often manifests in hostility or aggressive behavior than in women (Madsen, 2019; Winkler et al., 2005). Hostility, with the characteristics of responding to others with negative attitudes, resentment or suspicion (Buss, 1961) often going along with increased irritability (Born et al., 2008), has the potential to negatively affect the partner and the child. Despite this relevance, hostility has rarely been the focus of research on maternal perinatal adjustment (Born et al., 2008; Field et al., 2003; Graham et al., 2002).

Associations of parental-fetal bonding with prenatal anxiety and hostility
Generally, when pregnancy is dominated by negative attitudes and perceptions, contrary to uplifts and positive experiences, parents might feel overwhelmed and therefore distance themselves emotionally from the pregnancy and child (Raphael-Leff, 2005). Divergent associations of maternal-fetal bonding with prenatal anxiety have been hypothesized. Leifer (1980) postulated, that while general anxiety might lead to a self-centered perspective and thus hinder maternal-fetal bonding, elevated pregnancy-related anxieties were a sign of a successful adaptation process. Brazelton and Keefer (1982) conceptualized prenatal anxiety as a result of psychic energy that is activated to develop a relationship with the child, implicating a positive association between maternal-fetal bonding and anxiety. Research on the associations of parental-fetal bonding with prenatal anxiety showed inconsistent results (Alhusen, 2008; Cannella, 2005). In their meta-analysis of 72 studies, Yarcheski et al. (2009) reported a substantial variation in effect sizes across studies from trivial to moderate (Cohen's r = .02 to .37). Comparative studies implicate that the instruments chosen to assess both maternal-fetal bonding and anxiety might cause these variations due to their individual conceptual focus (Condon and Corkindale, 1997; Kunkel and Doan, 2003). The few published results on the association of paternal anxiety on paternal-fetal bonding are also mixed, ranging from a negative association for partners of women with high-risk pregnancies (Vreeswijk et al., 2014) and fathers from the general population (De Cock et al., 2016; Mercer et al., 1988) to nonsignificant associations for partners of women with low-risk pregnancies (Vreeswijk et al., 2014).

Few results on associations of parental-fetal bonding with hostility have been reported so far. Some studies indicate that lower maternal-fetal bonding was associated with higher irritation towards the fetus (Hjelmstedt et al., 2006; Pollock and Percy, 1999). Condon and Corkindale (1997) found a significant negative correlation between maternal-fetal bonding and anger, which was however not significant in multivariate analysis including anxious-depressive symptoms. For fathers, the few reported associations between bonding to the child and irritability or aggression are mixed with significant negative associations (Condon et al., 2013) or nonsignificant results (Hjelmstedt et al., 2007).

Couple dynamics between partner's anxiety or hostility and one's own bonding to the child have rarely been investigated, even though a partner's negative affect might interfere with the bonding process by distracting attention away from pregnancy and the fetus or by negatively influencing own mental health (Paulson et al., 2016; Wee et al., 2011). De Cock et al. (2016) reported a negative association between perinatal maternal-child bonding and paternal parenting stress. The association between maternal parenting stress and paternal-child bonding was not significant. Luz et al. (2017) found no influence of one's own or the partner's self-reported prenatal general anxiety on postnatal bonding in either parent. Evidence from two studies assessing strong forms of physical and verbal partner violence (Kita et al., 2016) or a high-risk group from women's shelters (Zeitlin et al., 1999) indicates that an aggressive partner hinders the development of the maternal-child bonding in the peripartum period.

Overall, due to divergent results or little research on the relevance of one's own and partner's anxiety and hostility for parental-fetal bonding, further investigation of these associations is needed (Yarcheski et al. 2009).

1.3 Attachment orientations as influencing factors in the perinatal period

The divergent associations between parental-fetal bonding and anxiety might further be caused by underlying characteristics. Empirical evidence indicates that attachment representations are associated with the emotional, behavioral and cognitive response to critical life events (Shaver and Hazan, 1993). Bowlby proposed that early experiences with their caregivers influenced the way in which children developed an idea of how relationships function in general, and that they shape the child's understanding of how worthy of love they are and how likely it is that their needs are fulfilled by the caregivers (Bowlby, 1969). These experiences manifest in inner working models as

a template for current and future relationships (Bowlby, 1973). Despite being relatively flexible for change across the lifespan, inner working models have been associated with socioemotional development and attachment patterns up into adulthood (Main et al., 1985). Besides a secure attachment style, factor analysis confirmed two major dimensions for insecure adult attachment: The first dimension is attachment-related anxiety, with a higher expectation of loss of or insufficient love in close relationships, leading to higher emotional activation and the wish of maximizing closeness to important others (Hazan and Shaver, 1987; Mikulincer et al., 2010). The second dimension is attachment-related avoidance, which results from the expectation of a caregiver who is not available to give comfort and is associated with a strong fear of rejection. Consequently, to minimize the risk of rejection avoidant individuals deny their need for comfort and security, leading to avoidance of intimacy or dependence in close relationships (Brennan and Shaver, 1998; Feeney et al., 2008).

Associations of parental-fetal bonding with adult romantic attachment styles

Condon (1993) theorized a hierarchical model of adult attachment, which he also applies to parental-fetal bonding, with the core experience of love driving the dispositions of getting to know, protecting and being with the other, avoiding separation and loss, and gratifying needs, which lead to behaviors following these urges. Parents would form their prenatal parental-fetal bond referring to their adult attachment representations, since these were relationship models also including caregiving for an important other. Insecure attachment styles might further influence the way parents respond to pregnancy and the baby. Empirical evidence supports the notion of a negative association of maternal-fetal bonding with attachment-related anxiety and avoidance (Mazzeschi et al., 2015; Priel and Besser, 2000). Mikulincer and Florian (1999) concluded based on their longitudinal findings that insecurely-attached women would use maladaptive coping mechanisms and perceived the fetus as a source of distress, leading to distancing strategies along with suppression of negative affect, and lower maternal-fetal bonding in the beginning and end of pregnancy. In anxiously attached women however, the wish for a loving, close relationship might gradually overcome their fear of loss and tendency for rumination. Thus, these women would show a delayed development of maternal-fetal bonding early in pregnancy, but bonding scores comparable to securely attached women in late pregnancy. For fathers, Hjelmstedt et al. (2007) report that a trait for detachment in own relationships was negatively associated with parental-fetal

bonding. These results highlight the relevance of investigating attachment styles as potentially underlying factors for the association between parental-fetal bonding and emotional distress.

1.4   Dissatisfaction with motherhood in the postpartum period

The birth of the baby marks a milestone in the transition to parenthood. Settling into new family and social constellations and personal roles, getting to know the child, and developing caregiving skills are central themes for both parents (Nyström, 2004; Parfitt & Ayers, 2014). These adjustments are influenced by personal characteristics, attitudes towards and expectations on parenthood (Ferketich and Mercer, 1989; Raphael-Leff, 2005). Research indicates that the period before and after giving birth are not separate phases, but that the prenatal processes of emotional and cognitive preparation and evaluation of pregnancy regarding uplifts and hassles influence the postnatal maternal adaptation (DiPietro et al., 2015; Kiehl and White, 2003). Especially a mismatch between idealized expectations of parenthood and the actual reality as a parent is associated with dissatisfaction in both partners (Henshaw et al., 2014; Steen et al., 2012). A dissatisfying experience in the parental role might further be indicative of a poor emotional adjustment in the postnatal period or increase the incidence or persistence of postnatal mood disturbances (Matthey, 2011). If not resolved, dissatisfaction might manifest in a long-lasting reduced parenting confidence and might be projected on the child. This might impair the mother-child interaction with the potential of leading to self-perpetuating negative interaction patterns, increasing the risk for long-term negative consequences in the dyadic relationship (Papoušek and von Hofacker, 1998). As part of this dissertation, the postnatal dissatisfaction with motherhood was investigated. Thus, the following section only focuses on results for the maternal dissatisfaction with motherhood.

Prenatal influences on the postnatal dissatisfaction with motherhood

Identifying prenatal factors that can predict postnatal dissatisfaction is beneficial to better understand the maternal adjustment process and to offer effective support. Lower maternal-fetal bonding has been associated with several aspects of motherhood. For the prenatal period, associations of low maternal-fetal bonding with lower prenatal care and preparation behavior (Lindgren, 2003), negative attitudes towards pregnancy, childbirth and caregiving (Huang et al., 2004; Stanton and Golombok, 1993) were found. Low maternal-fetal bonding further predicted postnatal dissatisfaction with the maternal role (Fowles, 1996), lower mother-infant bonding

(Dubber et al., 2015; Tichelman et al., 2019), less quality of the mother-child interaction (Siddiqui and Hägglöf, 2000; Thun-Hohenstein et al., 2008), more mother-reported difficult infant temperament and less positive maternal mood (LeBas et al., 2019).

Next to maternal-fetal bonding, prenatal aspects of maternal negative affect are potential indicators for the postnatal experience of and dissatisfaction with motherhood. Due to its specific focus, pregnancy-related anxiety might be a valid indicator of worries about capability as a caregiver in general (Standley et al., 1979). Women with higher pregnancy-related anxiety reported lower parenting competence, felt more restricted by their maternal role and socially isolated (Huizink et al., 2017). Prenatal hostility might further predict a negative experience of motherhood. Research indicates associations of prenatal maternal hostility or anger with gender role stress (Durkin et al., 2001), consistent prenatal smoking (Eiden et al., 2011), and postpartum aggression up to two years postpartum (Sotskova et al., 2015).

Attachment orientations, like adult romantic attachment styles, but also the remembered parenting by the own mother were further associated with the transition and adaptation to motherhood (Alexander et al., 2001; Jones et al., 2015). Insecure attachment styles were associated with a more general negative perception of parenthood (Rholes et al., 1997), less satisfaction with and personal meaning of parenthood (Rholes et al., 2006), less perceived competence in effective parenting and more unrealistic representations of the parental role (Jones et al., 2015). Besides the partner, the own mother becomes for many women an important support figure in the peripartum period (Martell, 2001). However, a representation of one's own upbringing as less optimal with unresolved inner mother-daughter conflicts might negatively influence the own parenting (Kretchmar and Jacobvitz, 2002; Raphael-Leff, 2005). There is evidence that the amount of maternal acceptance, care and love that a mother received in her own childhood positively predicts sensitivity towards her infant (Crockenberg and Leerkes, 2003). To avoid confusion of terms in this dissertation, the remembered caregiving by the own mother is referred to as recalled maternal caregiving.

1.5   Summary

The theoretical assumptions and empirical results reported above indicate that the parental-fetal bond is related to parameters of postnatal caregiving and the parent-child relationship. However, research on its associated factors, like prenatal anxiety or hostility, has been rare or led to mixed

results. This might be caused by heterogeneity in conceptualization and assessment, but also due to underlying influencing factors. Thus, the relevance of parental anxiety and hostility, and potentially underlying factors like adult attachment styles and dynamics in the couple relationship need further investigation. The review of the literature highlights a research gap especially for the paternal perspective of bonding to the fetus. Further, despite the hypothesized importance of maternal-fetal bonding in the transition to parenthood, its predictive relevance for postnatal adjustment to and potential dissatisfaction with motherhood has rarely been investigated in multivariate models including other relevant factors, like pregnancy-related anxiety and hostility, adult romantic attachment style and recalled parenting style. Understanding the relevance of prenatal predictors for the postnatal experience and potentially dissatisfying experiences is crucial for identifying parents struggling with adjustment early on.

1.6   Research Questions

The goal of this study was to address gaps in the literature reported above. The aims of the study were i) to systematically review the literature and investigate potential patterns in reported effects for the associations of maternal-fetal bonding with prenatal anxiety (article I, chapter 7), ii) to investigate the associations of bonding to the fetus in mothers and fathers with symptoms of generalized anxiety, hostility as well as insecure attachment styles (article IV, chapter 10), and iii) to investigate the longitudinal relevance of maternal-fetal bonding in multivariate model with pregnancy-related anxiety, insecure attachment styles and recalled maternal caregiving for the early postpartum dissatisfaction with motherhood (article V, chapter 11). Detailed descriptions on the specific research questions can be found in the individual articles (chapter 7 to 11). Additional aims were the translation of two in the current literature well-established questionnaires into German and investigation of their psychometric properties: for the assessment of the maternal and paternal bonding to the fetus the MAAS and PAAS (Condon, 1993) were investigated (article II, chapter 8), and for the assessment of pregnancy-related anxiety the Pregnancy-Related Anxiety Questionnaire- revised for parous women (PRAQ-R2; Huizink et al., 2015, article III, chapter 9).

2   Materials and Methods

The first research question was investigated by a systematic search and synthesis of the available literature, following the PRISMA guidelines (Preferred reporting items for systematic reviews and meta-analysis; Moher et al., 2009). The remaining research questions from this dissertation were

investigated empirically based on prenatal data of expectant parents and postnatal maternal data. In the following section, the studies, from which this data was derived, and the study designs are described. Next, details on the assessment procedure, materials and statistical analysis are given.

2.1 Study Design

The data for this study derive from two population-based prospective cohort studies (see Figure 1 for details on the study designs). The PAULINE study ("Prenatal Anxiety and Infant Early Emotional Development") was initiated in 2014 by Dr. med. Susanne Mudra and Prof. Dr. med. Michael Schulte-Markwort at the Department of Child and Adolescent Psychiatry, Psychotherapy and Psychosomatics at the UKE to investigate the influence of prenatal maternal factors on child development and the mother-child relationship in the first year postpartum.

The PRINCE study ("Prenatal Identification of Children's Health") focusses on the feto-maternal immune cross talk. The study was initiated in 2011 by Prof. Dr. med. Petra Arck, Prof Dr. med. Kurt Hecher, and PD Dr. med. Anke Diemert at the Department of Obstetrics and Fetal Medicine at the UKE. Protocols of the PAULINE study and the PAULINE-PRINCE cooperation were approved by the ethics committee of the Hamburg Chamber of Physicians (PV3694, PV5574).

The analyses in this dissertation were based on data from the second and third pregnancy trimester (PAULINE-PRINCE T1 to T2; PAULINE T0), and from three weeks postpartum (PAULINE T1).
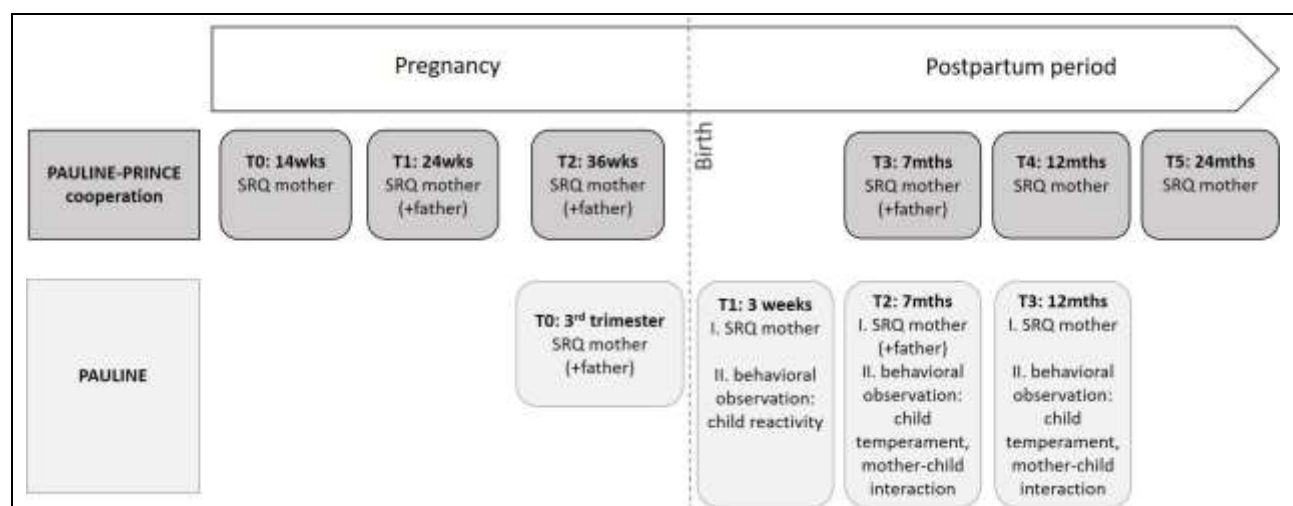

Figure 1. Design of the PAULINE-PRINCE cooperation and PAULINE study
SRQ=self-report questionnaires

2.2 Study samples

In both studies, women from the general population in Hamburg, Germany, were included. Pregnant women were recruited between 2014 and 2017 upon initial presentation at the UKE after being sent by their gynecologists or by midwives. Women lacking sufficient German language skills for answering the questionnaires, with chronic infections, substance abuse, severe complications related to pregnancy or child development, preterm birth (< 37th week of pregnancy) or low birth weight of the child (<2500 grams) were excluded. Additionally, in the PAULINE-PRINCE cooperation, women younger than 18 years, pregnant with twins or after assisted reproductive technologies were also excluded. Sample sizes in this dissertation differed depending on the research focus of each analysis and are stated separately in the results section of each article (chapter 7 to 11).

2.3 Procedure and Materials

Women answered self-report questionnaires as part of their prenatal study appointments at the UKE and their postnatal assessment in their homes. They were further asked about sociodemographic details, obstetric background, and at the postpartum assessment about birth details and newborn's health. The partners of participating mothers were invited to answer a comparable set of questionnaires once during pregnancy. To include as many men as possible, they were given the chance to fill out the questionnaire when accompanying their partner to their study appointment either in the second or third trimester of pregnancy. If not present at the appointments, they could fill out their questionnaire at home and send them back to the study team. Women and their partners were asked to fill out questionnaires independently. The outcome and predictor variables were mostly measured with well-established and frequently used instruments in studies with expectant mothers and fathers. Only postnatal dissatisfaction with motherhood was assessed with a new questionnaire, since it overcomes methodological shortcomings of prior scales (Matthey, 2011).

2.3.1 Outcome measures

Parental-fetal bonding. Parental-fetal bonding was assessed with the MAAS and PAAS (Condon, 1993). Next to a total score, the scales assess two dimensions: bonding *quality*, describing the affectionate relationship to the fetus, and bonding *intensity*, describing the time spent in mental preoccupation with the fetus. Items are scored from 1 to 5, with higher scores indicating higher bonding. The original MAAS has 19 items, the PAAS 16. Investigation of the psychometric

properties of German translations of MAAS and PAAS lead to shortened 13-item versions for both instruments. Scale reliabilities for the total score and subscales were convincing, with Cronbach's alphas ranging from $\alpha = .78$ to $.82$ for MAAS and $\alpha = .71$ to $.82$ for PAAS. For details see article II (chapter 8).

Dissatisfaction with motherhood. The 13-item Being a Mother Scale (BaM-13; Matthey, 2011) was used to assess the dissatisfaction with motherhood within the last 2-3 weeks and with the three subscales *adult-related dissatisfaction* (e.g., loneliness or boredom, missing previous life, perceived support), *child-related dissatisfaction* (e.g., insecurities regarding caretaking competence, worries for baby, irritation) and *emotional closeness* (feeling confident being with and emotional close to child). Items are answered on a 4-point scale, ranging from 0 to 3. Higher scores indicate higher dissatisfaction. Due to its insufficient scale reliability in this sample ($\alpha = .10$), the subscale *emotional closeness* was not further investigated. The scale reliabilities for the total score and remaining subscales were acceptable to good ($\alpha = .65$ to $.82$).

2.3.2 Predictor measures

Symptoms of generalized anxiety disorder. Prenatal symptoms of generalized anxiety disorder were assessed with the 7-item Generalized Anxiety Disorder Scale (GAD-7; Spitzer et al., 2006), which is a one-dimensional screening instrument. Items are rated on a 4-point scale, with higher scores indicating higher anxiety. Scale reliability was good for women ($\alpha = .81$) and men ($\alpha = .82$).

Pregnancy-related anxiety. Maternal current pregnancy-related anxiety was assessed prenatally with the 10-item Pregnancy-Related Anxiety Questionnaire-revised for parous women (PRAQ-R2; Huizink et al., 2015). Items are scored on 5-point scale ranging from 1 to 5. Higher scores indicate higher anxiety levels. Scales reliabilities were satisfactory to excellent ($\alpha = .77$ to $.90$). For further details on the psychometric properties of PRAQ-R2, see article III (chapter 9).

Hostility. Prenatal level of general hostility was assessed with the hostility subscale of the Brief Symptom Inventory (BSI; Derogatis and Spencer, 1993). The subscale consists of 5 items, answered on a 4-point scale ranging from 0 to 4 and asking for experience of hostile thoughts, annoyance, tendencies to get in arguments or uncontrollable anger outbursts within the last week. Higher scores indicate higher hostility. In this sample, reliability was low to acceptable for women ($\alpha = .52$ to $.74$) and men ($\alpha = .68$).

Adult romantic attachment style. The two dimensions attachment-related anxiety and avoidance were assessed prenatally with the revised version of the Experience in Close-Relationships (Sibley and Liu, 2004). For each dimension, 18 items are answered on a 7-point scale ranging from 0 to 7. Higher scores indicate higher attachment-related anxiety and avoidance. Reliability was good for attachment-related anxiety (women α = .89 to .94, men α = .87), and avoidance (women α = .85 to .87, men α = .84).

Recalled maternal caregiving. The memory of caregiving by the own mother was assessed in the participating women at three weeks postpartum with the Parental Bonding Instrument (PBI; Parker et al., 1979). 25-items assess the two dimensions care and overprotection, answered on a 4-point scale ranging from 1 to 4. Higher scores indicate higher perceived care and lower perceived overprotection. Reliability scores for maternal care (α = .92) and maternal overprotection (α = .91) were excellent.

2.4   Statistical Analyses

Univariate statistics (means, standard deviations, range or frequencies, where appropriate) were used to describe the sample regarding sociodemographic and obstetric background characteristics, and the distribution of scores in the outcome and predictor variables. Bivariate statistics (Pearson and Spearman correlations) were used to report on associations between relevant variables. To investigate influencing factors on parental-fetal bonding in article IV (chapter 10), as well as the predictive relevance of parental-fetal bonding on postnatal dissatisfaction with motherhood in article V (chapter 11), multiple linear regression analysis with blockwise entry were conducted. To investigate the factorial validity of the MAAS and PAAS in article II (chapter 8) and of the PRAQ-R2 in article III (chapter 9), methods from classical test theory were used: Confirmatory factor analyses (CFA) based on structure equation modeling were conducted to investigate model fit for the original factor solutions. Exploratory principal axis factoring (PAF) with oblique (promax) rotations were conducted to investigate the factor solutions without a predefined structure. Where necessary, missing values in the predictor variables were replaced using Expectation-Maximization imputation. Statistical analyses were conducted with MPlus 6.11 (Muthén & Muthén, 2015) and IBM© SPSS 22 (SPSS, 2013). A-priori power analyses were calculated with the R-package semPower (Moshagen, 2018).

3 Results

In the following section, the focus for each of the five articles of this cumulative dissertation is briefly summarized before reporting on the main results. The journal articles were written to stand alone as individual publications. Thus, repetitions and overlaps in the description of variables or methods in the study are difficult to avoid.

3.1 Article I. Investigating the association of maternal-fetal bonding with prenatal anxiety

Citation: Göbel, A., Stuhrmann, L.Y., Harder, S., Schulte-Markwort, M., Mudra, S. (2018). The association between maternal-fetal bonding and prenatal anxiety: an explanatory analysis and systematic review. *Journal of Affective Disorders, 239,* 313-327.

To answer the first research question on underlying patterns in the association of maternal-fetal bonding with prenatal anxiety, a systematic review of the available literature was conducted. Since research on paternal-fetal bonding was still scarce at the beginning of this study, this review focused on the maternal perspective only.

Initially, 3845 articles were identified via search of the online databases Medline/PubMed, Web of Science, PsycINFO and PSYNDEX, as well as by targeted reference search. Of these, 31 articles were included in this analysis. Most studies ($k = 26$) were conducted in the USA or Europe. Four studies were translated from Portuguese, French, Spanish, and Japanese in collaboration with native speakers working in scientific research. The sample sizes of the studies ranged from 9 to 403 (total $N = 4646$). Three studies scored low on the self-developed quality index and were therefore not included in further analysis.

Of the six identified instruments assessing maternal-fetal bonding, five were self-report questionnaires and one was an interview. The MFAS (Cranley, 1981; k = 12) is based on the in comparison broadest conceptualization of maternal-fetal bonding, including behaviors and attitudes representing an interaction and affiliation with the fetus, but also preparation for the maternal role (Cranley, 1979). Contrary to this broad definition, the MAAS (Condon, 1993; $k = 11$), and the PAI (Müller, 1993; $k = 6$) are based on the conceptualization of maternal-fetal bonding as the affectionate relationship. The Working Model of the Child Interview (Zeanah et al., 1995; $k = 1$) assesses the concept of an internal representation of the relationship with the future child, including the child's characteristics, the anticipated relationship with and the affective tone towards

the fetus and is therefore close to the construct definitions by Condon (1993) or Müller (1993). The Bonding Scale (BS; Figueiredo et al., 2005; $k = 2$), has the narrowest focus assessing maternal-fetal bonding as the affective experience as negative, positive or unclear emotions towards the fetus. Anxiety was mostly measured by self-report questionnaires and as general anxiety as a current state or trait characteristic. Specific forms of anxiety, like pregnancy-related anxiety ($k = 4$), symptoms of excessive worry and rumination ($k = 1$) or clinically diagnosed anxiety disorders ($k = 2$) were rarely investigated, which made a systematic comparison of the results difficult.

Associations between scores in the maternal-fetal bonding instruments with anxiety levels were investigated for total score and subscales. Most studies used bivariate methods for assessing the association between maternal-fetal bonding and anxiety. Associations with forms of anxiety across studies were significant not for the total scores of the different instruments, but for the MAAS *quality* dimension, assessing the affective relationship and emotional proximity towards the fetus.

Overall, the direction of reported significant associations between maternal-fetal bonding and the different forms of anxiety were negative. Thus, women with high anxiety levels reported lower levels of bonding to their child. The strengths of associations were for state and trait anxiety low to moderate. For pregnancy-related anxiety, the size of significant negative associations was slightly lower. Further, no significant differences in bonding were found for women with social or any anxiety disorders or excessive worry and rumination.

In summary, reported effects were most stable for the MAAS *quality* dimension, assessing the affective relationship and emotional proximity to the fetus. Associations with anxiety symptoms were overall negative and ranged in size from small to moderate.

3.2 Article II. Adaptation of the Maternal and Paternal Antenatal Attachment Scale for use in German-speaking parents

Citation: Göbel, A., Barkmann, C., Goletzke, J., Hecher, K., Schulte-Markwort, M., Arck, P., Diemert, A.* & Mudra, S.* (2019). Psychometric properties of 13-item versions of the maternal and paternal antenatal attachment scales in German. *Journal of Reproductive and Infant Psychology*, 1-13. (*shared last authorship)

As reported in article I (chapter 7), the MAAS is currently one of the most frequently used instruments for assessing bonding to the fetus. The aim of the study reported in article II (chapter 8) was to translate the PAAS into German and investigate the psychometric properties of both MAAS and PAAS in a German sample to close this gap in the literature.

In this study, data of 263 women in their third and 128 men in the second to third pregnancy trimester from the PAULINE and PAULINE-PRINCE samples were analyzed (total *N*=391). Descriptive statistics identified four items of the MAAS (12 - desire to hurt/punish fetus, 15 - anticipated positive/negative first reaction, 16 - desire to hold baby after birth, 19 - feelings towards fantasized fetal loss) and three items of the PAAS (8 - idea of baby's names, 13 - desire to hold baby after birth and 16 - feelings towards fantasized fetal loss) with low inter-item correlations and low discriminative power. In line with these observations, confirmatory factor analyses did not support model fit of the original factor solution for MAAS or PAAS. Thus, for both instruments, PAF was conducted without the critical items. For MAAS, item 6 (concept of the fetus as a person/thing) and 14 (in-/frequent concerns about diet) were due to their low factor loadings excluded during PAF. Thus, the analyses lead to reduced 13-item MAAS and PAAS versions with convincing psychometric properties.

The final factors *intensity* and *quality* explained 28.7% and 10.9% of the variance, respectively. Scale reliability was satisfying to good for the MAAS total score and the subscales (Cronbach's α = .78 to .82). For PAAS, the explained variance by *intensity* and *quality* was 26.3% and 10.5%, respectively. Scale reliability for the PAAS total score and the subscales was satisfying to good (Cronbach's α = .71 to .82). The distribution of items forming the *quality* (affective relationship, emotional proximity towards the fetus, seeing the fetus as real person) and *intensity* (frequency of thinking, talking about and dreaming of the fetus) dimensions were comparable for women and men, indicating rather comparable emotional and mental processes in both parents.

3.3 Article III. Adaptation of the Pregnancy-Related Anxiety Questionnaire-revised for parae women for use in German-speaking parents

Citation: Mudra, S.*, Göbel, A.*, Barthel, D., Hecher, K., Schulte-Markwort, M., Goletzke, J., Arck, P., Diemert, A. (2019). Psychometric properties of the German version of the pregnancy-related anxiety questionnaire-revised 2 (PRAQ-R2) in the third trimester of pregnancy. *BMC Pregnancy and Childbirth*, *19*(1), 242. (*shared first authorship).

For the assessment of pregnancy-related anxiety as one predictor of postnatal dissatisfaction with motherhood (article V, chapter 11), the internationally well-established PRAQ-R2 (Huizink et al., 2015) was translated. Further, its psychometric properties were investigated, which are reported in article III (chapter 9).

Data of N=360 pregnant women in their third trimester of pregnancy from the PAULINE and PAULINE-PRINCE sample were included in this study for the investigation of factorial stability. For the investigation of convergent and discriminant validity, data sets with the additionally required variables were available from $N = 253$ women.

The item characteristics, CFA and subsequent PAF confirmed model fit and the three-factor solution of the instrument. Scale reliabilities for PRAQ-R2 total and the subscales *fear of giving birth* (FoGB), *worries of bearing a physically or mentally handicapped child* (WaHC) and *concerns about own appearance* CoA were satisfying to excellent (Cronbach's α = .77 to .99). WaHC explained 40.2% of total variance, CoA 17.7% and FoGB 10.2%. Convergent validity was confirmed with up to moderate-sized positive correlations with general concerns going along with parenthood ($r = .27$ to .55), and with levels of state anxiety, trait anxiety, symptoms of generalized anxiety disorder, social phobia and depression ($r = .16$ to .44). Discriminant validity was supported by small to moderate-sized negative correlations with general self-efficacy. ($r = .16$ to .24).

Overall, the reported psychometric properties support the stability of the three-factor solution of the PRAQ-R2 and give further evidence for its construct validity. Thus, the German PRAQ-R2 is appropriate for the use in this study and German-speaking mothers.

3.4 Article IV: Investigating the influence of own and partner's anxiety, hostility and adult romantic attachment style on parental-fetal bonding

Citation: Göbel, A., Barkmann, C., Arck, P., Hecher, K., Schulte-Markwort, M., Diemert, A., Mudra, S. (2019). Couples' prenatal bonding to the fetus and the association with one's own and partner's emotional well-being and adult romantic attachment style. *Midwifery*, *79*, 102549.

In line with prior literature, in article I (chapter 7) varying effect sizes for maternal-fetal bonding with anxiety were reported, supporting the assumption of confounding factors influencing this relationship. Thus, for article IV (chapter 10), the relation between parental-fetal bonding and the parents' generalized anxiety and hostility was further investigated, including adult romantic attachment style as potentially underlying factor. A negative association was expected for the parental-fetal bonding dimensions with the parents' anxiety and hostility, as well as with insecure attachment styles.

The sample of this analysis consisted of k = 93 couples from the PAULINE-PRINCE and PAULINE cohort (total n = 186). Univariate descriptive statistics showed that the distribution of scores in bonding *quality* and *intensity*, symptoms of generalized anxiety, hostility as well as attachment-related anxiety and avoidance were comparable in women and men. However, bivariate results for bonding *quality* and *intensity* differed between partners. While maternal bonding *quality* and *intensity* was negatively associated with generalized anxiety, hostility and attachment-related avoidance, only paternal bonding *intensity* was associated with attachment-related avoidance. No associations were found for paternal bonding *quality*.

To investigate the relevance of the predictor variables on parental-fetal bonding, linear regression analyses were performed separately for bonding *quality* and *intensity* and separately for women and men. First, parity and sample origin were included as control variables. Then the predictor variables were added into the model.

For maternal bonding *quality*, 23% of the total variance was explained by the variables included in the final model. Negative, medium- to large-sized effects were found for maternal hostility (η_{part2} = 0.062) and attachment-related avoidance (η_{part2} = 0.147). Paternal hostility was positively associated with maternal bonding *quality*, with a medium-sized effect (η_{part2} = 0.073). For maternal bonding *intensity*, divergent associations with the included variables were found and 17% of the

variance was explained in the final regression model. Already 15% of the variance was explained by the control variables. Parity was the only variable with a significant, medium-sized effect (η_{part2} = 0.078) on *intensity*.

For men, none of the control or predictor variables significantly explained variance in paternal bonding *quality*. For paternal bonding *intensity*, 15% of the variance was explained in the final model. After controlling for parity, a medium-sized negative effect of attachment-related avoidance was found (η_{part2} = 0.078). Thus, in line with the maternal results, men who had at least one child reported lower bonding *intensity*. However, contrary to the women, men with higher levels of attachment-related avoidance reported lower bonding *intensity*.

In sum, for mothers, higher levels of hostility and attachment-related avoidance were associated with lower bonding *quality*. Unexpectedly, higher levels of partner´s hostility were associated with higher bonding quality. Contrary, fathers with higher attachment-related avoidance reported lower bonding *intensity*. Neither maternal bonding intensity nor paternal bonding quality were associated with the predictor variables.

Subsequent sensitivity analyses were conducted to assess the stability of results. Regression analyses were repeated with i) prior bootstrapping for nonparametric testing, ii) including only cases without missing data sets, confirming stability of results. Further, analyses were repeated including gestational age and the parents' depressive symptoms (assessed with the Edinburgh Postnatal Depression Scale, Cox; 1961) as potential correlates. These variables did not significantly explain additional variance in the outcome. The effect for maternal hostility on maternal-fetal bonding *quality* became nonsignificant after including depression into the model. These results might be explained by a suppressor effect, in which depressive symptoms share a high amount of variance with hostility but not bonding *quality*.

3.5   Article V. Investigating the predictive value of maternal-fetal bonding and further prenatal factors for the dissatisfaction with motherhood

Göbel A., Stuhrmann, L.Y., Schulte-Markwort, M., Mudra, S. Becoming a mother: Predicting early dissatisfaction with motherhood at three weeks postpartum. *Midwifery, 91*, 102824.

Article V (chapter 11) focuses on the relevance of maternal-fetal bonding for the dissatisfaction with motherhood at three weeks postpartum when included in multivariate analyses with pregnancy-related anxiety, hostility, adult romantic attachment style and recalled maternal caregiving. Supported by prior literature, and the results from the articles I (chapter 7), and IV (chapter 10), only the MAAS *quality* dimension was included as measurement for prenatal bonding. It was expected that lower maternal-fetal bonding, higher pregnancy-related anxiety and hostility, higher attachment-related anxiety and avoidance and less optimal caregiving by the own mother predicted higher overall dissatisfaction, adult-related (feeling bored, isolated, unsupported), and child-related (insecurities in caregiving, worries about and irritation with baby) dissatisfaction.

This longitudinal analysis was based on the maternal data from the PAULINE sample ($N = 100$). To investigate the individual relevance of the included predictor variables on the overall, adult- and child-related dissatisfaction, hierarchical multiple regression analyses with block-wise entry were performed, with parity as a control variable. The following paragraph summarizes the results of this analysis (for details, see chapter 11).

For overall and adult-related dissatisfaction, negative zero-order correlations were found with maternal-fetal bonding. Overall dissatisfaction, adult-related and child-related dissatisfaction correlated in the expected positive directions with pregnancy-related anxiety, hostility, attachment-related anxiety and recalled maternal care. Recalled maternal overprotection correlated positively with the overall dissatisfaction. No associations were found with attachment-related avoidance.

For the overall dissatisfaction, the included variables explained 41% of the variance, with parity already explaining 21.0% of the variance. Pregnancy-related anxiety and hostility explained 16.4% of variance (step 2). Neither maternal-fetal bonding (step 3) and nor attachment-related anxiety and avoidance (step 4) predicted overall dissatisfaction. In the fifth and final step, recalled maternal caregiving additionally explained 6% of the variance. Beyond parity, pregnancy-related anxiety and maternal care significantly predicted overall dissatisfaction, with medium- to large-sized effects ($\eta_{part}^2 = .105$ and $.114$, respectively). Primiparous women, women reporting higher

pregnancy-related anxiety and lower recalled maternal care reported higher dissatisfaction with motherhood. Primiparous women, women with higher pregnancy-related anxiety or hostility and those with lower recalled maternal care reported higher child-related dissatisfaction.

For the adult-related dissatisfaction, 20% of total variance was explained by the included variables, with parity explaining 5.4% (step 1). Pregnancy-related anxiety and hostility did not predict variance in the outcome (step 2). In step 3, maternal-fetal bonding significantly explained 4.8% of the variance, with a negative direction of effects. Attachment-related anxiety and avoidance did not significantly explain variance in the outcome (step 4). In the final step, recalled maternal caregiving explained 8.4% of the variance and turned the prior significant effect of maternal-fetal bonding into a trend ($p = .081$). Beyond parity, maternal care was the only significant predictor with a negative, medium-sized effect ($\eta_{part}^2 = .100$) on adult-related dissatisfaction.

For the child-related satisfaction the included variables explained 41% of the variance, with parity explaining 23.3 % of the variance. In step 2, pregnancy-related anxiety and hostility explained 18.2% of the variance. Maternal-fetal bonding (step 3) and attachment-related anxiety and avoidance (step 4) did not significantly explain additional variance in the outcome. In step 5, recalled maternal care and overprotection explained 3.5% of the variance. In this final model, pregnancy-related anxiety ($\eta_{part}^2 = .117$), hostility ($\eta_{part}^2 = .055$) and recalled maternal care ($\eta_{part}^2 = .064$) significantly predicted the child-related dissatisfaction with medium- to large-sized effects.

For sensitivity analysis, the regression analyses were repeated i) with stepwise regression with backwards entry of the variables, ii) including only cases without missing data, and iii) prior bootstrapping for nonparametric testing. Stability of results was confirmed. Only the effect of maternal care on child-related dissatisfaction turned into a trend ($p = .08$, 95% CI -.272 to -.003). Finally, regression analyses were repeated to additionally test for a potential relevance of maternal age and child's age at T1, which had no effect on explained variance or model stability.

In sum, bivariate correlations of overall and adult-related dissatisfaction with maternal-fetal bonding could not be confirmed in regression analyses or turned into a trend. Higher pregnancy-related anxiety and hostility, as well as lower recalled maternal care were the strongest predictors for higher dissatisfaction with motherhood after controlling for parity.

4 Discussion

In the following section, the presented results will be discussed along the main research questions focusing on parental-fetal bonding, and with reference to maternal dissatisfaction, potential influences on the parent-child relationship and implications for research and practice. Further, strengths and limitations of this dissertation will be discussed.

4.1. The association of maternal-fetal bonding with prenatal anxiety

The first aim of this dissertation was to investigate patterns for the heterogeneous results in the literature on the association of maternal-fetal bonding with prenatal anxiety. A systematic literature review that is presented in article I (chapter 7) was conducted to answer this research question. The synthesized results highlighted in line with previous literature (van den Bergh and Simons, 2009; Yarcheski et al., 2009) the variety in operationalization of both maternal-fetal bonding and prenatal anxiety. Synthesis of the literature showed that the overall construct of maternal-fetal bonding assessed with the total score of the included instruments was across studies not consistently related to different forms of anxiety. Only the *quality* dimension of the MAAS showed stable, small to moderate-sized negative relations with different forms of anxiety. These results are in line with earlier studies in which different measurements of anxiety, depression, anger or confusion (Condon and Corkindale, 1997; Kunkel and Doan, 2003) showed the strongest relation with the MAAS *quality* dimension and not the MFAS and MAAS total score, supporting the assumption that anxiety is especially associated with the emotional bonding to the fetus instead of attitudes and behaviors related to pregnancy itself or intensity of mental preoccupation (Condon, 1993; Condon and Corkindale, 1997). The overall negative direction of effects for different forms of anxiety with bonding *quality* further supported the assumption that anxiety might distract women from focusing on the positive, joyful experience of pregnancy and thus also from developing an emotional bond to their child (Condon, 1993; Raphael-Leff, 2005). Even though the association of bonding *quality* with pregnancy-related anxiety was not the focus of the analyses in this dissertation, it will be discussed briefly. As part of article I (chapter 7), two studies on the assessment of pregnancy-related anxiety were identified. In these studies, significant and negative correlations with only bonding *quality* were reported, which were rather low in size compared to associations with general state or trait anxiety (Walsh, 2014, van Bussel, 2010). In the PAULINE sample (article V, chapter 11), the bivariate correlation between *bonding* quality and overall pregnancy-related anxiety was negative, but not significant. Since pregnancy-related anxiety is a multidimensional construct

(Bayrampour et al., 2016), further research is needed to investigate the role of specific dimensions of pregnancy-related anxiety in the context of maternal-fetal bonding.

4.2. The association of maternal-fetal bonding with hostility

There has been little research on maternal hostile emotions in the prenatal period (Field et al., 2003; Graham et al., 2002), even though they occur alongside other emotional states and might be indicators for increased strain (Durkin et al., 2001). Thus, as part of the second research question, hostility was investigated in article IV (chapter 10) with the expectation of a negative effect of on parental-fetal bonding. In multivariate regression analysis a medium-sized effect of hostility on maternal boding *quality* but not *intensity* was found. These results might be explained by a pattern of maternal orientations, which Raphael-Leff (2005) describes as the "regulator" orientation. Regulators perceive the pregnancy as disrupting their performance in everyday life and the work sphere, especially at the end of pregnancy. They might externalize their perceived prenatal distress due to the changes caused by pregnancy resulting in higher hostility. Thus, the unborn can become the focus of their distress, which might lead to irritation directed towards the fetus and lower maternal-fetal bonding (Pollock and Percy, 1999; Raphael-Leff, 2005).The results in article IV (chapter 10) highlight the relevance of hostility for maternal-fetal bonding and are supported by prior findings on an association of higher prenatal hostility and irritation towards the fetus with lower prenatal bonding (Pollock & Percy, 1999) or consistency in prenatal smoking (Eiden et al., 2011), which is understood as a passive form of fetal abuse (Fernandez et al., 2019). A combination of low prenatal bonding and high hostility might increase the risk of harming the fetus (Fernandez et al., 2019), which would be of crucial clinical relevance. Clearly more research is needed on maternal hostility in the context of perinatal adjustment and maternal-fetal bonding. Since the BSI hostility subscale assesses general forms of hostility, it is of high interest to further investigate specific hostile thoughts or intentions directed to the fetus.

4.3 The association of maternal-fetal bonding with adult romantic attachment style

The range in correlation sizes across studies reported for bonding *quality* with forms of anxiety indicate that underlying factors might influence these associations. Investigating insecure adult attachment styles as such underlying factors seems especially relevant, due to their general influence on emotions, cognitions and behavior in stressful situations (Jones et al., 2015) and further their theorized (Condon, 1993; Müller, 1993) and empirically supported association with maternal-fetal bonding (Mikulincer and Florian, 1999).

As part of article IV (chapter 10), insecure adult romantic attachment styles were investigated in multivariate analysis with the expectation of a negative correlation with maternal-fetal bonding. A negative effect of attachment-related avoidance but not attachment-related anxiety for bonding *quality* was found. These results can be explained in line with Mikulincer and Florian (1999) that avoidant women might distance themselves from the fetus to suppress negative affect. Anxiously attached women might have at the end of pregnancy overcome their fear of loss and allow themselves to bond to the child. Attachment-related avoidance might further mediate the effect between anxiety and maternal-fetal bonding. In article IV (chapter 10), bivariate correlations of both maternal-fetal bonding and symptoms of generalized anxiety with attachment-related avoidance were found. In subsequent multivariate analysis, the association with symptoms of generalized anxiety could however not be confirmed. One explanation for this effect might be that attachment-related avoidance causes both higher symptoms of generalized anxiety and lower levels of bonding *quality*. However, since causal directions of this mediating effect cannot be tested in a cross-sectional design used in article IV (chapter 10), longitudinal analyses should further prove these assumptions.

4.4. The association of maternal-fetal bonding with paternal anxiety and hostility

Both maternal and paternal anxiety and hostility were assessed as a potential influence on prenatal bonding, with the expectation that poorer emotional well-being in the partner leads to lower bonding to the fetus. Bivariate positive correlations were found between maternal and paternal hostility, but not between symptoms of generalized anxiety of both partners. Unexpectedly, having a partner reporting higher hostility was associated with an increase of maternal-fetal bonding *quality*. This finding contrasts with results from previous studies, in which negative relations of self-reported levels of intimate partner verbal and physical violence with bonding to the fetus were reported (Kita et al., 2016; Zeitlin et al., 1999). A study by Levendosky et al. (2003) helps to explain the positive association of maternal bonding *quality* with partner's hostility. In their study, women experiencing more intimate partner violence reported more effective parenting towards their preschool-aged child and more often a secure attachment relationship between them and their child. The authors explained these results based on prior qualitative interviews (Levendosky and Graham-Bermann, 2001), in which some women reported that they tried to compensate for an abusive, neglectful father by being a better, more responsive parent themselves. Transferring these interpretations to the observed results from this dissertation, mothers with a more hostile partner

might bond emotionally stronger to the child to also compensate for an expectedly less supportive and less sensitive co-parent. Further, in line with Condon's (1993) model of attachment, the disposition to protect the child might be stronger in these women and the drive for developing a close emotional bond intensified. An alternative explanation for the association found here is that these women bond stronger to the child for their own sakes. Women with more hostile partners might subconsciously focus their wish for a close, loving relationship on the anticipated relationship with their child, leading to a hyperactivation of emotions and the urge for a stronger bond to the child. In line with this thought, it might be insightful to investigate adult attachment styles as mediators for the relation between partner's hostility and maternal-fetal bonding. However, if this interpretation holds true, there might be a risk that in these relationships the roles of giving and receiving care are at least partly switched in the mother-child dyad. Importantly, the study by Levendosky et al. (2003), as well as the results by Zeitlin et al. (1999) and Kita et al. (2016), cannot be directly compared to the analysis from this dissertation, since severe levels of intimate physical and verbal violence were not assessed by the BSI hostility subscale in the population-based sample of this study. Thus, the findings and conclusions presented here should be tested in future research.

4.5. Paternal-fetal bonding and its associated factors

To the knowledge of the author, article IV (chapter 10) currently presents the first assessment of paternal-fetal bonding in a German-speaking sample. The analysis of the MAAS and PAAS factor structure support the assumption of similar bonding processes related to the emotional "inner world experiences" (Condon, 1985, p. 280) for mothers and fathers in the developing relationship with their child. Further, the couples included in this study reported a comparable distribution of scores in bonding *quality* and *intensity*. However, associations with parental-fetal bonding differed between parents: Contrary to women, none of the included variables was associated with bonding *quality*. Further, in men attachment-related avoidance was not associated with lower bonding *quality* but with bonding *intensity*. These results are overall in line with studies that found no (Kunkel and Doan, 2003) or divergent associations between parental-fetal bonding and mental health variables in men, in contrast to their pregnant partners (Bouchard, 2011; Colpin et al., 1998; De Cock et al., 2016). In previous studies, expectant fathers report feeling emotionally less connected to pregnancy, the developing child and birth than their partners (Genesoni and Tallandini, 2009; Longworth and Kingdon, 2011). They may be more oriented towards their

pregnant partner and the future child (Colpin et al., 1998; Seimyr et al., 2009). Thus, developing an emotional bond to the unborn child might stay for many men more abstract and less emotionally intense throughout pregnancy and there might be no need for the activation of strategies to suppress negative affect. The observed negative association of bonding *intensity* with attachment-related avoidance is in line with prior results (Hjelmstedt et al., 2007). Avoidant men, like avoidant women, might distance themselves cognitively from the pregnancy and the fetus by avoiding thoughts directed to or conversations about their unborn child (Mikulincer and Florian, 1999), leading to less time spent in attachment mode. Further, fathers with an avoidant attachment style might generally have a less communicative relationship with their partner and avoid self-disclosing conversations (Shaver and Hazan, 1993). This might lead to less chances to get in actual contact with and mentally focus on the developing child. This assumption could be supported by evidence indicating that a higher quality in the couple relationship with higher dyadic adjustment and mutuality was for men stronger related to their prenatal bonding than for women (Bouchard, 2011; Gomez and Leal, 2007).

4.6. Predicting dissatisfaction with motherhood at three weeks postpartum

The final aim of the study was to investigate the predictive value of maternal-fetal bonding on dissatisfaction with motherhood at three weeks postpartum besides including pregnancy-related anxiety, hostility, adult romantic attachment style and recalled maternal care as additional influencing factors. In article V (chapter 11), zero-order correlations indicated a negative relation between maternal bonding *quality* and overall and adult-related dissatisfaction. Also, during multivariate analysis lower bonding *quality* significantly predicted higher adult-related dissatisfaction beyond parity, pregnancy-related anxiety and hostility. However, the effect of bonding *quality* on adult-related dissatisfaction turned nonsignificant, when recalled maternal care was included in the final step of the regression analysis. Thus, lower recalled maternal care was a stronger indicator for higher adult-related dissatisfaction than prenatal bonding *quality*. The association of maternal care with adult-related dissatisfaction is in line with empirical evidence on the influence of low recalled maternal caregiving on generally higher amounts of negative self-statements like self-criticism, amotivation or interpersonal disappointment (Ingram et al., 2001). Also, especially in the early weeks postpartum, mothers recalling less care by their own mothers might lack a positive role model for developing caregiving skills towards their child or lack a current supportive relationship with their own mother.

The results from article V (chapter 11) further highlight the relevance of pregnancy-related anxiety and hostility for the postnatal overall dissatisfaction or child-related dissatisfaction. These results add to the growing literature on the effect of pregnancy-related anxiety on postnatal outcomes and parenting variables (Huizink et al., 2017) and support the understanding of the construct as manifestation of concerns of the capability as a caregiver in general (Standley et al., 1979). The predictive relevance of prenatal hostility on child-related dissatisfaction adds to results in the literature that report for instance an association of prenatal hostility with postnatal depressive mood and heart rate response to the infant crying (Little, 1982) or with aggression in the couple dynamics postpartum (Sotskova et al., 2015). Longitudinal evidence showed that socially disadvantaged women with a history of externalized aggression, which is related but not equivalent to hostility, behaved more often hostile in interaction with their child in the first two years postpartum (Stack et al., 2012). The fact that the sample in this dissertation overall stems from the general population and represent a rather low-risk sample regarding their socioeconomic background indicates the relevance of hostility not only in high-risk samples, but also in apparently low-risk families.

4.7. Strength and limitations of this study

This dissertation enables further insight into the complex dynamics of the developing parental-fetal bond and its potentially underlying factors based on multivariate analysis. Due to the translation and the thorough investigation of the MAAS and PAAS (article II, chapter 8) and the PRAQ-R2 (article III, chapter 9), these internationally well-established questionnaires are now available for research and clinical practice for German-speaking parents. The MAAS and PAAS adaptations were the basis for the to the knowledge of the author first investigation of parental-fetal bonding in German couples with the attempt to address the substantial gap in the literature on prenatal bonding in expectant fathers and the relevance of partner's anxiety and hostility for prenatal bonding. Assessing of maternal dissatisfaction at three weeks postpartum lead to a comparable rare insight into the maternal experience at such an early stage postpartum and the longitudinal study design enables a causal interpretation of effects of prenatal factors on maternal dissatisfaction.

Despite these strengths, several limitations should be highlighted. To minimize the influence of potential confounders in the systematic literature review, studies focusing on teenagers and obstetric high-risk groups were excluded. These characteristics were partly also exclusion criteria in the PAULINE-PRINCE and PAULINE studies and the samples were rather homogenous regarding their socioeconomic background, which might limit generalizability of results. Also, a

selection bias cannot be ruled out, since recruitment was based on collaborating midwives or gynecologists in Hamburg. Also, paternal participation was limited to fathers whose partners were already enrolled in the PAULINE-PRINCE or PAULINE studies. Participating parents might generally have an elevated motivation of getting involved compared to those declining participation, potentially leading to an underrepresentation of those feeling uncomfortable with participating in a research project or those perceiving participation as an additional stressor. However, maternal and paternal score distributions for the included variables were comparable to norm or population-based samples in the literature (Ehrenthal et al., 2009; Geisheim et al., 2002; Huizink et al., 2015), which indicates appropriateness to transfer the results to the general population. Another bias that can - especially in context of self-report questionnaires - never be ruled out is that the assessment relies on the participant's awareness of emotions and the willingness to give honest report. Due to the limited sample sizes, structure equation modelling could not be conducted in the context of this dissertation, which would have been useful for understanding complex dynamics among included variables. Even though the reduction of PAAS items in article II (chapter 8) was in line with factor-analytical studies with Italian (Della Vedova and Burro, 2017) and Portuguese samples (Camarneiro and Justo, 2010; Gomez and Leal, 2007), a larger paternal sample would have been favorable to ensure generalizability of the adapted PAAS version. Finally, in article V (chapter 11) recalled maternal caregiving was assessed parallel to the outcome at three weeks postpartum. Even though stability of recalled maternal caregiving has been found across the life span (Wilhelm et al., 2005) a potential influence of the assessment cannot be ruled out, especially since women who just became mothers might reflect more critically or intensely on their own upbringing than before.

4.8. Implications for future research and clinical practice

The results support the assumption that the *quality* of the emotional relationship to the fetus is an entity distinct from other domains of the adjustment process in the peripartum period, like the intensity of mental preoccupation with the fetus, attitudes and behaviors regarding the maternal role or caregiving. This conclusion is of high relevance for future research and an implication that instead of using the total score of the chosen instrument, a specific investigation of individual domains of parental-fetal bonding is highly important to understand potential impairment by parental mental health and personal characteristics. To fully understand the nature of the construct and its relevance for the transmission of attachment patterns, assessment of prenatal bonding in

parents with a troubled childhood and an adult state of mind indicative of a disorganized attachment is needed in future research. Further, research in non-Western countries is needed to investigate whether the development of parental-fetal bonding is universal across cultures.

The results of this dissertation especially highlight the relevance of maternal and partner's hostility and attachment-related avoidance for the development of maternal-fetal bonding *quality*. Thus, maternal hostility as one manifestation of perinatal strain and its influence on the parent-child bond in the peripartum period clearly needs further investigation. With reference to the finding of higher maternal-fetal bonding *quality* in women with hostile partners it is of conceptual and clinical relevance to investigate whether very high levels of emotional bonding to the fetus could actually be indicative of a maternal representation of the mother-child relationship where the role of caretaker and caregiver are at least partly switched. Even though increased distress is often part of transitioning into a new phase in life and pathologizing of responses during the peripartum period should be avoided, not only the reported associations of hostility with lower bonding, but also with higher maternal dissatisfaction should be taken seriously due to their potential clinical relevance for the relationship with the child and partner indicated by prior evidence. Longitudinal studies on the consequences of the observed associations for infant development, parental mental health and parenting in the postpartum period and beyond are needed.

The low amount of explained variance in paternal-fetal bonding indicates divergent processes of emotional adjustment to parenthood in women and men. However, to enable better support for expectant fathers, it is important to understand the development of the parental prenatal bond and its associated factors in more detail. The negative association between attachment-related avoidance with paternal-fetal bonding *intensity* and results from prior literature on union quality with the partner as one predictor of paternal-fetal bonding (Bouchard, 2011; Gomez and Leal, 2007) indicate that further investigation of social and couple parameters might be beneficial. Another important influence might be the way men redefine their identity as a father. Condon (1985) already discussed that traditional role concepts might hinder men in expressing emotions and relating to pregnancy and caregiving. Habib and Lancaster (2010) found that men identifying themselves as hands-on caregivers or emotional supporters for their pregnant partners showed stronger paternal-fetal bonding than fathers self-identifying as functional helper for their partners. A variety of non-traditional parental roles might, despite leading initially to increased insecurity, be beneficial for fathers on the long run. Investigating associations of parental-fetal bonding with

parental self-identities in both partners, also in same sex couples, helps to understand the effect of parental roles on family relationships. Not only parental roles, but also the ways of becoming a parent are getting more complex. Understanding the development of parental-fetal bonding in couples depending on sperm or egg donation or even a surrogate in their wish for a child is important to emotionally support these parents. There has been little research on these issues so far. The few available studies report a comparable or higher level of parental-fetal bonding in parents using fertility treatment than in naturally receiving parents (Cataudella et al., 2016).

For clinical practice, the reported results indicate that women reporting higher anxiety and hostility and showing a rather avoiding attachment style are at higher risk of poor adjustment to motherhood and low emotional bonding to the fetus. Also, women with increased pregnancy-related anxiety might experience more difficulties with the postpartum reality of being a parent. Since data was assessed in a sample from the general population, the results indicate that every family, not only those identified as high-risk families, benefit from addressing negative emotional states, potential sources of strain or difficulties in developing a relationship to the fetus already in the prenatal period. Gynecologists or midwives should further be cautious about high levels of anxiety or hostility, and consistent low bonding to the fetus over the course of pregnancy. The PRAQ-R2 as well as MAAS and PAAS enable a brief and standardized evaluation of these two important parameters in mothers and fathers, respectively, and can be applied when necessary. Birth preparation classes might be an ideal setting to address these issues in an official, but still safe and rather discrete context. In case of intense difficulties, interdisciplinary support including psychotherapeutic treatment is needed. Including the co-parent generally stronger in prenatal care settings might be beneficial for both mothers and fathers with avoidant attachment styles to reduce insecurities about pregnancy and the unborn child. This might also foster parental conversations about the affective relationship with the fetus, potential concerns, and strain.

The results underline that an approach including dynamics between family members (Belsky and Fearon, 2004; Cowan et al., 1996) is beneficial when investigating potential precursors of prenatal bonding in both parents (Marsiglio et al., 2000) and also in peripartum care and therapeutic settings. Prospective longitudinal studies in low- and high-risk samples on the influence of parental-fetal bonding on parenting behavior and the parent-child relationship in interrelation with partner and child characteristics are needed, also beyond the first year after birth.

5 Abbreviations

The abbreviations appearing in the synopsis are listed in alphabetical order.

BaM-13 = Being a Mother Scale

BSI = Brief Symptom Inventory

CFA = confirmatory factor analyses

CI = confidence interval

CoA = concerns about own appearance

Dr. med. = doctor in medicine

ECR-R = Experience in Close Relationships Questionnaire - Revised

et al. = et alia (and others/colleagues)

FoGB = fear of giving birth

GAD-7 = Generalized Anxiety Disorder Scale

MAAS = Maternal Antenatal Attachment Scale

MFAS = Maternal Fetal Attachment Scale

PAAS = Paternal Antenatal Attachment Scale

PAF = principal axis factoring

PAI = Prenatal Attachment Inventory

PAULINE = study title "Prenatal Anxiety and Infant Early Emotional Development"

PBI = Parental Bonding Instrument

PD = private lecturer

PRAQ-R2 = Pregnancy-Related Anxiety Questionnaire- Revised for parous women

PRISMA = preferred reporting items for systematic reviews and meta-analysis

PRINCE = study title "Prenatal Identification of Children's Health"

Prof. = Professor

SPSS = Statistical Package for the Social Sciences

SRQ = self-report questionnaire

UKE = University Medical Center Hamburg- Eppendorf, Germany

USA = United States of America

WoHC = worries of bearing a handicapped child

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7   Article I
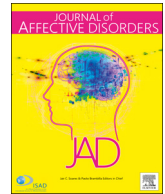
Review article

The association between maternal-fetal bonding and prenatal anxiety: An explanatory analysis and systematic review

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ABSTRACT

Background: The prenatal period can be associated with an increase in distress and anxiety. Research indicates that impaired mental well-being influences the development of prenatal maternal-fetal bonding, which manifests in representations, emotions and behaviors. However, the impact of prenatal anxieties on maternal-fetal bonding is still not fully understood, partly due to heterogeneity in the conceptualization and the measurement of both constructs. The aims of this review were to identify studies assessing the relation between both constructs and to investigate direction and size of effects for different types of prenatal anxiety and conceptualizations of maternal-fetal bonding.
Methods: A systematic search was carried out on January 7, 2017, and updated on October 23, 2017, based on four electronic databases and a targeted reference search. Of the 3845 identified publications, $K = 31$ studies fit the eligibility criteria.
Results: While components of maternal-fetal bonding centering around pregnancy or maternal role were not affected, the quality of perceived emotional proximity to the child, as assessed by the Maternal Antenatal Attachment Scale, was impaired by anxieties across studies. Associations were overall negative and of low to moderate size.
Limitations: Studies focusing on high-risk subpopulations were excluded. Included studies mostly assessed samples from Western societies, which limits the generalizability of results to non-Western cultures.
Conclusion: The quality of perceived emotional proximity to the fetus was consistently impaired by anxiety. Nevertheless, varying effect sizes indicate a more complex association that is influenced by underlying confounders. Multivariate analyses are needed to improve the understanding of the interacting factors that influence maternal-fetal bonding.

1. Introduction

Pregnancy is a time of adjusting to new living circumstances, role expectations and physical changes (Raphael-Leff, 2005). This time of increased vulnerability might also lead to an impaired sense of well-being, including distress and depressive or anxious symptoms (Biaggi et al., 2016).

One crucial developmental task during pregnancy is to form a relationship with the unborn child (Raphael-Leff, 2005). Rubin (1967) was among the first to include the development of an emotional bond to the child in a theoretical construct describing mental processes in pregnant women. Cranley (1981) developed and validated the first self-report questionnaire to assess the construct of maternal-fetal bonding. Since then, several divergent definitions with specific foci have been proposed, leading to heterogeneity in theory, assessment and even labeling (Alhusen, 2008; Brandon et al., 2009; Cannella, 2005; Van den Bergh and Simons, 2009). Some researchers, such as Cranley (1979), understand maternal-fetal bonding as an umbrella term for a multi-faceted construct with components including emotions towards the fetus and attitudes and behaviors regarding pregnancy and maternal role. Others postulate a narrow definition, focusing on representations of and the affective relationship to the child.

To reflect this variety, the construct in this review is defined as "an abstract concept, representing the affiliative relationship between a

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parent and a fetus, which is potentially present before pregnancy, is related to cognitive and emotional abilities to conceptualize another human being, and develops within an ecological system" (Doan and Zimerman, 2003; p.110). It is further referred to as maternal-fetal bonding, to ensure a differentiation from Bowlby's (1969) original attachment construct, which is focused on the child's experience of the reciprocal relationship with the primary caregiver and based on behavioral patterns initiated by the child to ensure survival. Early experiences manifest in internal representations about relationships and the expectation of receiving safety and security from a significant other, influencing relationships up into adulthood (Main et al., 1985). Influenced by adult attachment representations but unique to any other attachment relationship, the maternal-fetal bond is developed without reciprocity from a partner and follows the goal of providing security for the fetus (Condon, 1993; Müller and Mercer, 1993).

Due to the divergent definitions of maternal-fetal bonding, many different instruments have been utilized, some of them used in only a small number of studies (Van den Bergh and Simons, 2009). They are mostly based on individual, distinct conceptualizations and, therefore, measure specific components of this construct. Consequently, for the comparison of results across different studies, the conceptual focus of the identified instruments should be kept in mind (Condon and Corkindale, 1997).

Despite heterogeneity in conceptualization, an increase in maternal bonding over the course of pregnancy has been consistently reported (Cannella, 2005; de Cock et al., 2016; Rubin, 1976). Low maternal-fetal bonding was associated with lower levels of prenatal health behavior, more alcohol and nicotine use, higher irritability, risk of harm the fetus (Lindgren, 2003; Pollock and Percy, 1999), increased parenting stress postpartum (Mazzeschi et al., 2015), reduced maternal-infant bonding (Dubber et al., 2015; Müller, 1996; van Bussel et al., 2010) as well as less optimal mother-infant interaction, difficult child temperament, and adjustment problems (Branjerdporn et al., 2017; Siddiqui and Hägglöf, 2000; Thun-Hohenstein et al., 2008). These results stress the clinical relevance of this construct both during pregnancy and beyond. Thus, for a better understanding of perinatal adjustment processes, it is crucial to identify prenatal factors influencing maternal-fetal bonding.

Prenatal anxiety has been increasingly discussed as one of the factors potentially influencing perinatal outcomes, with a growing body of research on its prevalence and impact on mother and child. Elevated symptom levels of anxiety occur in up to 27% of pregnancies (Heron et al., 2004). Prevalence of anxiety disorders during pregnancy ranges from 4.1% for generalized anxiety disorders to 15.2% for any anxiety disorder (Dennis et al., 2017). Different forms of anxiety such as general anxiety on a current level (state anxiety) or personal disposition (trait anxiety), pregnancy-related anxiety (worries associated with pregnancy, the child's health, and birth), and clinical anxiety disorders may each have a distinct impact on outcomes in mother and child (Blackmore et al., 2016; Koelewijn et al., 2017; Korja et al., 2017). Recent research stresses the impact of prenatal anxiety, particularly pregnancy-related anxiety, on obstetric complications (Ding et al., 2014; Dunkel-Schetter and Tanner, 2012), postnatal mood and parenting behavior (Arch, 2013; Blackmore et al., 2016) and child socioemotional development (Huizink et al., 2003; Kingston et al., 2012; Korja et al., 2017).

The theories and empirical findings on a possible relation between prenatal anxiety and maternal-fetal bonding have been heterogeneous so far.

Brazelton and Keefer (1982) conceptualized elevated prenatal anxiety as a result of psychic energy that is activated to develop a relationship with the child and should be high in women experiencing close bonding to the fetus. Leifer (1980) conceptualized anxiety related to pregnancy and the fetus as part of a successful adaptation process throughout pregnancy. In contrast, women with general anxiety might stay more self-centered and avoid focusing on and bonding with the fetus.

Empirical studies indicate that impaired maternal mental health is a generally destabilizing factor that might negatively influence bonding to the child (Alhusen, 2008; Pollock and Percy, 1999) as well as influence maternal sensitivity and emotional tone during mother-child interaction (Feldman et al., 1997; Nicol-Harper et al., 2007). These results implicate a negative association between maternal anxiety and prenatal maternal bonding.

Mixed results are reported for the size of effects between both constructs (Alhusen, 2008; Cannella, 2005). In a meta-analysis, Yarcheski et al. (2009) report an overall small effect of Cohen's $r = 0.17$ for anxiety. However, they further report a substantial variation in effect sizes across studies ($r = 0.02–0.37$), suggesting further investigation of this association.

Methodological studies in which both anxiety and maternal-fetal bonding were assessed with several measures reveal that variations in effect sizes might be confounded by the individual conceptual focus of the chosen measurements (Condon and Corkindale, 1997; Kunkel and Doan, 2003).

These results lead to the assumption that not all aspects of maternal bonding might be affected by anxiety. Further, different forms of anxiety might have a distinct influence on these components. Yarcheski et al. (2009) did not differentiate between conceptual foci of the included instruments due to their meta-analytic approach. Consequently, investigating the associations between types of anxieties and divergent construct definitions of maternal-fetal bonding is an important step to disentangle and understand variations in both size and direction of effects. Analyzing the literature in a systematic review enables a detailed comparison of identified instruments and their individual underlying conceptualization. By this, different components of the broad concept of maternal-fetal bonding can be compared in their association with different forms of anxiety.

From a clinical perspective, it is of great relevance to understand how these constructs are associated. Prenatal anxiety can negatively influence perinatal outcomes in mother and child. An additional negative impact of prenatal anxiety on the developing maternal-fetal bond might further impair the development of a healthy mother-child relationship. Investigating how far anxieties influence maternal-fetal bonding could provide an insight into the early development of relationship-based problems that may have a long-lasting impact on child development and mother-child interaction. Understanding the nature of their association is an important step for the development of future preventive and supportive interventions in the perinatal period.

The goal of the current review is to systematically report and summarize the methodology and results of studies examining the relation between prenatal anxiety and maternal-fetal bonding. The main research questions are as follows: Which instruments and underlying constructs can be identified to assess maternal-fetal bonding? Do effect sizes and direction of effect differ depending on the conceptualization of maternal-fetal bonding assessed by the different instruments? Do specific types of anxiety differ in strength and direction of effect sizes with maternal-fetal bonding?

2. Methods

The PRISMA guidelines (Moher et al., 2009) were followed for conducting this systematic review. Key features of the review protocol are recorded in the international database of prospectively registered systematic reviews PROSPERO by the Centre for Reviews and Dissemination, New York (registration code: CRD42017057238).

2.1. Search

The online databases Medline/PubMed, Web of Science, PsycINFO and PSYNDEX were systematically searched on January 7, 2017. The search was updated in October 23, 2017. At both time points, all databases were searched on the same day. Regarding year of publication,

the results were included for the entire time from inception of the database up to the day of the search. Additional papers were identified by targeted reference search.

The search terms included "maternal-fetal bonding" and its synonyms "maternal-fetal relationship" and "/prenatal/antenatal/maternal bonding/attachment". Since prenatal anxiety is often more generally addressed as "distress" (Kingston et al., 2012), this umbrella term was also included in the search. Thus, the final search term was "(prenatal OR antenatal OR maternal OR maternal-f#tal) adj (relation* OR bonding OR attachment) and (anx* OR distress). af". To avoid language bias, no filters were set for the language of publication. As exploratory outcomes, we chose (a) estimates on shared variance between maternal-fetal bonding and any form of anxieties (e.g., general anxiety symptoms, anxiety disorders, or pregnancy-specific anxiety) in the prenatal period, as well as estimates of inferential statistics on both; (b) maternal-fetal bonding in groups high and low in anxiety; and (c) anxiety in groups high and low in maternal-fetal bonding.

Studies were included in this review when (a) they were published as journal articles and doctoral dissertations, (b) both maternal-fetal bonding and anxiety were assessed with validated instruments and (c) statistical analyses of the association between both constructs were reported. Regarding sample characteristics, studies were included when they assessed a sample of pregnant women who (d) represent the general population, (e) were diagnosed with anxiety disorders as dominant psychopathology, or (f) represent a normative control group in comparative study designs. In the last case, only the control group was of interest for this review.

Studies were excluded when exclusively assessing (a) expecting mothers with either teenage or high-risk pregnancies or (b) a clinical sample with multiple psychopathologies. Since teenage mothers and women with high-risk pregnancies (as defined by the authors of the studies; e.g., loss of a child, pregnancy complications, fetal malformation, chronic maternal disease, substance abuse) might face emotional and physical concerns differing from the average pregnant women (e.g., Bloom, 1995), an exclusive focus on these groups might confound the reported associations between anxiety and maternal-fetal bonding. Samples including women with multiple psychopathologies were excluded with the intention of minimizing a confounding effect of co-morbid symptoms.

2.2. Procedure

A total of 3845 articles were identified via database and reference search. After abstract review, 67 articles were assessed for eligibility. The first and second author of this review coded the articles for eligibility using a self-developed codebook (inter-rater agreement $r = 0.98$). Divergences in ratings were discussed to lead to a consent decision. See Fig. 1 for reasons leading to exclusion of articles.

2.2.1. Quality index

To fit the evaluation of the study quality as close as possible to the scope of this review (Centre for Reviews and Dissemination, 2009), a quality index (QI) was developed based on the criteria by Yarcheski et al. (2009) as well as the STROBE criteria (e.g., Vandenbroucke et al., 2007). Besides the general criteria concerning study design, methods and analyses, we included information regarding sample characteristics with potential influence on the development of maternal-fetal bonding or anxiety. The quality index consisted of nineteen criteria, which are listed in Appendix 1. The range of the final score was 0–39.

3. Results

3.1. Study descriptives

Of the 67 identified publications, $K = 31$ were included in the final

sample. For a detailed list of studies excluded during full-text coding, please contact the corresponding author.

Twenty-five (81%) publications were journal articles and six (19%) were doctoral dissertations. Most of the studies were published in English ($k = 26$; 83%). Five studies (16%) were published in German, Portuguese, French, Spanish, and Japanese and translated in collaboration with native speakers working in scientific research. In one case, the author of the study was additionally contacted to clarify ambiguities occurring during the translation process. Ten studies (32%) were conducted in the United States, 16 (52%) were from Europe, two (6%) were from each Asia, one (3%) from Australia, and one (3%) from South-America.

The total sample size for all studies was $N = 4646$. Individual sample sizes ranged from 9 to 403, with 25% of the studies ranging between 1–50; 32% between 51–100, and 19% between 101–200; 22% of studies had 201 or more participants. Ten studies (32%) included only nulliparous women, and nineteen studies (61%) additionally included parous women (two studies did not report details on parity). Regarding gestational age at assessment, the studies were rather homogeneous. Twenty-seven (87%) included women in their second to third trimester. In nine studies (29%), women in earlier stages of pregnancy were also included. Nineteen studies (61%) drew samples from the general population and one from a sample with low socio-economic status. In nine studies (29%), researchers compared control groups from the general population to high-risk index ($k = 4$ in-vitro fertilization; $k = 2$ prior perinatal loss; $k = 1$ positive Down's syndrome scan; $k = 1$ risk of preterm delivery; $k = 1$ hospitalized due to diverse pregnancy complications). Two studies (6%) included samples with clinically diagnosed anxiety disorders.

The average QI was $M = 23.5$ ($SD = 4.48$, range 13.5–33). In this study, a QI score equal to or above the 90th percentile (QI = 28.9) was defined as very high ($n = 3$). A QI score equal to or below the 10th percentile (QI = 18.1) was defined as very low ($n = 3$). Due to their very low QI scores (<18), three studies were at this point excluded from further analysis.

3.1.1. Anxiety instruments

To assess the general levels of anxiety, the State-Trait Anxiety Inventory (STAI-S / STAI-T, Spielberger et al., 1970) was used most frequently, with 16 studies reporting on the associations with STAI-S (total $n = 1843$) and 12 studies on the association with STAI-T (total $n = 1228$), followed by the Karolinska Scale of Personality – anxiety proneness scales (KSP, Schalling and Edman, 1993; $k = 2$, total $n = 173$), Beck's Anxiety Inventory (BAI, Beck and Steer, 1990; $k = 2$, total $n = 417$), Hospital Anxiety Depression Scale - anxiety subscale (HAD-A, Zigmond and Snaith, 1983; $k = 2$, total $n = 475$), Taylor Manifest Anxiety Scale (TMAS, Taylor, 1953; $k = 1$, total $n = 77$), Profile of Mood States – anxiety subscale (POMS-A, McNair, 1971; $k = 1$, total $n = 238$), and Depression Anxiety Stress Scales - anxiety subscale (DASS-A, Lovibond and Lovibond, 1995; $k = 1$, total $n = 215$).

STAI-S or HADS-A assess anxiety as a current level of nervousness, discomfort, worry and physical tension. POMS-A, DASS-A and BAI assess current levels of anxiety within the last week. In contrast, STAI-T or TMAS assess with one global score an underlying personality trait for anxiety. The KSP enables a division between specific forms of trait anxiety on the cognitive, somatic and motoric levels.

For the assessment of specific symptom clusters associated with anxiety, the Penn State Worry Questionnaire-Past Week (PSWQ-PW, Stoeber and Bittencourt, 1998; $k = 1$, total $n = 215$) and the Ruminative Response Scale-Short Form (RRS-SF, Nolen-Hoeksema et al., 2008; $k = 1$, total n = 215) were used. Pregnancy-related anxieties were assessed using the Pregnancy Outcome Questionnaire (POQ, Theut et al., 1988; $k = 1$, total $n = 15$), Pregnancy-Related Anxiety Questionnaire (PRAQ, van den Bergh, 1989; $k = 1$, total n = 731), Pregnancy Anxiety Questionnaire (PAQ, Rini et al., 1999; $k = 1$, total $n = 258$), and Emotional Response to Pregnancy Scale (ERPS, Hjelmstedt et al., 2003;
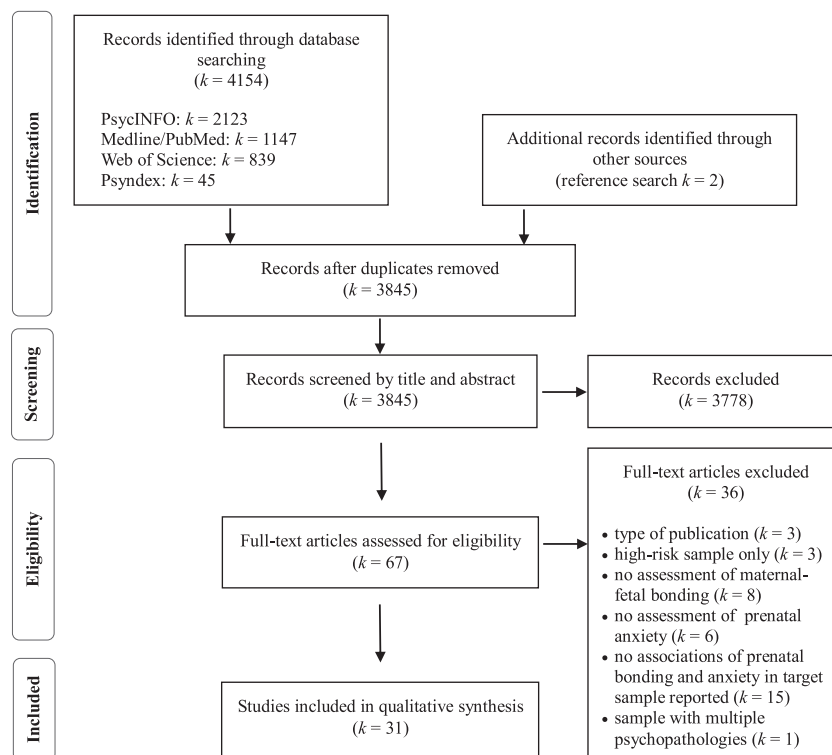
Fig. 1. PRISMA flow diagram.

$k = 1$, total $n = 97$). For the questionnaire-based instruments, a higher score indicates higher symptom severity. Two studies used the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-IV, First et al., 2002; total $n = 161$) or a women-specific version of the Composite International Diagnostic Interview (CIDI-Venus, Martini et al., 2009; total $n = 46$).

3.1.2. Maternal-fetal bonding instruments

The Maternal Fetal Attachment Scale (MFAS, Cranley, 1981; $k = 12$; total $n = 1520$) and the Maternal Antenatal Attachment Scale (MAAS, Condon, 1993; $k = 11$; total $n = 2226$) were the questionnaires used most frequently to assess maternal-fetal bonding, followed by the Prenatal Attachment Inventory (PAI, Müller and Mercer, 1993; $k = 6$, total $n = 818$) and the Portuguese Bonding Scale (BS, Figueiredo et al., 2005; $k = 2$, total $n = 178$). For these questionnaire-based instruments, a higher score indicates higher maternal-fetal bonding. One study additionally assessed the construct through interviews using the Working Model of the Child Interview (WMCI, Zeanah et al., 1995; total $n = 62$).

3.2. Construct definitions of maternal-fetal bonding of identified instruments

The conceptualizations of maternal-fetal bonding differ between the identified instruments. The MFAS was developed for use in the last pregnancy trimester, based on behaviors representing an affiliation and interaction with the fetus and behaviors and attitudes related to pregnancy, preparation behavior and the maternal role (Cranley, 1979). This broad concept definition is reflected in the five subscales: *giving of self, differentiation self from fetus, role-taking, attributing characteristics to the fetus*, and *interaction with the fetus*. Because of the rather low reliability scores on the subscale level (Cronbach's alpha between $\alpha = 0.52$ and 0.73), Cranley (1979) recommended a focus on the total score instead of the subscales.

The Prenatal Attachment Scale (PAI) is based on the definition of maternal-fetal bonding as a "unique, affectionate relationship" to the fetus (Müller and Mercer, 1993). Müller critically claimed that including behaviors and attitudes related to the maternal role would not capture the affective nature of maternal-fetal bonding (Müller and Mercer, 1993). In her validation study, she identified one broad global factor only (Cronbach's $\alpha = 0.81$), with the underlying themes *preparedness, fantasizing, affection* and *interaction*.

The MAAS is based on Condon's definition of the construct as the maternal "emotional tie or bond" to the fetus (Condon and Corkindale, 1997). He also focusses on the affective relationship towards the child. Condon further differentiates between two dimensions. The *quality* dimension refers to the maternal emotional experience in relation to the fetus (e.g., emotional closeness, involvement, tenderness and positive emotions to the child) and a mental representation of the fetus as a real person. A quantitative dimension, namely, the *intensity* of preoccupation with the fetus, describes the amount of time spent in attachment mode (e.g., frequency of interacting with, talking and thinking about or dreaming of the fetus) and refers to the position the child takes up in maternal thoughts, independent from the experienced emotions towards the fetus. Condon (1993) further proposes a perpendicular orientation of these two dimensions, leading to four possible categories: (1) positive preoccupied (high *quality*, high *intensity*), (2) positive disinterested (high *quality*, low *intensity*), (3) negative preoccupied (low *quality*, high *intensity*), and negative disinterested (low *quality*, low *intensity*). A total score (Cronbach's $\alpha > 0.8$, Condon, 1993) gives a global impression of maternal-fetal bonding.

The BS was developed by Figueiredo et al. (2005) as a Portuguese adaptation of the New Mother to Infant Bonding Scale (Taylor et al., 2005) to assess the maternal affection towards the child, only. Compared to those listed above, this conceptualization is the narrowest and most specific, focused on emotions experienced towards the fetus. The scale assesses the extent of positive, negative, and unclear emotions with three subscales, which show reasonable internal consistency (Cronbach's $\alpha = 0.61$, Figueiredo et al., 2005)

The WMCI (Zeanah et al., 1995) is based on the internal representation of the child and includes maternal perceptions and subjective experience of the child's characteristics, the anticipated relationship with and the affective tone towards the child (Benoit et al.,

Table 1
Overview of the construct definitions and scoring range for the included instruments assessing maternal-fetal bonding.

Instrument	Construct specifications	Scoring range
Maternal Fetal Attachment Scale (MFAS)	"the extent to which pregnant women engage in behaviors that represent an affiliation and interaction with their unborn child" (Cranley, 1981, p. 282) subscales: *giving of self, role-taking, differentiation self from fetus, attributing characteristics to the fetus, interaction with fetus.*	MFAS total: 24 - 120 *giving of self*: 5 - 25 *role-taking*: 4 - 20 *differentiation self from fetus*: 4–20 *attributing characteristics to the fetus*: 6–30 *interaction with fetus*: 5 - 25
Maternal Antenatal Attachment Scale (MAAS)	"the emotional tie or bond which normally develops between a pregnant women and her unborn child" (Condon and Corkindale, 1997, p. 359) subscales: *intensity* of preoccupation/ time spent in attachment mode *quality* of emotional bond to the fetus/ emotional proximity	MAAS total: 19–95 *quality*: 10–50 *intensity*: 8–45
Prenatal Attachment Inventory (PAI)	"unique, affectionate relationship that develops between a women and her fetus"(Müller and Mercer, 1993, p. 201) covered by the themes preparedness, fantasizing of the baby, affection for the baby, interaction with the baby; one global factor	PAI total: 21–84
Bonding Scale (BS)	"emotional involvement with the fetus" (Figueiredo et al. 2009, p. 146), asking about emotions in times mothers felt close to the fetus and positive and negative involvement, as well as emotions not positively or negatively related to the child subscales: *positive bonding, negative bonding, bonding not clear*	BS total: 0–11 *positive bonding*: 0–6 *negative ponding*: 0–3 *bonding not clear*: 0–2
Working Model of the Child Interview - prenatal adaptation (WMCI)	"perceptions and participative experience of their infant's individual characteristics and the relationship with the infant" (Benoit et al., 1997, p. 308), answers are analyzed for content, affective and qualitative components of representations categories: *balanced, disengaged, distorted*	–

1997). These aspects show similarity to Condon's conceptualization of maternal-fetal bonding. Answers are coded into a *balanced* category (caregiver as engrossed in his/her relationship with the infant), and two imbalanced categories, namely, *disengaged* (an intellectualized, emotionally distant view of the child) and *distorted* (confused, incoherent or even contradictory descriptions of the child and lack of emotional context or sensitivity). Originally designed for the postnatal period, the interview has been successfully adapted to pregnancy (Benoit et al., 1997).

3.3. Associations between maternal-fetal bonding and anxiety

In the following passage, associations between forms of anxiety and maternal-fetal bonding components assessed with different instruments are described. For an overview of individual conceptualizations of the maternal-fetal instruments, see Table 1. Details on the studies included in further analysis are listed in Table 2.

3.3.1. Associations with MFAS global construct
Most studies report associations for MFAS total score only. Of the eight studies using the original MFAS version, only one study reported a significant negative correlation between MFAS total and STAI-S (Gaffney, 1986). In seven studies, correlations for MFAS total with STAI-S, STAI-T (Cranley, 1979; Escallier, 1995; Mercer et al., 1988; Stanton and Golombok, 1993; Wachter, 2002) or TMAS (Lee, 1992) were not significant, nor were group differences in MFAS total between women scoring "light", "moderate" or "serious" in BAI (Schmidt and de Lima Argimon, 2009), or between women diagnosed with current anxiety disorders compared to a nonclinical control group (McFarland et al., 2011). In three studies, modified MFAS versions were used to adapt the scale to all pregnancy trimesters: Narita and Maehara (1993) excluded four items in their adaptation and reported significant, low- to medium-sized negative correlations for MFAS total with STAI-S throughout pregnancy and with STAI-T early in pregnancy. Sjögren et al. (2004) excluded seven items and found no prediction of the anxiety proneness scales of the KSP (*somatic anxiety, muscular*

tension, psychic anxiety, psychasthenia, inhibition of aggression) on MFAS total in multiple regression analysis. Using this adaptation, Walsh et al. (2014) reported significant negative correlations with the PAQ but no effect in subsequent structure equation modeling with one latent bonding factor (MFAS + MAAS subscales).

3.3.2. Associations with individual MFAS components
Associations for the MFAS subscales *giving of self, role-taking, differentiation self from fetus, attributing characteristics to the fetus*, and *interaction with the fetus* were reported in four studies. While in two studies, no correlations with STAI-S, STAI-T (Cranley, 1979) or TMAS (Lee, 1992) were found, Gaffney (1986) reported small- to medium-sized negative associations for STAI-S with *role-taking* and *giving of self*, as well as for STAI-T with *giving of self*. Sjögren et al. (2004) extracted four modified MFAS factors (*visualizing motherhood, wonder and worry, nourishing self and fetus, relation to self and own body*) and reported significant associations with the KSP anxiety proneness scales: while higher KSP *psychic anxiety* predicted lower scores for *visualizing motherhood* and *nourishing self and fetus*, KSP *somatic anxiety* predicted higher scores for *visualizing motherhood*, and *nourishing self and fetus*, KSP *psychasthenia* predicted higher scores for *wonder and worry*, and KSP *inhibition of aggression* predicted higher scores for the *nourishing self and fetus* factor.

The QI scores obtained by Cranley (1979), Gaffney (1986), Schmidt and de Lima Argimon (2009), and Wachter (2002) are below the calculated average. The three studies using modified versions of the MFAS have comparable high QI scores.

Overall, neither the broad, multifaceted construct nor the sub-dimensions of maternal-fetal bonding reflecting behaviors and attitudes towards pregnancy, role attainment and representation of the fetus, showed stable associations with different forms of anxiety.

3.3.3. Association with MAAS global construct
In eight studies, the results for MAAS total are reported. In three studies, no significant correlations for MAAS total with BAI (Allison et al., 2011), POMS-A (Condon and Corkindale, 1997) or PRAQ

Table 2
Overview of the studies included in analysis of results.

1st author, year (country)	Sample qualities (n)	Gestational age (M ± SD)[a]	Anxiety instrument + descriptives (M ± SD)	MFR instruments + descriptives (M ± SD)	Statistics used	Results	QI
MFAS							
Cranley (1979) (USA)[o]	GP (p1) (30)	35–40 w	STAI-S (39.5 ± 9.1); STAI-T (36.5 ± 6.8)	MFAS total (2.5 ± 0.7) role-taking (2.0 ± 0.9), differentiation (1.6 ± 0.8); interaction (3.5 ± 0.8); characteristics (2.9 ± 0.9) giving of self (2.2 ± 0.1)	Pearson correlation	STAI-S/ -T w MFAS total/ subscales ns.	20.5
Escallier (1995) (USA)[o]	GP (p -) (126)	3rd trimester	STAI-S (36.7 ± 10.7)	MFAS total (4.0 ± 0.3)	Pearson correlation	STAI-S w MFAS total ns.	25.5
Gaffney (1986) (USA)[o]	GP (p1) (100)	3rd trimester	STAI-S (36.0 ± 8.7); STAI-T (38.4 ± 9.2)	MFAS total (-) role-taking, differentiation, interaction, characteristics, giving of self (-)	Pearson correlation	STAI-S w MFAS total $r = -0.26$ ***, w role-taking $r = -0.20$*; w giving of self $r = -0.26$** STAI-T w MFAS total ns, giving of self $r = -0.26$**, STAI-S/ -T w other subscales ns.	18.5
Lee (1992) (Taiwan)[o]	CG (40) IG = IVF (37) (p0)	T1: 0–19 w (CG: 14 ± -) T2: 20–31 w (CG: 26.7 ± -)	TMAS T1/T2 (CG: 17.9 ± 7.3/ 16.5 ± 8.8)	T1/ T2 MFAS total (CG:76.1 ± 10.2/ 86.8 ± 9.6) role-taking (CG:14.7 ± 2.9/ 16.3 ± 2.8) differentiation (CG: 11.5 ± 2.1/ 13.8 ± 2.2); interaction (CG: 14.5 ± 2.9/ 17.6 ± 3.6); characteristics (CG: 17.6 ± 3.0/ 19.8 ± 3.2); giving of self (CG 18.0 ± 2.7/ 19.2 ± 2.5)	Pearson correlation	TMAS w MFAS total /subscales for T1/ T2 ns.	25.5
					multiple regression analyses	TMAS T1 no sign. predictor for MFAS total or subscales at T2 (no group difference for TMAS and MFAS results calculated for IC + CG combined)	
McFarland et al. (2011) (USA)[†]	MDD (35) MDD + AD (30); AD (8); CG (88) (p1)	T1: 26 w T2: 36 w	SCID-IV, MDD or AD during pregnancy	MFAS total (-)	generalized linear modeling	sign. main effect for MDD group $(LR\text{-}\chi^2) = 12.76$***; main effect for anxiety or interaction MDD w ANX ns.	22
Mercer (1998) (USA)[†]	CG (p1) (218)	24-35 w	STAI-S (-)	MFAS total (-)	Pearson correlation causal modeling	MFAS total w STAI-S; path STAI-S to MFAS total ns.(after including number of children, health status, relationship satisfaction)	24.5
			STAI-S + STAI-T (-)		Pearson correlation		23.5

(continued on next page)

Table 2 (continued)

1st author, year (country)	Sample qualities (n)	Gestational age (M ± SD)[a]	Anxiety instrument + descriptives (M ± SD)	MFR instruments + descriptives (M ± SD)	Statistics used	Results	QI
Narita and Maehara (1993) (Japan)†	GP (p0) (276)	T1: 5–15 w T2:16–23 w T3: 24–31 w T4: 32–40 w		Modification: - 4 items MFAS total (-)		for T1/ T2/ T3/ T4: STAI-T w MFAS total score r = −0.26*/ ns/ ns/ ns; STAI-S w MFAS total score r = −0.45 ***/ −0.17*/ −0.22***/ −0.17*	21.5
Schmidt (2009) (Brazil)†	GP (p1) (136)	6–9 months	BAI (-)	MFAS total (-)	Fisher's exact test	groups with light / moderate / serious BAI: difference in MFAS scores ns.	27.5
Sjögren (2004) (Sweden)†	GP (p0), G1 (41) G2 (35)	G1: 13 w G2: 35–36 w	KSP G1/ G2: som. anx (47.7 ± 8.3/ 48.1 ± 8.4); psych anx (45.4 ± 9.1/ 45.3 ± 9.2); musc. tension (46.9 ± 10.9/ 47.5 ± 8.7); psychasth. (48.4 ± 13.4/ 45.7 ± 9.2); inh. aggression (46.9 ± 11.0/ 49.3 ± 10.1)	modification: −7 Items MFAS total (G1: 2.8 ± 0.5/ G2: 3.1 ± 0.4) extracted factors: FI visualizing motherhood (-) FII wonder + worry (-) F III nourishing self + fetus (-) F IV relation to self + body (-)	Linear regression analysis	MFAS total: all KPS anxiety scales ns. FI: som. anx (b = 0.25*); psych. anx (b = −0.30*), FII: psychoasth (b = 0.22*) FIII: inh. aggression (b = 0.20*), som. anx (b = 0.23*) psych. anx (b = −0.22*)	
MFAS and additional measures							
Wachter (2002) (USA)[o]	GP (p0) (62)	28–38 w (31.3 ± 3.3)	STAI-S (32.7 ± 7.7) STAI-T (34.4 ± 8.6)	MFAS total (96.8 ± 8.8) WMCI balanced (79%), unbalanced (21%)	Pearson correlation linear regression analysis Logistic regression analysis	STAI-S/ -T w MFAS total ns; for MFAS total STAI-S/ -T ns. for WMCI classification (balanced vs unbalanced): STAI-S/ STAI-T ns.	20
Walsh et al. (2014) (UK)†	GP (p -) (258)	3 groups: 13 w (n = 57) 23 w (n = 94) 33 w (n = 107)	PAQ (2.3 ± 0.6)	MFAS (Sjögren version) total (4.1 ± 0.5); MAAS quality (4.5 ± 0.4); intensity (3.5 ± 0.5)	Pearson correlation partially- latent structural equation modeling	PAQ w MFAS total r = −0.16*; w MAAS quality r = −0.25**; w MAAS intensity ns. with MFAS Total + MAAS subscales as one latent factor: effect of PAQ ns.	28.5
MAAS							
Allison (2001) (UK)†	CG1: pre DS(p1) (200); CG3: neg. DS (p1),(81)	CG1: 8–18 w (12 ± -) CG3: 18–27 w (20 ± -)	BAI (CG1: 8.3 ± 7.5; CG3: 8.2 ± 7.4)	MAAS total; (CG1: 74.7 ± 7.1; CG3: 78.5 ± 7.1)	Pearson correlation	CG1/ CG2: BAI w MAAS total ns. (-)	21
Condon (1997) (Australia)†	GP (p1) (238)	3rd trimester	HAD-A (-), POMS-A (-)	MAAS total (75.5 ± 9.0), quality (45.2 ± 3.8); intensity (26.4 ± 4.9)	Pearson correlation multiple regression analysis t-test discriminant function analysis	MAAS total w HAD-A r = −0.25**; w POMS-A ns.; quality w HAD-A r = −0.41***; w POMS-A r = −0.22***; intensity w HAD-A / POMS-A ns.; POMS-A, HAD-A ns. group low MAAS total (< 25% Quartile) significant higher HAD-A (t = 2.80*); for POMS-A ns. total: HAD-A ns, POMS-A b = −0.67***; quality: HAD-A ns; POMS-A b = −0.57***; intensity HAD-A b = −0.84***, POMS-A ns,	19.5

Table 2 (continued)

1st author, year (country)	Sample qualities (n)	Gestational age (M ± SD)[a]	Anxiety instrument + descriptives (M ± SD)	MFR instruments + descriptives (M ± SD)	Statistics used	Results	QI
De Cock et al. (2016) (Netherlands)[†]	GP[(p1)] (322)	23–31 w (26 ± -)	STAI-S (-)	MAAS total (-)	latent class analysis	group w low MAAS total higher STAI-S than group w high MAAS or very high MAAS, *Wald* = 15.61***	33
Hart (2006) (USA)[†]	GP[(p0)], (53)	(29 ± 3.6)	STAI-S (34.0 ± 10.3) STAI-T (36.0 ± 9.4)	MAAS total (77.8 ± 6.7) quality (48.9 ± 3.7) intensity (24.3 ± 3.3)	Pearson correlation; t-tests; multiple regression analyses	MAAS total w STAI-S /STAI-T ns. quality: w STAI-S r = −0.35* w STAI-T r = −0.40*, intensity: STAI-S /- T ns. low total score (<76) higher STAI-T (t = 2.31*); and STAI-S (t = 2.51**); low quality (< 49) higher STAI-S (t = 2.42 **) and STAI-T (t = 2.73**); low intensity (< 27) vs high: difference in STAI-S/STAI-T ns. for quality (all controlled for age): Model 1: STAI-T b = −0.41**; Model 2: STAI-S b = −0.41**, Model 3: both STAI-T and STAI-S included: ns.	19.5
Kraft (2017) (Germany)[†]	<u>IG</u> = SAD, (22) CG[(p -)] (24)	22–24 w	CIDI-Venus	MAAS total (IG:76.2 ± 7.5, KG: 75.8 ± 8.1)	t-test	group difference IG vs CG for MAAS total ns.	25.5
Mako (2017) (Hungary)[†]	GP[(p1)] (237)	7–40 w (25.5 ± 8.5)	HAD-A (5.2 ± 3.7)	MAAS total (80.5 ± 8.2); quality (45.9 ± 3.9), intensity (30.1 ± 4.8)	Pearson correlation	HADS-A w MAAS total: r = −0.46***; w quality r = −0.55***; w intensity r = −0.34***	29
Schmidt et al. (2016) (Germany)[†]	GP[(p1)] (215)	T1 (13 ± 3.1) T2 (26 ± 5.1)	T1/ T2 DASS-A (3.3 ± 2.9/ 3.1 ± 2.9) PSWQ-PW (33.0 ± 20.0/ 31.2 ± 19.7) RRS-SF (26.4 ± 6.7/ 24.5 ± 6.7)	T1/ T2 quality (27.1 ± 4.9/ 28.6 ± 4.6); intensity (45.5 ± 3.8/ 46.9 ± 3.4)	Pearson correlation; multiple regression analyses	DASS-A T1 w quality T1/ T2 r = −0.19**/ −0.20**; w. intensity T1/ T2 ns.; DASS-A T2 w quality T1/ T2 r = −0.20**/ −0.29**; w intensity T1/ T2 r = 0.18**/ns.; RRS-SF T1 w quality T1/T2 r = −0.37**/ −0.29**; w intensity T1/ T2 ns./ r = −0.15*; RRS-SF T2 w quality T1/ T2 r = −0.37**/ −0.41**; w intensity T1/ T2 ns / r = −0.18*; PSWQ-PW T1 w quality T1/ T2 r = −0.31**/ −0.35** w intensity T1/ T2 r = −0.35**/ −0.45** PSWQ-PW T1/ T2 w intensity T1/ T2 ns. for quality: T2: DASS-A and PSWQ-PW and RRS-SF at T1 ns. (controlling for age, social support, number of children, quality T1); for intensity: T2: RRS-SF β = −0.18*; PSWQ-PW and DASS-A at T1 ns. (after controlling for age, social support, number of children, intensity T1)	28
		CG (11.5 ± 1.2)	STAI-S T1/ T2; (CG 35.8 ± 9.6/ 34.5 ± 11.0)	MAAS total T1/ T2: (CG 73.2 ± 8.9/ 75.8 ± 0.9)	ANOVA	highly anxious (STAI > 40; n = 18 of CG + IG) sign. lower MAAS total. F (1,	21.5

Table 2 (*continued*)

1st author, year (country)	Sample qualities (n)	Gestational age (M ± SD)[a]	Anxiety instrument + descriptives (M ± SD)	MFR instruments + descriptives (M ± SD)	Statistics used	Results	QI
Udry-Jorgensen et al. (2015) (Schwitzerland)[†]	CG (51) IG = IVF, (52)[(p-)]					85) = 102.73*** (differences CG vs IG in STAI-S or MAAS total ns.; results calculated for CG + IG combined)	28.5
van Bussel et al. (2010) (Belgium)[†]	GP[(p1)] 3 groups: G1 (403) G2 (30) G3 (298)	G1:8–15 w, G2: 20–26 w, G3: 30–36 w	PRAQ; (-)	MAAS total (72.1 ± 7.1/ 75.4 ± 6.4/ 76.6 ± 6.0), quality (43.8 ± 3.7/ 45.5 ± 3.2/ 46.0 ± 2.8); intensity (26.5 ± 4.5/ 28.0 ± 4.3/ 29.0 ± 4.3)	Pearson correlation	T1/ T2/ T3 PRAQ w MAAS total r = ns./ ns./ ns. PRAQ w quality $r = -0.14*/ -0.20***/ -0.18**$; PRAQ w intensity r = ns./ ns./ ns.	
PAI							
Armstrong (1998) (USA)[†]	CG (15)[(p0)] IG = PL (16)	2nd,3rd trimester	POQ (28.7 ± 4.6)	PAI (64 ± 8.1)	Pearson correlation	POQ w PAI ns.	20.5
Hjelmstedt (2003) (Sweden)[†]	CG (41) IG = IVF (56)[(p0)]	T1: 13 w T2: 26 w T3: 36 w	T1 STAI-T (IG: 33.1 ± 6.7, CG 30.9 ± 6.3); T2/ T3 STAI-S (CG 30.3 ± 6.8/ 28.9 ± 4.8); T2/ T3 ERPS losing pregn: (CG 4.6 ± 1.4/ 5.0 ± 3.6; health baby T2/ T3 (CG: 4.1 ± 0.7/ 3.9 ± 0.9) T3 KSP som. anx. (CG: 46.1 ± 8.9), psych. anx. (CG: 43.7 ± 8.3); musc. tension (CG 46.0 ± 7.6)	PAI T2/T3 (CG 54.1 ± 9.5 / 59.8 ± 9.5; IG: 54.1 ± 8.8 / 58.4 ± 9.2)	Pearson correlation multiple regression analyses	PAI T2 w STAI-T/ STAI-S T2/ ERPS T2/ KSP T1 ns.; PAI T3 with STAI-T/ STAI-S T3/ KSP T3 ns. ERPS anxiety losing pregnancy T3 $r = -0.22 ***$); for PAI T2: only marital satisfaction sign. predictor for PAI T3: next to age, KSP detachment, ERPS ambivalence no sign. predictors (difference CG vs IG in STAI / ERPS/ PKS/ PAI ns.; results calculated for whole sample)	25.5
Nelson (1998) (USA)[o]	GP[(p0)], (218)	days until birth: 15–142 (58.3 ± 15.1)	STAI-T (39.3 ± 8.5)	PAI (61.9 ± 9.8)	Pearson correlation	PAI w STAI-T ns.	26.5
Sawyer Cohen (2011) (USA)[o]	GP[(p1)] (194)	(27.2 ± 7.9)	STAI-T (36.6 ± 10.5)	PAI (58.7 ± 10.3)	Pearson correlation	PAI w STAI-T $r = -0.15*$	26.5
Tani (2017) (Italy)[†]	GP[(p0)], (167)	31–32 w	STAI-S (49.0 ± 3.5)	PAI (60.3 ± 10.6)	structural equation modeling	effect STAI-S on PAI: β = -0.25***	21.5
Zachariah (2004) (USA)[†]	GP[(p1)] (111)	(17.5 ± 4.3)	STAI-S (39.6 ± 11.1) STAI-T (41.0 ± 10.9)	(63.2 ± 15.7)	Pearson correlation	PAI w STAI-S/ -T ns.	29.5
Bonding Scale							
Figueiredo (2007) (Portugal)[†]	GP[(p0)] (87)	3rd trimester	STAI-S (38.5 ± 11.4) STAI-T (38.1 ± 7.9)	BS total (2.7 ± 0.2) pos. bonding (2.7 ± 0.4); neg. bonding (0.1 ± 0.2) bonding not clear (0.7 ± 0.5)	ANOVA / t-test linear regression analyses	high STAI-S (≥ 45) lower BS Total (t = 3.61***), lower pos. bonding (F = 4.35*); higher neg. bonding (F = 10.26***) and; STAI-T high (≥ 45) higher negative bonding (F = 7.57***), lower total score (t = 2.35*); STAI-S predictor for negative bonding (b = 0.46***); for BS total /pos. bonding/ bonding not clear ns.	22
Figueiredo et al. (2009) (Portugal)[†]	GP[(p0)] (91)	21–28 w	STAI-S (38.7 ± 11.2)	BS total (2.7 ± 0.2), pos. bonding: (2.7 ± 0.4),	multiple regression analyses		27

Table 2 (continued)

1st author, year (country)	Sample qualities (n)	Gestational age (M ± SD)[a]	Anxiety instrument + descriptives (M ± SD)	MFR instruments + descriptives (M ± SD)	Statistics used	Results	QI
				neg. bonding (0.1 ± 0.2), bonding not clear (0.7 ± 0.5)		STAI-S ns predictor for bonding total score and subscales beyond depression and cortisol level.	

Notes. [a] as reported for each study, in *w* = weeks (if not stated otherwise); [0] = dissertation, [†] = scientific article [p0] = expecting first child, [p1] = expecting at least second child, [p>] parity not reported; [-] = no details reported; IVF = In-vitro fertilization; PL = perinatal loss; DS = Down's syndrome scan; SAD = social anxiety disorder; MDD = major depressive disorder, AD = anxiety disorder (generalized anxiety disorder, panic disorder, social phobia, or anxiety not otherwise specified).

Anxiety instruments: STAI-S / -T = State-Trait Anxiety Inventory; KSP = Karolinska Scale of Personality (*som. anx* = somatic anxiety, *psyc. anx* = psychic anxiety, *psychasth.* = psychasthenia, *musc. tension* = muscular tension, *inh. aggression* = inhibition of aggression); BAI = Beck's Anxiety Inventory; HAD-A = Hospital Anxiety Depression Scale- anxiety subscale; TMAS = Taylor Manifest Anxiety Scale; POMS-A = Profile of Mood States - anxiety subscale; DASS-A = Depression Anxiety Stress Scales - anxiety subscale; PSWQ-PW = Penn State Worry Questionnaire – Past Week; RRS-SF and the Ruminative Response Scale –Short Form; POQ = Pregnancy Outcome Questionnaire; PRAQ = Pregnancy-Related Anxiety Questionnaire; PAQ = Pregnancy Anxiety Questionnaire; ERPS = Emotional Response to Pregnancy Scale; SCID-IV = Structured Clinical Interview for DSM-IV Axis I Disorders; CIDI-Venus = Composite International Diagnostic Interview, specification for women

Maternal-fetal bonding instruments: MFAS = Maternal Fetal Attachment Scale; MAAS = Maternal Antenatal Attachment Scale; PAI = Prenatal Attachment Inventory; BS = Bonding Scale; WMCI = Working Model of the Child Interview.

(van Bussel et al., 2010) were found. Further, women diagnosed by CIDI-Venus with social anxiety disorder did not differ in MAAS total from a nonclinical control group (Kraft et al., 2017). Three studies reported significant associations: Mako and Deak (2014) reported a medium-sized negative correlation between MAAS total and HAD-A. De Cock et al. (2016) reported that women with low MAAS total had significantly higher STAI-S scores, and Udry-Jorgensen et al. (2015) found lower MAAS total in women reporting high levels of STAI-S. In two studies, mixed results were found: Hart and McMahon (2006) reported significantly higher STAI-S and STAI-T scores in a group with low MAAS total compared to the remainders, but the correlations between STAI-S and STAI-T and MAAS total were nonsignificant. Finally, Condon and Corkindale (1997) report higher HAD-A scores in a group with low MAAS total compared to the remainders and a significant negative correlation between HAD-A and MAAS total. However, in follow-up multiple regression, the HAD-A score did not predict MAAS total.

3.3.4. Associations with individual MAAS components

The MAAS dimensions *intensity* and *quality* are investigated in six studies. Four studies reported nonsignificant correlations between *intensity* and STAI-S or STAI-T (Hart and McMahon, 2006), PAQ (Walsh et al., 2014), PRAQ (van Bussel et al., 2010), PSWQ-PW (Schmidt et al., 2016) or POMS-A (Condon and Corkindale, 1997). Two studies reported significant associations: Mako and Deak (2014) reported medium- to moderate-sized negative correlations with *intensity* and HAD-A. Schmidt et al. (2016) identified RRS-SF, but not DASS-A, as a negative predictor of *intensity* late in pregnancy. Condon and Corkindale (1997) reported mixed results, with HAD-A as a significant negative predictor of *intensity* in discriminant functions analysis, whereas bivariate correlations between *intensity* and HAD-A did not reach significance.

For *quality*, in all five studies, low- to moderate-sized negative correlations with the chosen anxiety instrument were reported (Condon and Corkindale, 1997; Hart and McMahon, 2006; Mako and Deak, 2014; Pisoni et al., 2016; Schmidt et al., 2016; van Bussel et al., 2010; Walsh et al., 2014). Subsequent multivariate analyses partly confirmed these associations. Using discriminant function analysis, Condon and Corkindale (1997) identified anxiety assessed with POMS-A, but not HAD-A, as a discriminant coefficient for *quality*. Hart and McMahon (2006) identified both STAI-S and STAI-T as significant negative predictors of *quality*. Schmidt et al. (2016) reported mixed results and could not confirm significant negative zero-order correlations for *quality* with DASS-A, RRS-SF and PSWQ-PW in multiple regression analysis.

While the QI scores for Condon and Corkindale (1997) and Hart and McMahon (2006) were comparatively low, the remaining studies using MAAS scored on the higher end of the reported QI range.

Overall, associations between different forms of anxiety and Condon's broad conceptualization are mostly nonsignificant or mixed, which is especially evident on a subscale level. Not the *intensity* or "time spent in attachment mode", but the *quality* of the affective relationship, including experience of emotional closeness towards the child and seeing the fetus as a real person, was negatively associated with different forms of anxiety across studies.

3.3.5. Associations with PAI global score

Two of the six studies reported significant negative associations between PAI and anxiety: Sawyer Cohen (2011) reported significant small- to medium-sized correlations between PAI and STAI-T. Tani et al. (2017) found a significant negative influence of STAI-S on PAI in structure equation modeling. In four studies, no associations could be found for PAI with STAI-S, STAI-T, the KSP anxiety scales (included here: *somatic anxiety, psychic anxiety, muscular tension, psychasthenia, lack of assertiveness*) or POQ (Armstrong and Hutti, 1998; Hjelmstedt et al., 2003; Nelson, 1998; Zachariah, 2009). Further, a

Table 3
Summary of reported associations between anxiety and maternal-fetal bonding measures.

	MFAS original		MFAS modified		MAAS		PAI	BS	
	total	subscales	total	subscales	total	subscales	total	total	subscales
Negative	1	2 *GoS* 1 *R-T*	3	1 *FI* 1 *FIII*	5	6 *Q* 3 *I*	2	–	–
Nonsignificant	10	1 *Diff* 1 *IA* 1 *Char*	1	1 *FIV*	6	2 *Q* 5 *I*	7	3	1 *PB* 1 *BN*
Positive	–	–	–	1 *FI* 1 *FII* 1 *FIII*	–	–	–	–	1 *NB*

Notes: When conducted, results of multivariate analysis are reported.
Labeling subscales: GoS = giving of self; R - T = role - taking, Diff = differentiation self - fetus, IA = interaction w fetus, Char = characteristics, FI = visualizing motherhood, FII = wonder + worry, FIII = nourishing self + fetus, FIV = relation self + body; Q = quality, I = intensity, PB = positive bonding, BN = bonding not clear, NB = negative bonding

significant low- to medium-sized negative association with the ERPS subscale *anxiety about losing pregnancy* did not remain significant in subsequent multiple stepwise regression analysis (Hjelmstedt et al., 2003).

While Tani et al. (2017) and Armstrong and Hutti (1998) scored below average in their QI, the remaining studies assessing PAI scored comparably high in QI.

Overall, the global construct assessed by PAI of the developing affectionate relationship to the child was, across studies, not consistently associated with different forms of anxiety.

3.3.6. Associations with BS components

In the first study by Figueiredo et al. (2007), women with high STAI-S scored lower on the BS total and *positive bonding*. Further, women high in STAI-S or STAI-T scored higher on *negative bonding*. In a subsequent multiple regression analysis, STAI-S, but not STAI-T was a significant predictor of *negative bonding* beyond depression. In their second study, with a slightly larger sample, Figueiredo et al. (2009) focused on STAI-S to predict BS total and subscale scores and could not confirm a predictive power of STAI-S in multiple regression analysis.

While the QI of their first study (Figueiredo et al., 2007) was slightly below the average, the second study showed a comparable high QI.

Overall, the initial associations between state anxiety and *positive bonding* or *negative bonding* could not be confirmed in a further analysis.

3.3.7. Associations with WMCI representations

Wachter (2002) compared the *balanced* to the two unbalanced (*disengaged* and *distorted*) WMCI categories. In logistic regression analysis, neither STAI-S nor STAI-T were significant predictors of the WMCI classification beyond relationship satisfaction.

QI for this study was comparable high.

In this one study, no effect of state or trait anxiety on the WMCI categories was found.

3.4. Direction and size of effects depending on anxiety instrument

A summary of reported associations is given in Table 3. Anxiety was mostly assessed as current levels of general state or trait anxiety. Only a few instruments assessed clinically diagnosed anxiety disorders or more specific symptom clusters associated with anxiety. The samples of women diagnosed with social anxiety disorder (Kraft et al., 2017) or any anxiety disorder (McFarland et al., 2011) did not differ significantly in their bonding from nonclinical control groups. Regarding the more specific symptom clusters, only RRS-SF (Schmidt et al., 2016) was a significant negative predictor of MAAS *intensity*.

The reported significant associations were overall negative, across different forms of anxiety and maternal-fetal bonding constructs, with a higher anxiety level being associated with lower bonding to the child.

Only one study reported a significant positive association for a personality trait of somatic complaints, psychasthenia and anger inhibition, with subscale dimensions of a modified version of MFAS (Hjelmstedt et al., 2003).

Regarding effect size, the significant associations for both state and trait anxiety were low- to moderately sized. The strongest correlation was reported for HADS-A and *quality* of bonding with $r = 0.55$. Across studies, current levels of anxiety showed a tendency of slightly higher and more stable associations with different aspects of maternal-fetal bonding than traits of general anxiety or specific forms of predispositions for anxiety.

Four studies reported results on pregnancy-related anxiety, with low negative correlations ranging from $r = -0.14$ to -0.25. In two studies, the results did not remain significant in multivariate analysis (Hjelmstedt et al., 2003; Walsh et al., 2014).

3.5. Summary of results

Overall, no consistent associations with forms of anxiety were found for the global construct definitions of maternal-fetal bonding as assessed with MFAS or PAI. For the MAAS global construct, mixed results were reported.

For the specific components of maternal-fetal bonding, the associations were again mostly nonsignificant. Single significant negative associations for MFAS *giving of self* with state and trait anxiety or for MFAS *role-taking* with state anxiety were reported. Modified MFAS subscales showed significant negative associations with traits of psychic anxiety and psychasthenia and positive associations with traits of inhibition of anger and somatic anxiety. The emotion-focused conceptualization of bonding assessed by BS can in this context be understood as one subdimension of the broad construct. Initial negative associations with state and trait anxiety levels could not be confirmed in multivariate analysis.

For the MAAS *intensity* dimension, the results were mixed. Only the MAAS *quality* dimension, which describes the affective experience of positive emotions towards the fetus, feeling emotional close to the child and picturing the child as a person, showed stable negative associations with different forms of anxiety. Negative, low- to moderate-sized correlations were found for *quality* and levels of general state and trait anxiety, as well as pregnancy-related anxiety.

Associations with state anxiety were slightly stronger than for trait anxiety or pregnancy-related anxiety. Initial negative correlations of *quality* with symptoms of rumination and worry failed to stay significant in the subsequent multivariate analysis.

4. Discussion

The aims of this review were to systematically summarize the

methodology and results of studies assessing the association between maternal-fetal bonding and prenatal anxiety and to investigate whether effect sizes and direction of effects differed depending on the construct definition of maternal-fetal bonding assessed by the chosen instruments. Further questions assessed whether the specific types of anxiety differed in their strength and direction of effects with maternal-fetal bonding.

The individual studies reviewed here show heterogeneity in their operationalization of maternal-fetal bonding and anxiety, as well as in methods of statistical analysis. Overall, half of the studies reported significant associations, which were low- to moderate-sized, with an overall negative direction of effects. The MAAS *quality* dimension shows the most robust findings and stable negative associations with anxiety measures across studies. These results indicate that not all aspects of the broad concept of maternal-fetal bonding are affected by anxiety but that the quality of perceived emotional proximity to the fetus is particularly affected, including positive emotions towards the fetus and the representation of the child as a person.

Since BS and WMCI are used in one or two studies only, a generalization of these individual results is not possible. Consequently, they are not included in the following discussion. More studies investigating their association with anxiety are needed.

4.1. Conceptualizations of maternal-fetal bonding and associations with anxiety

The instruments assessing maternal-fetal bonding vary strongly in their scope. Differences in the conceptualization and properties of the instruments might explain the heterogeneous results reported here.

Most of the studies identified in this review report associations with anxiety only for MFAS global score, which also covers aspects of maternal behaviors and attitudes towards the maternal role and pregnancy itself. Not all of the aspects, which are understood by Cranley (1981) as components of maternal-fetal bonding, might individually be affected by maternal anxiety. This might explain the overall nonsignificant results found in this review for the MFAS total score. Due to the low scale reliability of the MFAS subscales (Cranley, 1979) and the few reported results, associations on subscale level cannot be generalized in this context.

Müller and Mercer (1993) postulated a unidimensional construct of the PAI with a global score only. In contrast, other researchers using factor analytic techniques identified four to five underlying dimensions (e.g., Nelson, 1998; Siddiqui and Hägglöf, 2000). Thus, the concept of the PAI can also be understood as a broad one. Not all aspects covered by the PAI might be affected by anxiety, which could explain the mostly nonsignificant associations reported in this review for the PAI global score across different studies.

In comparison, Condon's (1993) approach to separate the quality of emotional bonding from the rather quantitative intensity of mental preoccupation with the fetus seems relevant for the associations with anxiety. While results for the association between *intensity* and anxiety are mixed, the *quality* dimension shows stable, low- to moderate-sized negative correlations across different anxiety instruments, which in some cases exceed those reported by Yarcheski et al. (2009). These results support the assumption that the emotional proximity towards the fetus, with the experience of positive feelings and emotional closeness to the child, is specifically affected by anxiety.

These divergent results for the two MAAS dimensions might further explain the nonsignificant results for MFAS and PAI. Independent from the experience of emotional bonding to the child, the *intensity* dimension refers to the "time spent in attachment mode" (Condon, 1993) and the mental preoccupation with the fetus. In both instruments, items cover aspects comparable to the *intensity* dimension (e.g., thinking

about or talking to the fetus, concerns about diet). Therefore, these items might assess the intensity of preoccupation with the fetus as an indicator for maternal bonding rather than highlight the quality of the emotional experience in this bonding process. This seems especially relevant for the PAI, which is also focused on the affectionate relationship. In the PAI, women are asked about the frequency with which they experienced the thoughts or situations described in some of the items. Hence, some PAI items cover the quantity of preoccupation with the fetus, which might not be impaired by anxieties.

From a clinical perspective, it is interesting that the intensity of preoccupation alone does not correlate with anxiety in general, even though a mental preoccupation at the high end of the dimensional range shows parallels to symptoms of rumination, which often occurs in anxiety disorders (e.g., Schmidt et al., 2016). These results are in line with Condon's (1993) assumption that women with patterns of positive preoccupation (high *quality* and *intensity*) and positive disinterest (high *quality*, low *intensity*) had a generally positive and strong bond with the child. In the latter pattern, the mother might be distracted from thinking about the fetus by other aspects of her environment (e.g., work or other children) that might influence mental preoccupation with the fetus but not the experience of emotional proximity. The specific associations with *quality* and levels of anxieties reported here are further in line with results by Pollock and Percy (1999), who found that women referred for psychological evaluation with impaired mental well-being and higher rates of personality disorders, as well as preoccupied and dismissing attachment, showed mostly low *quality* scores with negatively preoccupied (low *quality*, high *intensity*) and disinterested (low *quality*, low *intensity*) MAAS patterns. The negatively preoccupied group further reported a higher level of irritability with the fetus.

4.2. Associations with different forms of anxiety

The operationalization of maternal-fetal bonding differs across studies, as does that of anxiety. Most studies used questionnaire-based screening tools. Only a small number of studies included samples with anxiety disorders diagnosed by structured clinical interviews. Further, some of the anxiety self-report measures in this review were used in only one or two studies, making it difficult to generalize and compare their results.

Regarding the assessment of general levels of anxiety, the literature broadly differentiates between levels of current state of anxiety and a personal trait or disposition to be generally more anxious (e.g., Meades and Ayers, 2011; Spielberger et al., 1970). The STAI became one of the most established self-report forms to assess both state and trait anxiety (Meades and Ayers, 2011). This is also reflected in this review, with sixteen studies reporting results with STAI-S and twelve studies with STAI-T. A comparison of the results reveals a tendency for state anxiety to be more often significantly and slightly more strongly associated with maternal-fetal bonding.

Four studies in this review assessed pregnancy-related anxiety. On a correlational level, these studies reported negative, low associations with the MAAS *quality* subscale and MFAS and PAI. These first results suggest a negative impact of pregnancy-related anxiety also on different aspects of maternal-fetal bonding and contradict theories indicating a positive association (e.g., Leifer, 1980).

Among all studies the strongest reported association was found between MAAS *quality* and HADS-A, also assessing currently elevated levels of anxiety. Compared to the rather low associations between MAAS *quality* and trait or pregnancy-related anxiety these results suggest that a general level of anxiety might have a stronger impact on perceived emotional proximity to the fetus than pregnancy-related anxiety, which most pregnant women experience to some degree (e.g., Huizink et al., 2003). Further research assessing different forms of

anxiety is needed to replicate these first results for pregnancy-related anxiety and proof this assumption.

The overall negative direction of effects is in line with the results of Yarcheski et al. (2009) and Alhusen (2008). Possible explanations for this effect might be that the mother is too distracted by her anxieties to focus on the relationship with the fetus, as Leifer (1980) proposed for general levels of anxiety, or even avoids emotional involvement to cope with a heightened vulnerability during pregnancy (e.g., Mikulincer and Florian, 1999). Nevertheless, even for MAAS *quality*, the size of reported effects varied between low and moderate across studies, even when the same instruments were used. This is in line with the report by Yarcheski et al. (2009) and indicates that there are more complex associations between both constructs. Underlying characteristics of the individual samples might influence the potential impact of anxiety on maternal-fetal bonding.

Thus, heterogeneity in results might further be explained with the statistics and included predictor variables used to analyze associations. In many of the reviewed studies, associations between anxiety and maternal-fetal bonding are reported via correlational methods. Therefore, the analysis in this review is predominantly based on these methods. Nevertheless, in some cases, subsequent multivariate analyses cannot confirm significant zero-order correlations. Since maternal perinatal adjustment is a complex process in which different personal and contextual factors are important (e.g., Raphael-Leff, 2005), it is also not unlikely that the association between maternal-fetal bonding and anxiety is an indirect one that is influenced by underlying factors. The perception of and satisfaction with adult relationships could be potential confounders (Mazzeschi et al., 2015; Yarcheski et al., 2009). Both Müller and Mercer (1993) and Condon (1993) outlined the importance of adult attachment representations for the developing bond to the fetus. Negative associations for anxious and dismissing adult attachment patterns with maternal-fetal bonding have been reported in previous studies (Mazzeschi et al., 2015; Mikulincer and Florian, 1999). Contemporary research further indicates that dismissing attachment is not necessarily associated with higher anxiety levels compared to secure and preoccupied attachment (e.g., Nielsen et al., 2017; Nolte et al., 2011). Down-regulating coping strategies to avoid the experience of distress and anxiety might lead to both low anxiety and low bonding to the child (e.g., Mikulincer and Florian, 1999). These results are further in line with researchers' calls to investigate predictors for maternal-fetal bonding not just in isolation but in more complex designs and in terms of their dependence on each other to identify potential interaction effects (Bouchard, 2011). Since only a small number of studies report multivariate analyses and with varying predictor variables, these associations cannot be further generalized and should be the focus of future research.

5. Limitations

This review has several limitations. Regarding the search criteria, gray literature was not included, but only published studies that were identified by electronic or reference search. Since the quality index was developed for this review, its values cannot be compared to those used in other studies. Due to the approach used to give an overall estimation of study quality, more detailed information on internal or external validity is not reported. Further, to ensure generalizability of results and to minimize the effect of potential confounders, studies focusing exclusively on teenage and high-risk pregnancies or pregnant women with multiple psychopathologies were excluded. Additionally, most identified studies assessed samples from Western societies. Therefore, a

generalization of results to an Asian, African or South American cultural background cannot be guaranteed.

6. Conclusion

The results of this systematic review lead to the conclusion that not all aspects of maternal-fetal bonding, might be affected by anxiety but that more specific components might be affected. The quality of emotional proximity to the fetus in particular, with a positive affect towards the fetus and picturing the child as a real person, was consistently impaired by anxieties across studies. The current state of anxiety was slightly more strongly associated with maternal emotional bonding than were traits of anxiety. Both prenatal bonding and prenatal anxiety have been associated with perinatal outcomes in mother and child as well as in the mother-child interaction and infant socio-emotional development. An additional impairment of the maternal emotional bonding to the fetus by anxiety might intensify the impact of both anxiety and maternal-fetal bonding on the developing postnatal mother-child relationship. Nevertheless, the reported associations are of low to moderate size, and multivariate analyses could, in some cases, not confirm prior zero-order correlations. Therefore, the association between anxieties and maternal emotional bonding might be influenced by underlying personal and contextual variables. Future studies should analyze maternal bonding and its associated factors in complex multivariate models to disentangle interactive prenatal adjustment processes.

Conflicts of interest

Authors declare that they have no conflict of interest.

Contributors

Ariane Göbel developed the research question, conducted the literature search, data extraction, quality assessment and interpretation of findings, drafted and revised the manuscript and approved the final version. Lydia Yao Stuhrmann coded the extracted articles for eligibility and further contributed to the drafting of the manuscript, manuscript revision and approval of the final version. Susanne Harder contributed to the research design, drafting of the manuscript, manuscript revision and approval of the final version. Michael Schulte-Markwort contributed to the development of the final research question, the research design, drafting of the manuscript, manuscript revision and approval of final version. Susanne Mudra contributed to the development of the final research question, the research design, data extraction, drafting of the manuscript, manuscript revision and approval of the final version. All authors agree to be accountable for all aspects of this work.

Appendix

Table A1.

Table A1

Scoring quality index.

1. Qualification first author	1 = B.*Sc*/ M.*Sc*/ Diploma	2 = doctoral degree	3 = doctoral degree + multiple publications in MFR
2. Type of publication	1 = dissertation/ journal article	2 = peer-reviewed article	
3. Funding	1 = yes		
4. Information regarding recruitment procedure given	1 = yes		
5. Sampling method	1 = convenience	2 = matched	3 = random
6. Recruitment catchment area	1 = monocentric	2 = multicentric	
7. Sample size	1 = 1–50	2 = 51–100	3 = 101–200 4 ≥ 201
8. Report on drop-out	0.5 = information at one of multiple assessment points	1 = information at all relevant assessment points	
9. Report on eligibility and exclusion criteria	1 = one criteria reported	2 = both criteria reported	
10. Study design	1 = correlational	2 = causal modeling	3 = comparative
	4 = methodological	5 = longitudinal	6 = quasi-experimental
11. Report on alpha level and power analysis	0.5 = one criteria reported	1 = both criteria reported	
12. Report on reliability (R) and validity (V) MFB instrument	1 = only previous R or V	2 = R <u>or</u> V for current study	3 = R <u>and</u> V for current study
13. Report on reliability (R) and validity (V) ANX instrument	1 = only previous R or V	2 = R <u>or</u> V for current study	3 = R <u>and</u> V for current study
14. Used statistics	1 = bivariate	2 = multivariate	
15. Report on dealing with missings / not fulfilled assumptions	0.5 = one criteria reported	1 = both criteria reported	
16. Gestational age	0.5 = range/trimester reported	1 = descriptive statistics reported	
17. Socioeconomic background (income, education, occupation)	0.5 = one characteristic reported	1 = at least two characteristics reported	
18. Social background (marital status/years in relationship, occupation status, ethnicity)	0.5 = one characteristic reported	1 = at least two characteristics reported	
19. Pregnancy-related characteristics (parity, gravidity, pregnancy planned)	0.5 = one characteristic reported	1 = at least two characteristics reported	

Note. If a particular topic is not addressed in the original article, it is scored 0. The quality index (QI) has a possible range of 0–39. MFB = maternal-fetal bonding; ANX = anxiety.

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8 Article II

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Psychometric properties of 13-item versions of the maternal and paternal antenatal attachment scales in German

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ABSTRACT

Objective: To assess scale reliability and factorial validity of the Maternal and Paternal Antenatal Attachment Scale in a German sample.

Background: Prenatal bonding to the child is an important aspect for parents and has been associated with the early parent-child relationship. The maternal and paternal versions of the Antenatal Attachment Scale (MAAS/PAAS) with the dimensions bonding quality and intensity are among the best-established questionnaires for parental-fetal bonding. However, a German translation of the PAAS and investigations of the factor structure of both MAAS and PAAS are still lacking.

Method: 263 women and 128 men from Hamburg, Germany, were assessed during pregnancy (total sample $N = 391$).

Results: Factor analyses did not support the original factor structures of both scales. Still, two factors equivalent to the original quality and intensity dimensions were identified. Scale reliability for the extracted factors was satisfying to good for both instruments.

Conclusion: The revised 13-item versions for MAAS and PAAS are proposed as reliable and valuable measurements of parental-foetal bonding. The scales contribute to the cross-cultural comparison of research on maternal and paternal-foetal bonding. Identifying parents with bonding difficulties already prenatally can enable specific forms of support addressing the parent-child-relationship in the peripartum period.

Abbreviations: Maternal Antenatal Attachment Scale (MAAS). Paternal Antenatal Attachment Scale (PAAS). confirmatory factor analysis (CFA). Root Mean Squared Error of Approximation (RMSEA). Standardized Root Mean Square Residual (SRMR). Comparative Fit Index (CFI). Tucker Lewis Index (TLI). principal axis factoring (PAF). mean (M). standard deviation (SD). standard error (SE). item difficulty (Pi). Kaiser-Meyer-Olkin value (KMO)

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Introduction

During pregnancy, one crucial aspect for parents is to develop an emotional relationship to the unborn child (Raphael-Leff, 2005; Rubin, 1967). This so-called parental-foetal bonding is discussed as a factor relevant for the intergenerational transmission of attachment patterns and for the parent–child relationship (Condon, 1993; Mikulincer & Florian, 1999; Müller, 1993). Longitudinal studies support the assumption of associations of parental-foetal bonding with parent-infant bonding (Dubber, Reck, Müller, & Gawlik, 2015; Müller, 1996; van Bussel, Spitz, & Demyttenaere, 2010), mother-infant interaction and child socioemotional development (Branjerdporn, Meredith, Strong, & Garcia, 2017; Siddiqui & Hägglöf, 2000; Thun-Hohenstein, Wienerroither, Schreuer, Seim, & Wienerroither, 2008). Further, low maternal-foetal bonding has been associated with less pregnancy-related health practices (Lindgren, 2003), less positive attitudes towards pregnancy, childbirth and childcare (Stanton & Golombok, 1993) and a higher tendency for the intention to bottle-feed the child (Foster, Slade, & Wilson, 1996; Huang, Wang, & Chen, 2004). The few studies investigating paternal-foetal bonding report mixed results and indicate different developmental trajectories and divergent associations with potentially influencing factors compared to maternal bonding (Bouchard, 2011; Colpin, De Munter, Nys, & Vandemeulebroecke, 1998; Kunkel & Doan, 2003; Righetti, Dell'Avanzo, Grigio, & Nicolini, 2005). Overall, there is still little research on this topic. However, what is lacking is a cross-cultural assessment of the construct with comparable, valid instruments, which is crucial for identifying factors influencing its development and for understanding its relevance for the postpartum period.

Since Cranley (1981) developed the Maternal-Fetal Attachment Scale (MFAS) as the first self-report questionnaire, the conceptualization of parental-foetal bonding has been critically discussed, leading to a range of definitions and measurements (Alhusen, 2008; Brandon, Pitts, Denton, Stringer, & Evans, 2009; van Den Bergh & Simons, 2009). Besides the MFAS (Cranley, 1981) and its paternal version (PFAS; Weaver & Cranley, 1983) or the Prenatal Attachment Inventory (PAI; Müller, 1993), the Maternal/Paternal Antenatal Attachment Scale (M/PAAS; Condon, 1993) has become one of the instruments most often used to assess prenatal bonding (Göbel, Stuhrmann, Harder, Schulte-Markwort, & Mudra, 2018; van Den Bergh & Simons, 2009). The M/PAAS is based on the definition of parental-foetal bonding as the developing parental 'emotional tie or bond' to the foetus (Condon, 1993) with two underlying dimensions. A *quality* dimension refers to the emotional experience in relation to the foetus (e.g., emotional proximity, emotions to the child). An *intensity* dimension refers to the amount of time spent with mental preoccupation with the foetus (e.g., frequency of talking/thinking about the foetus).

Condon (1993) validated the questionnaires in 112 Australian couples across pregnancy and reported slightly different factor solutions for mothers and fathers. Thus, the MAAS consists of 19 and the PAAS of 16 items. For Dutch and French MAAS versions satisfying to good scale reliability (Cronbach's α = .78 to .87 for MAAS total, α = .69 to .80 for *quality*, α = .73 to .77 for *intensity*) and convincing construct validity were reported (Mako & Deak, 2014; van Bussel et al., 2010). Still, in current factor-analytical studies, alternative factor solutions showed a better model fit than the original. In a Portuguese sample of 107 women and 105 men assessed across pregnancy, exploratory factor analyses revealed divergent item loadings on the two factors and led to the exclusion of two MAAS and PAAS items due to

insufficient psychometric properties (Gomez & Leal, 2007). The authors further suggested using the total score only. In another study with 212 Portuguese couples in the second trimester of pregnancy, Camarneiro and Justo (2010) found a divergent item distribution and excluded four MAAS items and one PAAS item due to low factor loadings. They reported for MAAS and PAAS acceptable to satisfying reliability for their extracted *quality* (Cronbach's α = .73 and .73, respectively) and *intensity* dimensions (α = .60 and .69, respectively). In 482 Italian women in their second to third trimester, the MAAS two-factor structure was confirmed, but with four items from *quality* loading higher on *intensity*, and one item showing an insufficient factor loading (Busonera, Cataudella, Lampis, Tommasi, & Zavattini, 2016). For an Italian PAAS, validated in 165 men in the third trimester of pregnancy, Della Vedova and Burro (2017) extracted the alternative factors *fantasizing about the unborn baby* and *anticipating the real baby*, but with only the first factor showing satisfying reliability (α = .76 and .49, respectively). For a Spanish MAAS, validated in 525 pregnant women in their first to third trimester, seven items were excluded, though the two-factor structure was confirmed, with acceptable to satisfying reliability for the total scale (α = .73) and subscales (α = .65 to .66; Navarro-Aresti, Iraurgi, Iriarte, & Martínez-Pampliega, 2016). For a French MAAS, validated in 117 pregnant women in the third trimester, four factors were extracted, but only a factor comparable to the *quality* dimension, a factor labelled *representation of the foetus*, and the total score showed adequate reliability (α = .74, .62 and .71, respectively; Denis, Callahan, & Bouvard, 2015). In most of these studies, the two-dimensional conceptualization comparable to the original reported by Condon (1993) was confirmed, but partly with substantial item reduction. These results underline the need for further factor-analytical examination of MAAS and PAAS, especially when adapting for use in different languages (Navarro-Aresti et al., 2016).

In a German sample of 161 women in their third trimester of pregnancy, acceptable to satisfying scale reliability for the MAAS total score (α = .73), *quality* (α = .68) and *intensity* (α = .68) were reported (Goecke et al., 2012). However, to our knowledge, a detailed analysis of the factor structure of a German MAAS is still lacking. Additionally, a German version of the PAAS or of comparable instruments assessing paternal-foetal bonding could not be identified in the literature. Thus, the aim of this study was to investigate the psychometric properties of MAAS and PAAS in a German sample and to contribute to factor-analytical results from current cross-cultural studies.

2. Method

2.1 Study design

The data for this cross-sectional analysis derives from a collaboration between two related ongoing population-based prospective longitudinal studies (PRINCE – 'Prenatal Identification of Children's Health' and PAULINE – 'Prenatal Anxiety and Infant Early Emotional Development') based at the University Medical Centre Hamburg-Eppendorf, Germany. Data for this analysis were collected from the cohort via self-report questionnaires. Participants signed informed consent forms to the inclusion of material pertaining to themselves and that they acknowledge that they cannot be identified via study publications as well as that their data was fully anonymized. The study protocols were approved by the ethics committee of the Hamburg Chamber of Physicians (PV3694, PV5574).

2.2. Study sample and procedure

Pregnant women were recruited upon initial presentation at the university after being sent by their gynecologist or midwives between 2014 – 2018. Women with a singleton pregnancy and 18 years or older were included in the sample. Women with chronic infections, substance abuse, or a pregnancy after assisted reproductive technologies, and participants with a poor understanding of German were excluded. Since it was expected that variance in parental-foetal bonding would increase across pregnancy (Yarcheski et al., 2009), maternal-foetal bonding was for this analysis assessed in the third pregnancy trimester. Partners of included women were invited to fill out a questionnaire once during pregnancy. To include as many men as possible, they were given the chance to fill out the questionnaire when accompanying their partner to their study appointment either in the second or third trimester of pregnancy. Women and their partners were asked to fill out questionnaires independently. Of the $N = 263$ women participating in the study, $N = 128$ men agreed to be included in this analysis ($N = 391$ participants).

2.3. Variables and instruments

2.3.1. Parental-foetal bonding
To assess maternal-foetal bonding, a German translation of the MAAS by Hochreuther (2012) was used. The PAAS was translated into German for the purpose of this study following the recommendations by Bracken and Barona (1991). Two members of the study team independently translated the English version into German. A final consent translation was developed together with the PI of the study and back-translated by two independent experts in English, who were blind to the study content and the original questionnaire. Items are scored from 1 to 5, with total scores ranging from 19 to 95 for MAAS, and 16 to 80 for PAAS. For MAAS, the *quality* score (11 items) ranges between 11 and 55, the *intensity* score (8 items) ranges between 8 and 40. For PAAS, the *quality* score (8 items) ranges between 8 and 40, and the *intensity* score (6 items) between 6 and 30.

2.3.2. Background information
Participants filled out questionnaires about their monthly household income, educational background, relationship status, parity and gestational age.

2.4. Statistical analysis

Statistical analyses are based on methods from classical test theory. First, descriptive statistics of the items, as well as inter-item correlations and item difficulty were reported. While the inter-item correlation coefficient r should be high between items loading on the same factor due to their shared variance, it should be low between items loading on different factors. The item difficulty P_i refers to the frequency of high versus low item score across the sample. P_i ranges from 0 to 100, with high values (>85) indicating that most participants gave a high score in this item and low values indicating that most participants scored this item low (<50). Factorial validity for the factor solutions was assessed with confirmatory factor analysis (CFA) based on structure equation modelling. Models were estimated using robust maximum likelihood. The following criteria were

used to evaluate model fit: 1) χ^2 for model fit, testing for the null hypothesis that the model fits the data, 2) Root Mean Squared Error of Approximation (RMSEA), with scores ≤ 0.05 indicating good model fit, 3) Standardized Root Mean Square Residual (SRMR), with scores ≤ 0.05 indicating good model fit, and 4) Comparative Fit Index (CFI) and the Tucker Lewis Index (TLI), with scores ≥ .95 indicating good model fit. Next, explorative principal axis factoring (PAF) was conducted with oblique (promax) rotation to investigate the factor loadings without imposing a predefined structure on the data. Factor loadings > .30 were considered indicative of importance (Nunnally, 1978). The number of extracted factors were identified with the scree-test and factors with eigenvalues < 1 were excluded. Scale reliability was assessed with Cronbach's α. Only complete data sets were included. Statistical analyses were conducted with MPlus 6.11 (Muthén & Muthén, 2015) and IBM© SPSS 22 (SPSS, 2013).

A-priori power analyses were calculated with the R-package semPower (Moshagen, 2018) and independently for both questionnaires due to their divergent number of items. Power analyses for our main aim of a CFA based on structure equation modelling with the original two-factor solution and the specifications RMSEA = .05, α = .05 and β = .20 estimated a required sample size of N = 130 for MAAS (df = 151), and N = 161 for PAAS (df = 103). Regarding the sample size in this analysis, the maternal sample fulfilled requirements of the power calculation, while the paternal sample was slightly underpowered.

3. Results

3.1. Sample characteristics

Most women were in a relationship at first assessment (96.6%). The participants were well educated and had an average to high household income (Table 1). Women reported a higher education level than participating men.

3.2. Item characteristics

Item characteristics of MAAS and PAAS are listed in Table 2. Item means ranged from average to high for both instruments, with low standard deviations. Distributions were left-skewed and kurtosis varied. Inter-item correlations ranged for MAAS from $r = .01$ to $r = .62$ and for PAAS from $r = .01$ to $r = .64$. Item difficulties ranged for MAAS from $P_i = 33$ to 99, and for PAAS from $P_i = 13$ to 95. For MAAS, inter-item correlations of the items 12 ($r ≤ .24$), 15 ($r ≤ .27$), 16 ($r ≤ .20$) and 19 ($r ≤ .30$) were low. Further, their item difficulty indices indicated low discriminative power. For PAAS, low inter-item correlations were found for the items 8 ($r ≤ .24$), 13 ($r ≤ .23$) and 16 ($r ≤ .16$).

3.3. Factorial analyses

3.3.1 CFA

Model fit indices for the original factor solutions of MAAS and PAAS are listed in Table 3. For both instruments, the model fit indices did overall not fit the recommended cut-off scores. For MAAS, standardized factor loadings ranged for *quality* from .15 (standard

Table 1. Characteristics of the sample[1] (*N* = 391 participants in total).

	total sample women (*n* = 263)	participating men (*n* = 128)
Age at assessment, in years; *M* (*SD*)	32.7 (3.9)	35.6 (4.3)
Range	20 to 44	24 to 50
Gestational age at assessment; *M* (*SD*)	35.4 (1.7)	31.0 (9.6)
Range	29 to 41	12 to 40
Expecting first child, *n* (%)	123 (46.8)	77 (59.2)
Education, *n* (%)		
Main or middle school	53 (20.2)	40 (31.3)
High school graduation	60 (22.8)	49 (38.3)
University degree	139 (52.9)	38 (29.7)
No information available	11 (4.2)	1 (0.8)
Monthly household income, *n* (%)		
≤ 1000 €	9 (3.4)	3 (2.3)
1001–2000 €	18 (6.8)	6 (4.7)
2001–4000 €	95 (36.1)	48 (37.5)
≥ 4001 €	128 (48.7)	65 (50.8)
no information available	13 (4.9)	6 (4.8)

[1]Pregnancy details based on women's report.

error *SE* = .08) to .73 (*SE* = .08) and for *intensity* from .30 (*SE* = .07) to .76 (*SE* = .04). The factors *quality* and *intensity* correlated with *r* = .45. Residual variances of the items ranged from .43 (*SE* = .06) to .98 (*SE* = .03). The explained variance in the individual items by their designated factor ranged from 1.6% to 57.2%. Variance of the items 6, 12, 16, and 19 was not significantly predicted by the underlying factor (all r^2 ≤ .12, *p*s ≥ .10). For PAAS, standardized factor loadings for *quality* ranged from .05 (*SE* = .10) to .73 (*SE* = .06) and for *intensity* from .28 (*SE* = .09) to .69 (*SE* = .06). Residual variances ranged from .46 (*SE* = .91) to .99 (*SE* = .01). The explained variance in the individual items by their designated factor ranged from 0.0% to 53.7%. Variance of the items 3, 7, 8, 12 and 16 was not significantly predicted by the underlying factor (all r^2 ≤ .08, *p*s ≥ .13).

3.3.2 PAF

For MAAS, a PAF with unrestricted baseline estimation was conducted. Items 12, 15, 16 and 19 were excluded from analysis due to low inter-item correlations. For PAF with the remaining MAAS items, sampling adequacy was confirmed, with a Kaiser-Meyer-Olkin value of KMO = .83. The Bartlett's test of sphericity, $\chi^2(105)$ = 1143.74, *p* < .001 also supported the appropriateness of PAF. Analysis with oblique promax rotation revealed three factors with eigenvalues ≥ 1, explaining 40.2% of total variance. Since the scree plot indicated a two-factor solution (see Figure 1), and only item 8 and 18 were additionally loading on a third factor explaining 3% of variance, a second PAF was conducted restricted to two factors. The factor loadings of the final solution are listed in Table 4. The items 6 and 14 did not load strong enough on any factor to be included in the subscale scores. In contrast to the original distribution by Condon (1993), item 10 loaded in this study on the first factor resembling the *intensity* scale. The two extracted factors 1 (*intensity*) and 2 (*quality*) explained 27.8% and 10.9% of variance in the final model, respectively.

For PAAS, the PAF with unrestricted baseline estimation was conducted without the items 8, 13, and 16, due to low inter-item correlations. Sampling adequacy was confirmed with KMO = .81. The Bartlett's test of sphericity, $\chi^2(78)$ = 409.78, *p* < .001 supported the appropriateness of PAF. Three factors with eigenvalues ≥ 1 were

Table 2. MAAS and PAAS item characteristics listed as for the original factor solution.

MAAS		M	SD	skewness	kurtosis	P_i
Quality						
3-	Positive/negative feelings towards foetus	4.76	0.48	−2.09	5.04	94.00
6-	Concept of foetus as 'person'/'thing'	4.76	0.62	−2.93	9.31	94.00
9-	Tender/irritable feelings towards foetus	4.74	0.46	−1.35	0.46	93.50
10-	Clear/vague mental picture of foetus	3.62	0.97	−0.74	0.29	65.50
11-	Happy/sad feelings about foetus	4.81	0.52	−3.31	13.83	95.25
12-	Absence/desire to hurt or punish foetus	4.93	0.27	−4.61	22.70	98.25
13-	Feeling emotionally close to/distant from foetus	4.79	0.56	−2.92	8.66	94.75
15-	Anticipate positive/negative first impression of baby	4.84	0.36	−1.91	1.65	96.00
16-	Desire to hold baby immediately/later	4.90	0.40	−4.26	16.90	97.50
19-	Sadness/mixed feelings towards fantasized foetal loss	4.96	0.36	−10.55	114.25	99.00
Intensity						
1-	Frequent/infrequent thoughts of foetus	4.11	0.75	−0.73	0.87	77.75
2-	Strong/weak feelings accompanying thoughts of foetus	3.69	0.93	−0.72	0.49	67.25
4-	Strong/weak desire to read or get information about foetus	3.77	0.98	−0.66	0.10	69.25
5-	Frequent/infrequent picturing foetus in imagination	3.85	0.90	−0.73	0.32	71.25
8-	Frequent/infrequent talking to foetus	3.22	1.12	−0.08	−0.74	55.50
14-	Frequent/infrequent concern regarding mother's diet	3.63	0.89	−1.02	1.34	65.75
17-	Frequent/infrequent dreams about baby	2.33	1.09	0.25	−1.11	33.25
18-	Frequent/infrequent palpation of foetus	4.33	0.65	−0.62	0.18	83.25
Additional item included only in total score						
7-	Foetus depending on well-being	3.77	0.98	−0.84	0.72	69.25

PAAS		M	SD	skewness	kurtosis	P_i
Quality						
1-	Frequent/infrequent thoughts of foetus	3.12	1.01	0.17	−0.54	53.00
2-	Strong/weak feelings accompanying thought of foetus	3.62	0.74	−0.53	1.05	65.50
3-	Positive/negative feelings towards foetus	4.72	0.56	−1.89	2.59	93.00
7-	Tender/irritable feelings towards foetus	4.81	0.42	−2.69	9.25	95.25
9-	Happy/sad feelings towards foetus	4.74	0.53	−2.44	7.12	93.50
11-	Feeling emotionally close to/distant from foetus	4.09	0.80	−0.64	0.07	77.25
12-	Anticipate positive/negative first impression of baby	4.83	0.49	−3.92	18.03	95.75
16-	Sadness/mixed feelings towards fantasized foetal loss	3.69	1.86	−0.75	−1.43	67.25
Intensity						
4-	Strong/weak desire to read or get information about foetus	2.96	1.06	−0.19	−0.26	49.00
5-	Frequent/infrequent picturing foetus in imagination	2.67	1.12	0.14	−1.02	41.75
8-	Clear/vague idea of baby's names	4.14	1.06	−1.13	0.54	78.50
10-	Frequent/infrequent thoughts of future child	2.89	1.03	0.08	−0.91	47.25
15-	Frequent/infrequent palpation of foetus	4.19	0.88	−0.88	0.34	79.75
14-	Frequent/infrequent dreams about baby	1.53	0.67	1.23	1.68	13.25
additional items included only in total score						
6-	Concept of foetus as 'person'/'thing'	4.47	0.84	−1.51	1.78	86.75
13-	Hold neonate immediately/later	4.60	0.64	−1.51	2.11	90.00

M = mean; SD = standard deviation; P_i = item difficulty.

Table 3. Model fit for the original MAAS and PAAS factor solution.

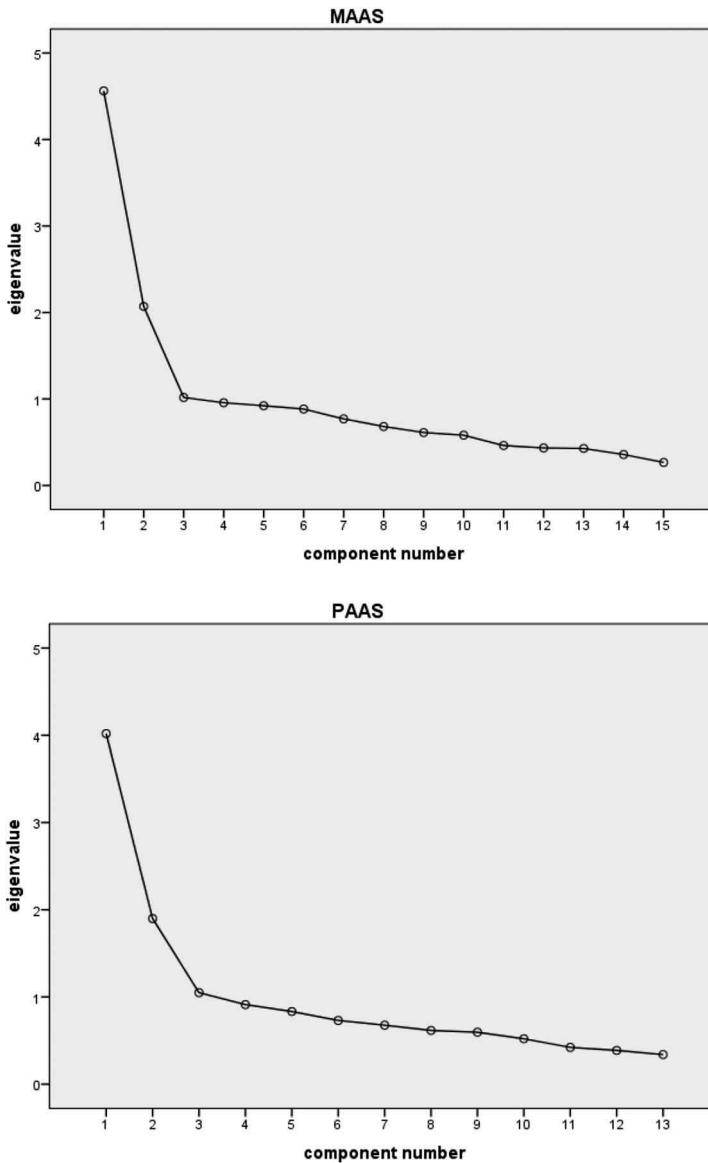|	MAAS Original ($n = 262$)	PAAS Original ($n = 124$)
CFA fit indices		
χ^2 (*df*)	319.48 (134)	152.13 (76)
p (χ^2)	.00	.00
CFI/TLI	.80/.77	.78/.73
RMSEA (90% CI)	.07 (.06, .08)	.09 (.07, .11)
p (RMSEA≤0.05)	.00	.00
SRMR	.08	.09

Figure 1. Scree plots of the unrestricted PAF for both MAAS and PAAS.

identified, explaining together 39.9% of variance. The scree plot indicated a two-factor solution (see Figure 1) and only item 12 loaded on a third factor, explaining 3.0% of the total variance. A second PAF restricted to a two-factor solution was conducted, which showed a satisfying KMO of .82. Bartlett's test of sphericity was significant, $\chi^2(78) = 409.78$, $p < .001$. The two factors explained 36.5% of the total variance. The items 1 and 2, which originally corresponded to the *quality* factor, loaded on the first factor forming an *intensity* factor. These results are comparable to the factor loadings of these two items found for the MAAS. The items 11 and 6

Table 4. Final pattern matrix for alternative MAAS (*n* = 262) and PAAS (*n* = 124) two-factor solutions extracted in our analyses and item-scale correlations.

MAAS		Loadings on		r_{if}	r_{is}
		Factor 1 (*I*)	Factor 2 (*Q*)		
5-	Frequent/infrequent picturing foetus in imagination (*I*)	.76		.63	.57
2-	Strong/weak feelings accompanying thoughts of foetus (*I*)	.76		.68	.67
1-	Frequent/infrequent thoughts of foetus (*I*)	.67		.63	.65
4-	Strong/weak desire to read or get information about foetus (*I*)	.59		.50	.48
7-	Foetus depending on well-being (-)	.57		.51	.51
8-	Frequent/infrequent talking to foetus (*I*)	.55		.51	.53
18-	Frequent/infrequent palpation of foetus (*I*)	.53		.51	.50
10-	Clear/vague mental picture of foetus (*Q*)	.50		.46	.45
17-	Frequent/infrequent dreams about baby (*I*)	.38		.31	.27
14-	Frequent/infrequent concern regarding mother's diet (*I*)	-	-		
11-	Happy/sad feelings about foetus (*Q*)		.83	.61	.31
13-	Feeling emotionally close to/distant from foetus (*Q*)		.71	.47	.34
3-	Positive/negative feelings towards foetus (*Q*)		.70	.66	.44
9-	Tender/irritable feelings towards foetus (*Q*)		.52	.60	.27
6-	Concept of foetus as 'person'/'thing' (*Q*)	-	-		
PAAS		Loadings on		r_{if}	r_{is}
		Factor 1 (*I*)	Factor 2 (*Q*)		
1-	Frequent/infrequent thoughts of foetus (*Q*)	.74		.60	.56
5-	Frequent/infrequent picturing foetus in imagination (*I*)	.70		.59	.56
10-	Frequent/infrequent thoughts of future child (*I*)	.67		.63	.62
2-	Strong/weak feelings accompanying thought of foetus (*Q*)	.60		.61	.64
15-	Frequent/infrequent palpation of foetus (*I*)	.60		.54	.52
4-	Strong/weak desire to read or get information about foetus (*I*)	.55		.46	.43
14-	Frequent/infrequent dreams about baby (*I*)	.49		.45	.45
11-	Feeling emotionally close to/distant from foetus (*Q*)	.47		.46	.46
6-	Concept of foetus as 'person'/'thing' (-)	.32		.37	.41
7-	Tender/irritable feelings towards foetus (*Q*)		.82	.68	.30
9-	Happy/sad feelings towards foetus (*Q*)		.63	.59	.31
3-	Positive/negative feelings towards foetus (*Q*)		.56	.32	.23
12-	Anticipate positive/negative first impression of baby (*Q*)		.34	.42	.16

Two-factor restricted PAF with promax rotation and Kaiser normalization;
In brackets: original factor loadings on *I* = intensity, *Q* = quality by Condon (1993); r_{if} = item-factor correlation, r_{if} = item-scale correlation

also loaded on *intensity* instead of *quality*. Items on factor 2 resembled the *quality* factor. For the final factor solution (Table 4), the factors 1 (*intensity*) and 2 (*quality*) explained 26.3% and 10.5% of variance, respectively.

3.3.3. Scale scores, item-scale correlation and reliability

For MAAS, item-factor correlations ranged for *intensity* from *r* = .31 to .68 and for *quality* from *r* = .47 to .66. Total item-scale correlations ranged from *r* = .27 to .67. Scale reliability was good for both the total score (13 items, *M* = 51.86, *SD* = 6.00), and *intensity* (9 items, *M* = 32.69, *SD* = 5.39), with α = .81 and α = .82, respectively, and satisfying for *quality* (4 items, *M* = 19.10, *SD* = 1.56), with α = .78.

For PAAS, item-factor correlations ranged for *intensity* from *r* = .37 to .63 and for *quality* from *r* = .42 to .68. Total item-scale correlations ranged from *r* = .16 to 64. Scale reliability for the extracted factors was good for the total score (13 items, *M* = 48.62, *SD* = 5.79) and *intensity* (9 items, *M* = 29.54, *SD* = 5.28), with α = .81 and α = .82, respectively, and satisfying for *quality* (4 items, *M* = 19.03, *SD* = 1.61) with α = .71.

4. Discussion

The aim of this study was to investigate the psychometric properties of the German versions of MAAS and PAAS and to contribute to the investigation of the factorial structure of both instruments. For both questionnaires, two factors forming the *intensity* and *quality* dimensions as postulated by Condon (1993) could be extracted by PAF, but with slightly different factor loadings compared to the original versions.

For the MAAS, we excluded the items 6 ('concept foetus person/thing'), 12 ('desire to hurt/punish foetus'), 14 ('concern regarding diet'), 15 ('first impression of baby'), 16 ('desire to hold baby'), and 19 ('fantasizing foetal loss') from further analyses due to insufficient inter-item correlations or factor loadings. Their low associations with the remaining items are comparable to those reported in other factor-analytical studies. For a Portuguese MAAS version by Gomez and Leal (2007), the items 12, 16 and 19 were also excluded and item 6 and 14 showed the lowest factor loadings. In another study with a Portuguese sample, Camarneiro and Justo (2010) excluded the items 14, 15, 16, and 19. The items 6 and 12 had the lowest factor loadings. For a Spanish MAAS version, the items 6, 12, 14, 15, 16, 19 and further item 18 were excluded (Navarro-Aresti et al., 2016). These results support the extracted factor structure in this study and indicate that across different cultural backgrounds and different stages of pregnancy these items do not sufficiently differentiate between levels of bonding *quality* or *intensity*.

For the PAAS, the items 8 ('ideas baby's names'), 13 ('desire to hold baby') and 16 ('fantasized foetal loss') were excluded due to their low associations with the remaining items. The items 6 ('concept foetus person/thing') and 12 ('first impression of baby') showed the lowest loadings on their factor, which is comparable with results for an Italian version (Della Vedova & Burro, 2017). In both Portuguese versions (Camarneiro & Justo, 2010; Gomez & Leal, 2007), item 16 was also excluded. The low associations of item 6 and 13 with the remaining items are comparable to Condon's (1993) original validation. Overall, the PAAS items identified with low inter-item correlations and factor loadings are comparable to those found for the MAAS in this study, which indicates rather similar emotional and mental processes in mother and father. Despite the item reduction, our factor solutions for MAAS and PAAS still consist of two factors equivalent to the *intensity* and *quality* factors by Condon (1993). Items loading on the first-factor focus on the frequency of mental preoccupation and interaction with the foetus and also the strength of emotions that occur during mental preoccupation, which Condon (1993) defined as bonding *intensity*. Contrary, items focussing on the quality of the occurring emotions in relation to the foetus (tender, happy or positive feelings as opposed to irritable, sad or negative feelings) and for mothers also the representation of the foetus as a real person, load on the second factor describing the 'affective experience', as Condon (1993) characterizes the *quality* dimension. The amount of explained variance by these factors is comparable to the original validation (Condon, 1993). Scale reliability was satisfying to good for both questionnaires and for MAAS higher than the reliability scores reported in another German sample based on the original factor solution (Goecke et al., 2012).

Overall, the extracted factor solutions are supported by results from other factor-analytical studies. However, this study has some limitations. Since not all partners could be reached for participation, the paternal sample was slightly underpowered. Thus, the paternal results should be interpreted with caution. Further, a selection bias

might be possible, which potentially explains the lower education level of participating men compared to women. Further studies are needed to clarify possible reasons for this, such as less time for or less interest in participation in more educated partners. Women were overall rather homogenous regarding their socioeconomic background. These aspects might limit the generalizability of results. Follow-up analysis needs to confirm the extracted factor structure for both instruments in diverse samples.

The extracted versions for MAAS and PAAS enable a focused assessment of the *quality* and *intensity* of parental-foetal bonding in German-speaking parents. Since studies report associations of maternal-foetal bonding with health practices and attitudes related to pregnancy, childbirth and childcare, and further indicate a relevance of parental-foetal bonding to the early parent–child relationship, further research on the construct, its influencing factors and its relevance for the postpartum period is needed. Especially for the paternal perspective, research is still lacking. The MAAS and PAAS are currently among the best-established measurements for parental-foetal bonding. Therefore, these German adaptations of the MAAS and PAAS can serve as valuable tools for the investigation of bonding processes in German-speaking parents, which would also enable the comparison of research results across different cultures. In clinical practice, it might be beneficial to integrate the assessment of parental-fetal bonding into standard care and preparation classes for parents. Addressing prenatal bonding in parents may help clinicians to identify those struggling to adjust to pregnancy and parenthood early during pregnancy. A comparable low bonding score could serve as an indicator for parents who might benefit from support focussing on their emotional transition process and on potential circumstances that might hinder their bonding process. The German MAAS and PAAS are short questionnaires, feasible especially for the clinical use that can be beneficial for providing individual and focused support for parents in the perinatal period.

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9   Article III

RESEARCH ARTICLE   **Open Access**

Psychometric properties of the German version of the pregnancy-related anxiety questionnaire-revised 2 (PRAQ-R2) in the third trimester of pregnancy

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Abstract

Background: Pregnancy-related anxiety (PrA) has been identified as a construct distinct from general stress and anxiety with a negative impact on birth and child outcomes. Validated instruments with good psychometric properties to assess pregnancy-related anxiety in German-speaking expectant mothers are still lacking. The Pregnancy-Related Anxiety Questionnaire revised for its use independent of parity (PRAQ-R2) assesses fear of giving birth (FoGB), worries of bearing a physically or mentally handicapped child (WaHC) and concerns about own appearance (CoA). The aim of this study was to investigate the psychometric properties of the PRAQ-R2 in a German sample of pregnant women in their third pregnancy trimester.

Methods: The PRAQ-R2 and several questionnaires measuring different forms of anxiety as well as depressive symptoms and perceived general self-efficacy were administered cross-sectionally in a sample of nulliparous and parous women ($N = 360$) in the third trimester of pregnancy.

Results: Reliability was satisfactory to excellent for the PRAQ-R2 total scale (Cronbach's $a = .85$) and the subscales ($a = .77$ to .90). Confirmatory and exploratory factor analysis confirmed the three-factorial structure of the instrument. The three factors together explained 68% of variance. Construct validity was confirmed by positive low- to moderate-sized correlations of the PRAQ-R2 total score and the subscales with measurements of anxiety and depression and by negative low correlations with general self-efficacy.

Conclusions: The German version of the PRAQ-R2 is a valid and feasible measurement for pregnancy-related anxiety for research and clinical practice.

Keywords: Pregnancy-related anxiety, PRAQ-R2, Psychometric properties, Prenatal, Anxiety

Background

During the last decade, the research focus on maternal mental health has expanded from the postpartum to the prenatal period. Several studies provided evidence of a negative impact of prenatal maternal anxiety on pregnancy and birth outcome or infant developmental problems [1, 2]. Pregnancy-related anxiety (PrA), which centers around

infant's health, childbirth, and maternal bodily changes and appearance, has been identified as a construct distinct from general anxiety and anxiety disorders [3, 4]. Published evidence indicates that PrA was a strong predictor for birth and pregnancy-related outcomes (e.g. birth procedure, pregnancy complications), postpartum maternal mood and long-term child-related consequences (e.g. infant cerebral, cognitive and emotional development, temperament or behavioral outcomes) [3–12].

These results not only underline the clinical relevance of PrA but also emphasize the importance of a differentiated approach to assessing different forms of prenatal anxiety. Only a few instruments measure the broad

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construct of PrA sufficiently across pregnancy [13, 14]. Most instruments available in German assess specific aspects of PrA only, such as the scales of Lukesch [15] and Ringler [16] focusing on fear of childbirth or the Baby Schema Questionnaire [17] focusing on concerns about the child's health. The German Cambridge Worry Scale (CWS; [18]) assesses birth- or child-specific worries besides other areas of potential prenatal concern. Nevertheless, widely used instruments focusing on the broader concept of PrA are not yet validated in German, which makes a transcultural comparison of PrA-related findings more difficult.

One of the globally most frequently used instruments, the Pregnancy-Related Anxiety Questionnaire (PRAQ [19];) has been revised by Huizink and colleagues [20] into a feasible abbreviated 10-item version (PRAQ-R) with the three subscales "fear of giving birth" (FOGB), "worries of bearing a physically or mentally handicapped child" (WaHC), and "concerns about own appearance" (CoA). To enable the use of the instrument regardless of parity the questionnaire has been recently adapted (PRAQ-R2; [21]) by rephrasing one item to "I am anxious about the delivery". Psychometric properties of the PRAQ-R2 were assessed in nulli- and parous women from Finland in their 24th and 34th weeks of pregnancy [21]. Internal consistencies were high for the total score (nulliparous/parous 24th week $\alpha = .84/.82$, 34th week $\alpha = .84/.85$) and satisfactory to high for the subscales FoGB (nulliparous/parous 24th week $\alpha = .79/.71$, 34th week $\alpha = .75/.75$), WaHC (nulliparous/parous 24th week $\alpha = .77/.80$, 34th week $\alpha = .80/.83$) and CoA (nulliparous/parous 24th week $\alpha = .80/.80$, 34th week $\alpha = .82/.81$). Confirmatory factor analysis supported the three-factor solution for the PRAQ-R2 independent of parity and gestational age [21]. In current studies on French [22] and Turkish [23] versions of the PRAQ-R2, convincing psychometric properties were reported and the three-factor structure confirmed. Associations of PrA with different forms of anxiety and depression have been reported in prior literature. Moderately sized correlations between the PRAQ-R total score and the scales of the State-Trait Anxiety Inventory for state anxiety (STAI-S; $r = .46$ to $.63$) and trait anxiety (STAI-T; $r = .46$ to $.60$) were found [24–26]. On subscale level, correlations with STAI-S and STAI-T were comparable in size for FoGB ($r = .26$ to $.39$), WaHC ($r = .27$ to $.39$) and CoA ($r = .24$ to $.33$). Moderate associations of the PRAQ-R total score with the Edinburgh Postnatal Depression Scale ($r = .36$; [26]) and the Beck Depression Inventory have been reported ($r = .37$ to $.51$; [27]). In regression analyses, general levels of anxiety and depression explained only a small amount of variance in PrA, supporting the assumption of PrA as a distinct construct [20].

Blackmore et al. [3] found in the second and third trimester of pregnancy significant positive correlations of symptoms of generalized anxiety disorders (GAD) with FoGB ($r = .12$ to $.24$, respectively) and WaHC ($r = .22$ to $.23$, respectively). Martini et al. [28] investigated specific birth- and child-related fears in the perinatal period. They found that women with social phobia (SP) reported higher postpartum child-related anxiety than a control group.

General self-efficacy has been identified as a potential protective factor for PrA. Perceived self-efficacy is generally defined by Bandura [29] as a cognitive process, in which a person evaluates own capabilities to cope with different situations and to act in a way to master challenging situations. Empirical studies support the assumption of negative associations between perceived self-efficacy and anxiety [30]. Focusing on pregnancy and childbirth as potentially challenging situations, previous studies showed that women with higher fear of giving birth perceived their general and birth-related self-efficacy as lower [31]. Despite the fact that the PRAQ-R2 has proved to be a reliable instrument [21], a psychometric investigation of a German translation of the PRAQ-R2 is still lacking. Thus, the aim of this study was to investigate the reliability as well as factorial and construct validity (convergent and discriminant) for the PRAQ-R2 in a population-based sample of nulliparous and parous women from northern Germany in their third trimester of pregnancy.

Regarding convergent validity, we expected positive associations of the PRAQ-R2 with pregnancy-related worries as well as state and trait anxiety, depression and symptoms of GAD and SP according to previous research [3, 20, 28]. Regarding discriminant validity, we expected negative correlations of the PRAQ-R2 total score with perceived general self-efficacy in line with previous studies [30, 31].

Methods

Study design and sample

The data derive from two related ongoing population-based longitudinal pregnancy cohorts (PRINCE – "Prenatal Identification of Children's Health" and PAULINE – "Prenatal Anxiety and Infant Early Emotional Development") based at the University Medical Center Hamburg-Eppendorf.

Pregnant women were recruited upon initial presentation at the university after being sent by their resident gynecologists or midwifes between 2014 and 2018. Women pregnant with a singleton child and 18 years or older were included in this study. Women with high-risk pregnancies regarding maternal chronic infections, severe complications in mother or child, substance abuse, as well as women with a pregnancy after assisted reproductive technologies (ART) were excluded. Also, women lacking sufficient German language skills were excluded. All participants signed informed consent forms. There was no incentive to participate and study

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involvement was voluntary. The study protocols were approved by the ethics committee of the Hamburg Chamber of Physicians (PV3694, PV5574).

For PRAQ-R2 and further relevant psychometric questionnaires, full datasets were available for 253 pregnant women. To ensure statistical power for this analysis, PRAQ-R2 data of additional 107 women were pooled from the PRINCE-study. Overall, psychometric data of 360 women in the third trimester of pregnancy were analyzed.

Variables and instruments
PRAQ-R2
The ten PRAQ-R2 items are scored with five response options (1 = "absolutely not relevant" to 5 = "very relevant"). A total score (range from 10 to 50) and one score for each of the subscales FoGB (3 items, range from 3 to 15), WaHC (4 items, range from 4 to 20) and CoA (3 items, range from 3 to 15) can be calculated.

The PRAQ-R2 [21] was translated into German for the purpose of this study following the recommendations by Bracken and Barona [32]. Permission to use the PRAQ-R2 was given by the author, Professor Anja Huizink. The English version was independently translated into German by two members of the study team. Based on these two translations, a final German version was developed. Minimal differences in wording were discussed with the PI of the study until consent was reached. This German version was back-translated from German by two blinded independent expert linguists without knowledge about the study content and the original questionnaire. A comparison of the back-translated versions with the original questionnaire revealed no semantic change in the items due to the translation process. Finally, the German version was handed out to two pregnant and two non-pregnant women, who were not familiar with the content of the study and reported no difficulties in understanding the items.

Instruments for the assessment of convergent validity

- Pregnancy-specific worries: The CWS [33] assesses prenatal anxiety with 17 items rated on a 5-point scale and with mean scale scores ranging from 0 to 5. The subscales "socio-medical" (centering around birth and handling of the baby) and "health of the baby" show similarities to FoGB and WaHC. The subscales "socio-economic and relations" and "health of mother/other" focus on aspects of the social environment and living circumstances as parents. We excluded one item regarding employment problems, which was irrelevant for our participants at this time of pregnancy due to legally binding maternity leave in Germany, starting 6 weeks before the estimated time of delivery. In our sample,

reliability was good for the total score (Cronbach's $\alpha = .82$) and satisfactory for the subscales ($\alpha = .60$ to $.76$).
- General State and Trait Anxiety: State and trait anxiety were assessed with the STAI [34], which consists of two 20-item subscales (STAI-S/–T). Items are rated on a 4-point scale so that scale scores range from 20 to 80 (STAI-S Cronbach's $\alpha = .94$; STAI-T Cronbach's $\alpha = .92$).
- Symptoms of Social Phobia: Symptoms of SP were measured with the 3-item Social Phobia Inventory (Mini-SPIN; [35]). Items are rated on a 5-point scale, and scale scores range from 0 to 15 (Cronbach's $\alpha = .86$).
- Symptoms of Generalized Anxiety Disorder: We assessed symptoms of GAD with the 7-item Generalized Anxiety Disorder Scale (GAD-7; [36]), which is a one-dimensional screening instrument. Items are rated on a 4-point scale, and a total score ranges from 0 to 21 (Cronbach's $\alpha = .86$).
- Depressive Symptoms: Depressive symptoms were measured with the 10-item EPDS [37]. Items are rated on a 4-point scale, and scale scores range from 0 to 30 (Cronbach's $\alpha = .87$).

Instrument for the assessment of discriminant validity

- General perceived self-efficacy: We assessed general self-efficacy using the 3-item General Self-Efficacy Short Scale (German name Allgemeine Selbstwirksamkeitsskala, ASKU; [38]). Items are rated on a 5-point scale. The calculated mean scale scores range from 1 to 5 (Cronbach's $\alpha = .92$).

Sociodemographic and obstetric data
Participants were asked via self-report forms about socio-economic data such as maternal age, household income and educational background based on highest school degree as well as about data on parity and prior or current pregnancy complications, such as pregnancy-related hypertension, preeclampsia, HELLP-syndrome, gestational diabetes, preterm labor, miscarriage, preterm birth, as well as maternal infections during pregnancy.

Statistical analyses
We used descriptive statistics (M = mean, SD = standard deviation, range, percentages) to describe the study participants. To test the psychometric properties of the PRAQ-R2, first scale reliability was assessed with Cronbach's α. Second, factorial validity was assessed with confirmatory factor analysis (CFA) based on structure equation modeling. Based on the conclusion by Huizink et al. [20] we tested a first order CFA with three correlating factors. Model fit was evaluated with χ^2 for model

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fit, Root Mean Squared Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR) and Comparative Fit Index (CFI). Factor loadings >.30 were considered indicative of importance [39]. Additionally, explorative principal axis factoring (PAF) was conducted with oblique (promax) rotation to test, whether the items would load on the same three factors without a-priori restriction on their structure.

Finally, construct validity was evaluated using correlational analysis. In the case of not normally distributed scale scores, Spearman's rank correlation was used. The measurements used for construct validity were assessed in 253 women. CFA was conducted with MPlus 6.11 [40] and IBM© SPSS 22 [41]. The rate of missing items was very low for PRAQ-R2 items (0.6%) and the predictor variables (≤2.4%). Thus, missings were replaced using the Expectation-Maximization imputation.

To calculate a CFA for three factors and 10 items based on a RMSEA of .05, α of .05 and a power of 80%, a sample size of 317 was required to ensure statistical power (calculated with R-package semPower; [42]). With a total sample of $N = 360$, statistical power was given.

Results

Sample characteristics

Overall, the cohort was well educated and had an average-to-high income and most women were in a relationship. Fifty-four percent of the women were expecting their first child. For detailed information on socioeconomic and obstetric cohort characteristics, see Table 1.

PRAQ-R2 item characteristics

Item means were low to medium (range: $M = 1.70$ to 2.83), with overall low standard deviations (range: $SD = .87$ to 1.08), and items were partly left-skewed (range: 0.10 to 1.38); values for kurtosis varied (range: 0.01 to 1.55). According to Kline [43], the distribution of item scores was appropriate for the subsequent analysis. Cronbach's α for the PRAQ-R2 total score was high with .85. All item-intercorrelations were statistically significant. Cronbach's α for the subscales were satisfactory to excellent (FoGB: $\alpha = .77$, WaHC: $\alpha = .90$ and CoA: $\alpha = .89$). PRAQ-R2 item characteristics are listed in Table 2.

Factorial validity

Confirmatory factor analysis for PRAQ-R2 showed an acceptable-to-good model fit in the sample, χ^2 (32)= 98.539, $p < .01$, CFI = .97, TLI = .96, RMSEA = 0.08 (90% CI .06, .09), SRMR = .06. Standardized factor loadings are presented in Fig. 1. Low- to medium-sized correlations on the subscale level confirmed the three-factor solution of the PRAQ-R2. The factor loadings were lowest for item 3 ("I am worried about not being able to control myself during labor and fear that I will scream", $r = .49$).

Table 1 Characteristics of the sample ($N = 360$)

Variable	
Maternal age in years, *M* (*SD*), range	32.75 (3.77), 20 to 44
In a relationship *n* (%)	349 (96.9)
Education, *n* (%)	
main or middle school	74 (20.6)
high school graduation	88 (24.4)
university degree	186 (51.7)
information not provided	12 (3.3)
Monthly household income, *n* (%)	
≤ 1000 €	8 (2.2)
1001–2000 €	20 (5.5)
2001–4000 €	136 (37.8)
≥ 4001 €	173 (48.1)
information not provided	23 (6.4)
Ethnic background, *n* (%)	
Central European	344 (95.6)
Arabian	5 (1.4)
Eurasian	3 (0.8)
Asian	3 (0.8)
information not provided	5 (1.4)
Gestational age in weeks, *M* (*SD*), range	38.59 (1.81), 31 to 42
Expecting first child, *n* (%)	195 (54.2)
Complications, *n* (%)	
Women reporting complications in current pregnancy[a]	66 (18.3)
Gestational diabetes	18 (5.0)
Maternal infections during pregnancy, not pregnancy-related	10 (2.8)
Pregnancy-related hypertension	9 (2.5)
False labor	7 (1.9)
Preeclampsia	6 (1.6)
HELLP-Syndrome	3 (0.8)
Others	16 (4.4)
Women reporting complications in previous pregnancy[b]	19 (5.3)
previous miscarriage	73 (20.3)

[a]multiple answers possible [b] history of preterm labor or preterm birth and previous complications as listed in [a]

Explorative principal axis factoring with an unrestricted baseline estimation for the PRAQ-R2 revealed a satisfactory three-factor solution. Sampling adequacy was confirmed with a Kaiser-Meyer-Olkin value of .81. Correlations between items were sufficiently large for PAF. The Bartlett's test of sphericity, χ^2 (45)=2082.740, $p < .001$, also supported the appropriateness of PAF.

Table 2 PRAQ-R2 item characteristics and values of item reliability (N = 360)

	M	SD	Total-item correlation	Cronbach's *a*, if item was deleted
Fear of giving birth	7.26	2.53		
Item 1 - worry about pain	2.83	.99	.53	.84
Item 2 - anxious about delivery	2.53	1.08	.54	.84
Item 3 - worry about losing control	1.71	.98	.53	.84
Fear of bearing a physically/mentally handicapped child	8.41	3.50		
Item 4 – child mentally handicapped	2.29	1.06	.61	.83
Item 5 – perinatal death of child	2.01	1.04	.56	.84
Item 6 – physical defect of child	2.20	.96	.60	.84
Item 7 – child in poor health	1.70	.87	.60	.84
Concerns about own appearance	6.30	2.90		
Item 8 – not regaining figure	2.06	1.02	.53	.84
Item 9 – unattractive appearance	2.01	1.02	.57	.84
Item 10 – weight gain	2.08	1.08	.51	.84
Total score	21.97	6.74		

The score for each item ranges from 1 to 5

Analysis with promax rotation revealed three factors with eigenvalues ≥1, which explained 68.1% of the total variance (FoGB = 10.2%, WaHC = 40.2%, CoA = 17.7%). Factor loadings were again lowest for item 3 (*r* = .31).

Construct validity

Correlations of PRAQ-R2 total and subscales with the other instruments were all significant (Table 3). Distributions of the variables assessed for construct validity were skewed to the left for anxious and depressive symptoms (range 0.86 to 2.1) and to the right for perceived self-efficacy (– 0.92). Thus, Spearman correlations were calculated. The PRAQ-R2 total score correlated moderately with the CWS total score. On a subscale level, WaHC was strongly correlated with especially the CWS "health of the baby" subscale. Further, FoGB was strongly correlated with the CWS "socio-medical" subscale. CoA

was moderately correlated with the CWS "socio-medical" subscale. In comparison, the PRAQ-R2 total score and its subscales showed the lowest correlations with the CWS "socio-economic and relations" subscale.

Furthermore, the PRAQ-R2 total score showed significant positive associations with state anxiety, trait anxiety and symptoms of GAD and the strongest associations with depressive symptoms.

Of the subscales, WaHC showed the highest correlations with these instruments, which were moderate-sized. The lowest correlations with these instruments were reported for CoA.

A different pattern was found for symptoms of SP. The PRAQ-R2 total score and WaHC showed the lowest correlations with symptoms of SP compared to FoGB and CoA.

As expected, the PRAQ-R2 total score and subscales correlated negatively with general self-efficacy. On the
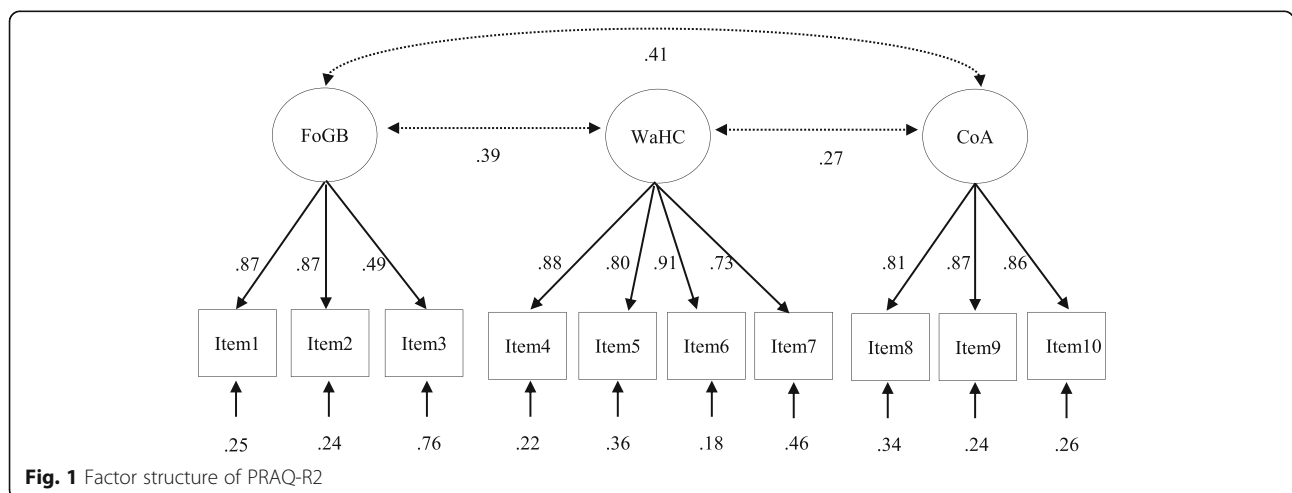
Fig. 1 Factor structure of PRAQ-R2

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Table 3 Descriptive statistics of the variables assessed for construct validity and their correlations with the PRAQ-R2 total score and its subscales (*n* = 253)

Variable	M	SD	PRAQ-R2			
			Total	FoGB	WaHC	CoA
CWS-total score	0.87	0.53	.55**	.44***	.50***	.27***
socio-medical	1.12	0.78	.60***	.59***	.45***	.30***
socio-economic	0.70	0.65	.18**	.12*	.13*	.17**
health of the baby	1.14	0.93	.60***	.33***	.77***	.18**
health of mother/ others	1.08	0.97	.27***	.16**	.27***	.11*
STAI-S	34.15	0.77	.40***	.30***	.38***	.18***
STAI-T	34.52	8.81	.40***	.28***	.34***	.22***
Mini-SPIN	2.85	2.74	.29***	.25***	.16**	.24***
GAD-7	3.90	3.44	.39***	.28***	.33***	.21**
EPDS	5.31	4.87	.44***	.32***	.35***	.26***
ASKU	4.19	0.63	−.30***	−.24***	−.28***	−.15**

$p < .05$; **$p < .01$; ***$p < .001$;
* Instruments: *CWS* Cambridge Worry Scale, *STAI-S/ STAI-T* State-Trait Anxiety Inventory, *Mini-SPIN* Short version of the Social Phobia Inventory, *GAD-7* 7-item Generalized Anxiety Disorder Scale, *EPDS* Edinburgh Postnatal Depression Scale, *ASKU* General Self-Efficacy Short Scale

subscale level, the strongest medium-sized association was again reported for WaHC.

Additional analysis of a 9-item version of the PRAQ-R2

Since item 3 showed the overall lowest factor loading in confirmatory and exploratory analysis, an alternative 9-item version of the PRAQ-R2 without this item was tested. BIC and AIC indicate a slightly better model fit (for details see Appendix). The 9-item version explained 72% of the variance in the sample compared to the 68% of the original 10-item PRAQ-R2.

Discussion

The aim of this study was to assess the psychometric properties of the German translation of the adapted PRAQ-R2 in a sample of in total 360 parous and nulliparous women in the last trimester of pregnancy. Reliability for the PRAQ-R2 total score and its subscales was confirmed for women in the third pregnancy trimester. The three-factor structure assessing birth- as well as child-related worries and concerns regarding mother's appearance and bodily changes during pregnancy was replicated. The subscales FoGB, WaHC and CoA together explained 68% of the total variance.

Both confirmatory and exploratory factor analysis showed satisfactory model fit, which is in line with the results reported in the validation studies of both PRAQ-R [20] and PRAQ-R2 [21]. Factor loadings of the individual items on their specific factor were high and very similar to Huizink et al. [20]. Thus, PRAQ-R2 showed high factorial validity in our sample. Further, item means and standard deviation were overall comparable for the nulliparous and parous women assessed at week 34 in the original validation sample [21]. Regarding factorial validity, our results are

further comparable to the psychometric properties of the PRAQ-R2 in French [22] and Turkish [23] samples. However, regarding item means, the French and Turkish women assessed in these studies scored higher on item level [23] and in the subscales and total score [22], respectively. Further research investigating these aspects more carefully might clarify, whether these differences are systematic and caused by specific underlying factors.

As in the original validation studies by Huizink et al. [20, 21], item 3 ("I am worried about not being able to control myself during labor and fear that I will scream") showed the lowest mean scores, the lowest factor loadings and highest error variances. For the French and Turkish sample of multiparae women, this item also showed the lowest factor loadings [22, 23]. Model fit indices indicate a slightly better fit for the 9-item version, with an overall higher percentage of explained variance. While the percentage of explained variance decreased for FoGB, the percentage of explained variance increased for WaHC and CoA. Nevertheless, the reported associations with symptoms of SP indicate that item 3 might be relevant in women experiencing specific forms of anxieties. Further analyses of the PRAQ-R2 in more diverse or high-risk samples could highlight the background of our results. Therefore, we decided to keep this item, despite the slight improvements in model fit of a 9-item version. Convergent validity was confirmed by positive associations between PRAQ-R2 and CWS, which were highest between FoGB and the CWS "socio-medical" subscale as well as between WaHC and the CWS subscale "health of baby". These results indicate that both instruments are suitable to assess child- and birth-related concerns besides other relevant topics. Nevertheless, the size of the correlation coefficients indicates that the PRAQ-R2 is not

redundant to the CWS but a valuable addition for a brief and focused assessment of PrA. Moreover, the PRAQ-R2 is able to assess maternal concerns about bodily changes in pregnancy, which is a unique feature of this instrument in comparison to other measurements of PrA [14].

Further, positive but only low- to medium-sized associations were reported with depression and state and trait anxiety as well as with symptoms of GAD and SP. These results are in line with previous studies [24–26] and support the assumption of pregnancy-related anxiety as an independent construct. On a subscale level, WaHC showed the strongest associations with symptoms of GAD, which is consistent with previous findings [3]. Symptoms of SP were less associated with the PRAQ-R2 total score and its subscales compared to other forms of anxiety. Only few studies have focused on the associations of PrA and SP thus far. Martini et al. [28] showed that women with clinically diagnosed SP more often indicated their child-related anxiety after birth as excessive. Unfortunately, due to different study designs and measurements, the results are not sufficiently comparable. Thus, the association between prenatal SP and different forms of PrA, including bodily and child-related concerns before birth, needs to be the focus of further studies. Discriminant validity was confirmed by negative associations between perceived self-efficacy and PRAQ-R2 total and subscales. As expected, higher perceived general self-efficacy was associated with lower pregnancy-related anxiety, which is consistent with findings of Lowe [31] or Salomonsson, Gullberg [44]. Since previous studies often focused on fear of childbirth and birth-related self-efficacy, our results expand these results to other aspects of PrA and show that general self-efficacy is also negatively associated with child-related worries and concerns about own appearance. Among the strengths of our study are the sample size, the involvement of parous and nulliparous women as well as the population-based design. Our population-based sample is comparable to the general population regarding the percentages of prior miscarriages [45] as well as the prevalence of current pregnancy complications [46, 47].

Besides the strengths of our study, there are also some limitations to consider. First, the sample was rather homogenous regarding relationship status and socioeconomic background, which might limit the generalizability of our results. Second, since participation was voluntary and without financial compensation, we cannot rule out a selection bias in our sample. Third, the exclusion criteria applied in our study may have led to the exclusion of women who potentially are at risk of having higher levels of PrA. Therefore, the reported values of PrA might be an underestimation of PrA in the overall population of German pregnant women.

Thus, our findings should be replicated in a more diverse sample of similar sample size including women with high-risk pregnancies, in particular regarding the relevance of item 3. Further, the psychometric properties of the German version should be investigated at earlier stages of pregnancy to confirm measurement invariance reported in the original questionnaire [21]. Moreover, it would be interesting to investigate the predictive validity of the PRAQ-R2 in cross-cultural longitudinal studies, for example regarding its relation to worries about the child's development or health postpartum.

Conclusion

The German Pregnancy-Related Anxiety Questionnaire, revised for parous and nulliparous women (PRAQ-R2), enables a feasible and reliable assessment of prenatal anxiety related to this particular pregnancy, the health of the unborn as well as labor and childbirth. Our study confirms the high factorial and construct validity of the three-factor solution of the PRAQ-R2 in a sample of German-speaking women in the last trimester of their pregnancy. The German PRAQ-R2 can serve as a suitable and valid measurement of pregnancy anxiety, for clinical and scientific purposes.

Appendix

Table 4 Comparing results of CFA and PAF in original 10-item version of the PRAQ-R2 and an alternative 9-item version after excluding item 3

	10-item version	9-item version
CFA		
χ^2 (*df*)	98.54 (32)	55.66 (24)
p (χ^2)	.00	.00
CFI/TLI	.97/.96	.98/.98
RMSEA (90% CI)	.08 (.06, .09)	.06 (.04, .08)
p (RMSEA ≤0.05)	.01	.19
SRMR	.06	.03
AIC/BIC	8446.28/8317.98	7391.57/7508.15
PAF		
KMO	.81	.79
Bartlett's test of sphericity χ^2 (*df*)	2082.74 (45)	1958.71 (36)
p (χ^2)	.00	.00
Explained variance (%)		
FoGB	10.16	11.16
WaHC	40.24	41.60
CoA	17.69	19.60
PRAQ-R2 total score	68.09	72.34

KMO Kaiser-Meyer Olkin criterion of sampling adequacy, *AIC* Akaike's Information Criterion, *BIC* Schwarz's Bayesian Criterion

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10 Article IV

Couples' prenatal bonding to the fetus and the association with one's own and partner's emotional well-being and adult romantic attachment style

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ABSTRACT

Objective: Developing an emotional bond to the fetus is a highly relevant task for both parents. However, research on the influence of emotional well-being and relationship dynamics on parental-fetal bonding is limited, especially regarding the paternal experience. Additionally, the roles of prenatal anxiety and hostility in parental bonding need further investigation. The aim of this study was to investigate the importance of one's own anxiety and hostility, adult romantic attachment style and one's partner's anxiety and hostility for parental-fetal bonding quality and intensity.
Design: Data were assessed cross-sectionally and analyzed using linear regression models.
Setting: The study took place at the University Medical Center Hamburg-Eppendorf, Germany.
Participants: Ninety-three pregnant women and their partners (total $n = 186$).
Measurements and findings: Participants completed questionnaires in mid to late pregnancy. For mothers, higher levels of hostility and attachment-related avoidance were associated with lower bonding quality. Unexpectedly, higher levels of partner hostility were associated with higher bonding quality. Fathers with higher attachment-related avoidance reported lower bonding intensity. Neither maternal bonding intensity nor paternal bonding quality was associated with the predictor variables.
Key conclusion: Prenatal bonding is individually influenced by emotional well-being and romantic attachment styles, with different effects in mothers and fathers.
Implications for practice: Potential negative emotional states and couple dynamics in the peripartum period should be addressed in prenatal care. Birth preparation classes might be an ideal context to generally inform parents about these topics. Distressed parents might benefit from interdisciplinary support focusing on perinatal mental health and parental-fetal bonding.

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Introduction

One central task during pregnancy is developing an emotional bond to the fetus (Rubin, 1967). Research indicates that the parental-fetal bond is associated with maternal pregnancy-related health practices (e.g. obtaining prenatal care, learning about pregnancy and childbirth, excercise, eating routines, Lindgren, 2003), intention to bottle-feed the child (Huang et al., 2004) and attitudes towards pregnancy, giving birth and childcare (Stanton and Golombok, 1993). Furthermore, influences of the prenatal parental-fetal bond on the postnatal parent-child relationship (Condon et al., 2013; Dubber et al., 2015) and mother-child interactions (Siddiqui and Hägglöf, 2000; Thun-Hohenstein et al., 2008) were found. These reports highlight the importance of prenatal bonding for both mothers and children in the peripartum period. Research further indicates the influence of both emotional well-being and relationship processes on prenatal bonding (Cannella, 2005; Alhusen, 2008). The peripartum period, as a time of adjustment to new living situations and changes in family or couple dynamics, can manifest in a full range of emotional reactions. However, anger or hostility as possible feelings during the adjustment process have rarely been investigated in the peripartum period (Graham et al., 2002). Furthermore, research has mostly focused on the maternal perspective (DiPietro, 2010). However, especially in Western societies, the paternal role has been changing from that of a breadwinner to that of an active caretaker

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(Parke, 2013; Xue et al., 2018), with fathers being more involved in prenatal care or birth preparation classes and often attending the birth (Kiernan and Smith, 2003). Findings on the positive influence of paternal involvement in the peripartum period on parental and child health (Plantin et al., 2011), as well as findings on the unique contribution of the father-child relationship in the child's socioemotional development (Bretherton, 2010), support this shift. The reported results underline the role of parents' emotional bonding to their children in the peripartum period and the importance of better understanding and supporting their development. Thus, investigating the parental-fetal bond and its influencing factors in both parents may foster the understanding of the emotional adjustment process in the peripartum period and of the complex dynamics of the developing parent-child relationship.

Parental-fetal bonding

Cranley (Cranley, 1981, p. 282) conceptualized the parental-fetal bond as parental "behaviors that represent an affiliation and interaction with their unborn child," and introduced the Maternal and Paternal Fetal Attachment Scales (MFAS; Cranley, 1981; PFAS; Weaver and Cranley, 1983). In contrast, Condon (1993) defined parental-fetal bonding as focusing on the developing affectionate bond with the fetus and introduced the Maternal/Paternal Antenatal Attachment Scale (MAAS/PAAS; Condon, 1993). Since then, diverse definitions and measurements have been developed (Brandon et al., 2009; van den Bergh and Simons, 2009). This diversity might be due to the specific nature of this prenatal relationship. The concept of parental-fetal bonding refers to the caregiver's perspective alone, because the prenatal relationship develops without a dyadic face-to-face interaction. Thus, this relationship is based on a mixture of "fantasy and reality, with the fetus being a recipient par excellence of projection" (Condon, 1993, p.168) It is further proposed that the parental-fetal bond is influenced by adult attachment styles and the way in which parents conceptualize their relationships in general (Condon, 1993; Müller, 1993). Prior literature indicates an increase in parental-fetal bonding throughout pregnancy (Habib and Lancaster, 2010; van Bussel et al., 2010). Condon (1993) further differentiates between two independent dimensions of parental-fetal bonding. First, the *quality* dimension refers to the emotional experience related to the fetus. Second, the *intensity* dimension refers to the amount of time spent mentally preoccupied with the fetus. While *intensity* is supposed to be influenced by the parental environment (e.g., workload or childcare), *quality* is supposed to be influenced by parental psychological variables (Condon, 1993). Thus, impaired emotional well-being might hinder the bonding process in parents. Furthermore, parents struggling with mental health issues might perceive the fetus as an additional source of distress or irritation, leading to a negative perception of the developing relationship or even leading to an increased risk of the parent harming the fetus (Pollock and Percy, 1999; Raphael-Leff, 2005).

Emotional well-being and parental-fetal bonding

Since pregnancy is a time of change and adjustment, increased distress and impaired emotional well-being in parents are not unlikely (Teixeira et al., 2009). Particularly in parents with a general tendency towards excessive worry, the transition to parenthood, with its unpredictability, might cause anxiety and distress (Blackmore et al., 2016; Mudra et al., 2019). Although prenatal difficulty in adjustment can manifest in overall negative affect or hostility directed towards others or oneself (Durkin et al., 2001; Parfitt and Ayers, 2014; Wong et al., 2016), studies focusing on hostility in the peripartum period are still rare (Graham et al.,

2002; Field et al., 2003). Moreover, in some previous studies, gender differences have been discussed, with men expressing impaired emotional well-being more often by exhibiting higher irritability, hostility or anger (Winkler et al., 2005; Madsen, 2019). Generally, the mental health issues of the partner can additionally impair one's own emotional well-being during the prenatal period (Paulson et al., 2016; Philpott et al., 2017).

Regarding the association between parental-fetal bonding and parents' emotional well-being, mixed results have been reported (Yarcheski et al., 2009). In the MAAS, anxiety being negatively correlated with *quality,* but not *intensity*, was significant across studies, but in some studies, this relationship became insignificant when additional influencing factors were included during multivariate analyses (Condon and Corkindale, 1998; Schmidt et al., 2016; Göbel et al., 2018). Few studies on the relationship between parental-fetal bonding and hostility exist. In a sample of high-risk women, MAAS scores were negatively associated with irritation towards and risk of harming the fetus (Pollock and Percy, 1999). In contrast, Sjögren et al. (2004) found positive associations between the MFAS score and general irritability in a sample of low-risk mothers. Condon and Corkindale (1997) reported a significant negative association between anger and MAAS *quality*, but not *intensity*, which was not significant in multivariate analysis. In fathers, negative associations between anxiety and PFAS scores and PAAS *quality* were reported (Mercer et al., 1988; Vreeswijk et al., 2014), but not for trajectories of paternal-fetal bonding across the peripartum period (De Cock et al., 2016). Others found no associations between parental-fetal bonding dimensions and general mental health status (Colpin et al., 1998), aggression and irritability (Hjelmstedt et al., 2007) or neuroticism (Bouchard, 2011) in fathers compared to their partners. Due to the few and divergent prior results, more research on the association between parental-fetal bonding and perinatal emotional well-being is needed (Yarcheski et al., 2009).

Influence of partner's emotional well-being on one's own bonding to the fetus

Little is known about the direct influence of partners' emotional well-being on one's own level of prenatal bonding. A partner struggling with emotional distress might affect one's own bonding process by either negatively influencing one's own well-being or by distracting one's attention away from the fetus. De Cock et al. (2016) reported lower perinatal bonding to their child in women, but not men, when their partners reported higher parenting stress. Luz et al. (2017) found no influence of one's own or one's partner's self-reported prenatal anxiety on the postnatal bonding of either parent. Notably, in both studies, associations were not reported for the prenatal period alone or independently for bonding *quality* or *intensity*. Evidence from two studies indicates that an aggressive partner hinders the development of the maternal-child bond as assessed with the Mother-to-Infant Bonding Scale (Kita et al., 2016) and the Arbeit's Differentiation Scale (Zeitlin et al., 1999) in the peripartum period. Importantly, Zeitlin et al. (1999) investigated these relationships in a high-risk group from women's shelters. Whether the described associations are present in samples from the general population needs further investigation.

Adult romantic attachment style and parental-fetal bonding

Associations between parental-fetal bonding and emotional well-being might also be influenced by factors underlying both well-being and parental-fetal bonding, like adult romantic attachment styles, as mental representations of close relationships (Mikulincer and Florian, 1999). Prior analysis of adult romantic

attachment styles has pointed to two major dimensions: first, attachment-related anxiety, with higher expectations for the loss of love or for receiving insufficient love in close relationships, and second, attachment-related avoidance, exhibited in the avoidance of intimacy or feelings of dependence on others (Brennan and Shaver, 1998; Feeney et al., 2008). Insecure attachment styles were further associated with strategies to handle stressful situations. Based on longitudinal analyses, Mikulincer and Florian (1999) proposed that insecurely attached women perceived the fetus as a source of distress, leading to distancing strategies and lower bonding at the beginning and the end of pregnancy. In anxiously attached women, the wish for a loving, close relationship might gradually overcome their fear of loss. Thus, these women show a delayed development of maternal-fetal bonding early in pregnancy but show bonding scores comparable to those of securely attached women in late pregnancy. Further research found negative associations of attachment-related anxiety and avoidance with MAAS *quality*, but less frequently with *intensity* (Priel and Besser, 2000; van Bussel et al., 2010; Mazzeschi et al., 2015). However, associations with adult romantic attachment style were not significant when MFAS and MAAS items were combined into one global bonding factor (Walsh et al., 2014) or when trajectories in bonding scores across the whole peripartum period were compared (De Cock et al., 2016). For fathers, Hjelmstedt et al. (2006, 2007) report that the trait of showing detachment in their own relationships was negatively associated with parental-fetal bonding measured with the MFAS and the PFAS.

Overall, the results reported above highlight the need for research on parental-fetal bonding, especially in fathers. Mixed results in the literature regarding associated variables could be caused by underlying influencing factors. Additionally, hostility has rarely been addressed in the context of emotional states in the peripartum period, and to our knowledge, thus far, no studies have investigated the role of the partner's emotional well-being on the separate development of bonding *quality* and *intensity*. Thus, the aim of this study was to investigate the influence of anxiety and hostility, adult romantic attachment style, and partner's anxiety and hostility on prenatal bonding *quality* and *intensity* in couples in the second to third trimester of pregnancy. Based on the theoretical background and empirical results reported above, we expected to find negative associations between one's own and one's partner's symptoms of generalized anxiety and hostility, as well as between one's own attachment-related anxiety or avoidance and prenatal bonding.

Methods

Study design

The data for this cross-sectional within-group analysis was derived from a collaboration between two related ongoing population-based prospective studies, carried out at the University Medical Center Hamburg-Eppendorf, Germany (PRINCE – 'Prenatal Identification of Children's Health' and PAULINE- 'Prenatal Anxiety and Infant Early Emotional Development', for details, see Bremer et al., 2017; Mudra et al., 2020). Data were collected from the cohorts of both studies via self-report questionnaires in the second or third trimester of pregnancy. Sets of questionnaires were identical in both studies. Participants signed informed consent forms. The study protocols were approved by the ethics committee of the Hamburg Chamber of Physicians (PV3694, PV5574).

Study sample and procedure

To assess a population-based low-risk sample, pregnant women from the field population in Hamburg, Germany were recruited upon initial presentation at the university after being sent by their resident gynecologist or by midwives between 2014 and 2018. Only women with a singleton pregnancy and being 18 years or older were included. Women with chronic infections, substance abuse, or a pregnancy after assisted reproductive technologies and participants with a poor understanding of German were excluded. Partners of included women were also invited to fill out a comparable set of questionnaires when accompanying the women to their study appointment. Women and their partners were asked to fill out questionnaires independently. Data from $k = 93$ couples ($n = 186$ participants) were included in this analysis. Of these, $k = 50$ couples were from the PRINCE cohort (subsample I), and $k = 43$ were from the PAULINE cohort (subsample II).

Variables and instruments

Outcome (Parental-fetal bonding): For the assessment of maternal- and paternal-fetal bonding, German translations of the MAAS and PAAS (Condon, 1993) were used. Items were rated on a 5-point scale. Exploratory factor analyses of the German versions in a larger sample led to shortened 13-item adaptations (Göbel et al., 2019). In this study, scale reliabilities for the MAAS were satisfactory to good for the total score (ranging from 13 to 65), with $\alpha = 0.82$; for *quality* (4 items, ranging from 4 to 20), with $\alpha = 0.71$; and for *intensity* (9 items, ranging from 9 to 45), with $\alpha = 0.82$. For the PAAS, scale reliabilities were satisfactory for the total score (ranging from 13 to 65), with $\alpha = 0.70$; for *quality* (4 items, ranging from 4 to 20), with $\alpha = 0.70$; and for *intensity* (9 items, ranging from 9 to 45), with $\alpha = 0.70$.

Predictors:

- Symptoms of generalized anxiety disorder (GAD) were assessed with the 7-item Generalized Anxiety Disorder Scale (GAD-7; Spitzer et al., 2006), which is a one-dimensional screening instrument. Items are rated on a 4-point scale, and the total score ranges from 0 to 21. In this study, reliability was good for women ($\alpha = 0.81$) and men ($\alpha = 0.82$).
- General hostility was assessed with the hostility subscale of the Brief Symptom Inventory (BSI; Derogatis and Spencer 1993; Geisheim et al., 2002), assessing instances of hostile thoughts, annoyance, argumentative tendencies or uncontrollable anger outbursts. The subscale consists of 5 items, answered on a 4-point scale. The mean scale scores, ranging from 0 to 4, were calculated. Reliability was low to acceptable for women ($\alpha = 0.52$) and men ($\alpha = 0.68$).
- Adult romantic attachment style was assessed with the revised version of the Experience in Close Relationships questionnaire (ECR-R; Sibley and Liu 2004; Ehrenthal et al., 2009), which assesses attachment-related anxiety and avoidance. For each dimension, 18 items are answered on a 7-point scale, with a mean scale score ranging from 0 to 7. Reliability was good for attachment-related anxiety (women $\alpha = 0.89$, men $\alpha = 0.87$) and avoidance (women $\alpha = 0.87$, men $\alpha = 0.84$).

Statistical analyses

First, descriptive statistics including Pearson correlations were calculated for parental-fetal bonding and the predictor variables. To analyze the question under research, linear regression analyses were conducted independently for women and men and separately for *quality* and *intensity*. Variables were entered block-wise: to control for potential effects of the sample, the subsample from which participants' data originated, gestational age and parity were considered as control variables in the first step. The predictor variables of anxiety and hostility, attachment-related anxiety and avoidance, and partner's anxiety and hostility were included in the

Table 1
Characteristics of the sample ($N = 93$ couples).

		Women		Men	
Age at assessment, in years; M (SD)		32.6	(3.28)	35.1	(4.47)
	range	23 to 40		24 to 49	
Gestational age at assessment; M (SD)		32.1	(6.08)	32.34	(6.66)
	range	22 to 39		22 to 41	
Education, n (%)					
	Main or middle school	20	(21.5)	27	(29.0)
	High school graduation	19	(20.4)	29	(31.2)
	University degree	50	(53.8)	34	(36.6)
	No information provided	4	(4.3)	3	(3.2)

Table 2
Descriptive statistics of the variables in the model ($N = 93$ couples).

	Women			Men		
	M	SD	Range	M	SD	Range
Bonding quality (M/PAAS quality)*	4.82	0.29	3 to 5	4.78	0.33	3 to 5
Bonding intensity (M/PAAS intensity)*	3.62	0.51	2 to 5	3.27	0.58	2 to 5
Generalized anxiety symptoms (GAD-7)	3.54	2.75	0 to 13	3.83	3.04	0 to 16
Hostility (BSI Hostility scale)*	0.58	0.49	0 to 3	0.55	0.49	0 to 2
Attachment-related anxiety (ECR-RD)*	2.09	0.84	1 to 5	2.12	0.80	1 to 4
Attachment-related avoidance (ECR-RD)*	1.80	0.74	1 to 5	1.93	0.62	1 to 4

Notes. *mean scale scores reported.
MAAS/PAAS = Maternal/Paternal Antenatal Attachment Scale; GAD-7 = 7-item Generalized Anxiety Disorder Scale; BSI = Brief Symptom Inventory; ECR-RD = Experience in Close Relationships-Revised, German Version.

second step. Associations were considered significant at $p \leq .05$, two-tailed. Missing data points in the predictor variables were replaced using expectation-maximization imputation. Statistical assumptions for multiple regression analyses were fulfilled. Sizes of significant effects are reported with η_{part}^2 as a measure of explained variance, with values of $\eta_{part}^2 = 0.01$ indicating a small effect, $\eta_{part}^2 = 0.06$ indicating a medium-sized effect and values of $\eta_{part}^2 = 0.14$ indicating a large effect. For all analyses, IBM SPSS, Version 22 (SPSS, 2013) was used.

Results

Sample characteristics

Sociodemographic details of the sample are listed in Table 1. The participants were well educated overall. Household income was average to high: three percent of the couples reported an income $\leq 1000€$, and three percent reported an income between 1001 and 2000€. Thirty-nine percent reported an income between 2001 and 4000€, and 51% reported an income $\geq 4001€$. Sixty-one percent of all women were expecting their first child. Fourteen percent had experienced a prior miscarriage, and 12% reported some kind of complication in the current pregnancy. The samples from the two studies were comparable regarding parity, miscarriages and pregnancy complications. Maternal age (Cohen's $d = 0.58$), gestational age at assessment in women ($d = 2.20$) and men ($d = 2.20$), and education levels in women ($d = 0.55$) and men ($d = 0.55$) were, on average, lower in subsample I than in subsample II. Descriptive statistics for the outcome and predictor variables are listed in Table 2. The distributions of scores for GAD, hostility and adult romantic attachment style were low to moderate. Men from subsample II reported higher GAD scores ($M = 4.60$, $SD = 3.36$) than those in subsample I ($M = 2.93$, $SD = 2.33$; $d = 0.59$) and higher hostility scores ($M = 0.69$, $SD = 0.56$) than those in subsample I ($M = 0.40$, $SD = 0.35$; $d = 0.65$). Samples did not differ in other predictors or the outcome variables.

Bivariate associations among the included variables

Bivariate correlations between the outcome and predictor variables for women and men are listed in Table 3. Neither outcome nor predictor variables were significantly correlated with gestational age at assessment. For mothers, significant small- to medium-sized negative correlations were found between bonding *quality* and symptoms of GAD, hostility, and attachment-related avoidance. For *intensity*, a significant medium-sized negative association was found with parity and small- to medium-sized negative associations were found with GAD, hostility and attachment-related avoidance. For paternal bonding *quality*, no significant associations with any of the control or predictor variables were found. For *intensity*, a significant medium-sized negative association with parity and a significant small-sized negative association with attachment-related avoidance were found.

Prediction of parental-fetal bonding

Since gestational age was not significantly correlated with any of the other variables, it was not included in the subsequent regression analyses. The complete regression models for maternal-fetal bonding *quality* and *intensity* are listed in Table 4.

After controlling for sample origin and parity, maternal hostility had a significant medium-sized negative effect ($\eta_{part}^2 = 0.062$) on *quality*. Furthermore, attachment-related avoidance had a significant large-sized negative effect ($\eta_{part}^2 = 0.147$) on *quality*. Finally, partner's hostility significantly and positively predicted maternal bonding *quality*, with a medium-sized effect ($\eta_{part}^2 = 0.073$). Overall, 23% of the variance in quality was explained by the included variables. In summary, women who were more hostile and avoidant had lower bonding *quality* scores, but those with more hostile partners showed higher bonding *quality* scores.

For maternal-fetal bonding *intensity*, 17% of the variance was explained in the first step. Parity was the only variable with a significant, medium-sized effect on *intensity* ($\eta_{part}^2 = 0.078$). Thus, women who had given birth before reported lower bonding *in-*

Table 3
Bivariate correlations between variables for mother (values above diagonal) and father (values below diagonal).

	1	2	3	4	5	6	7	8	9	10
1. Bonding quality	–	.34**	.03	−.10	−.41**	−.31**	−.08	−.31**	.01	.09
2. Bonding intensity	.23*	–	−.36**	−.05	−.30**	−.28**	−.11	−.26*	−.07	−.19
3. Parity	.01	−.37**	–	−.01	.23*	.28**	.13	.38**	−.07	.25*
4. Gestational age	.11	.04	.04	–	.08	.20	.04	.06	.18	.19
5. Generalized anxiety symptoms	−.04	.04	−.07	.14	–	.63**	.42**	.47**	.11	.29**
6. Hostility	−.09	−.04	.25*	.15	.52**	–	.37**	.41**	.08	.36**
7. Attachment-related anxiety	−.07	−.13	.16	.01	.33**	.28**	–	.42**	.05	.25*
8. Attachment-related avoidance	−.08	−.26*	.06	.02	.17	.26*	.56**	–	.43**	.15
9. Generalized anxiety symptoms of partner	−.06	−.12	.23*	.07	.11	.29**	.32*	.20	–	.52**
10. Hostility of partner	−.04	−.03	.28**	.15	.08	.36**	.23*	.15	.63**	–

Notes. ** $p < .01$; * $p < .05$.

Table 4
Prediction of **maternal**-fetal bonding dimensions *quality* and *intensity*.

Steps	Quality				Intensity			
	b	SE b	β	p	b	SE b	β	p
1								
Constant	19.50	0.19		.000	34.73	0.76		.000
Sample	−0.38	0.23	−0.17	.109	−1.68	0.88	−0.19	.060
Parity	−0.06	0.24	−0.03	.806	−3.64	0.91	−0.39	.000
	$R_{adj}^2 = 0.01$, $p = .273$				$R_{adj}^2 = 0.15$, $p = 0.000$			
2								
Constant	20.39	0.38		.000	36.41	1.50		.000
Sample	−0.47	0.22	−0.22	.038	−1.26	1.00	−0.14	.193
Parity	0.34	0.24	0.15	.165	−2.67	1.01	−0.29	.010
Generalized anxiety symptoms	−0.02	0.05	−0.05	.705	−0.10	0.22	−0.06	.639
Hostility	−0.13	0.06	−0.29	.023	−0.22	0.25	−0.12	.374
Attachment-related anxiety	0.22	0.15	0.16	.136	0.41	0.62	0.08	.506
Attachment-related avoidance	−0.78	0.21	−0.45	.000	−1.05	0.89	−0.15	.243
Generalized anxiety symptoms of partner	−0.01	0.04	−0.01	.902	0.01	0.17	0.01	.954
Hostility of partner	0.73	0.29	0.31	.013	−0.49	1.18	−0.05	.679
	$R_{adj}^2 = 0.23$, $p = 0.000$				$R_{adj}^2 = 0.16$, $p = 0.403$			

Notes. Linear regression analyses; $N = 90$.

Table 5
Prediction of **paternal**-fetal bonding dimensions *quality* and *intensity*.

Steps	Quality				Intensity			
	b	SE b	β	p	b	SE b	β	p
1								
Constant	19.16	0.42		.000	31.08	0.91		.000
Sample	0.24	0.28	0.09	.762	−0.20	1.07	−0.02	.854
Parity	−0.77	0.25	0.01	.924	−4.07	1.09	−0.38	.000
	$R_{adj}^2 = 0.01$, $p = .948$				$R_{adj}^2 = 0.12$, $p = .001$			
2								
Constant	19.21	0.61		.000	34.65	1.96		.000
Sample	0.12	0.27	0.05	.660	−0.99	1.13	−0.09	.385
Parity	0.05	0.28	0.02	.866	−4.63	1.17	−0.43	.000
Generalized anxiety symptoms	0.01	0.05	0.03	.828	0.00	0.21	0.00	.998
Hostility	−0.27	0.32	−0.84	.402	1.11	1.32	0.11	.400
Attachment-related anxiety	−0.11	0.20	−0.08	.594	0.62	0.83	0.09	.455
Attachment-related avoidance	0.74	0.25	0.04	.770	−2.70	1.03	−0.31	.010
Generalized anxiety symptoms of partner	−0.01	0.06	−0.02	.991	−0.15	0.24	−0.08	.526
Hostility of partner	−0.02	0.07	0.04	.806	0.31	0.28	0.15	.265
	$R_{adj}^2 = 0.08$, $p = .989$				$R_{adj}^2 = 0.15$, $p = .180$			

Notes. Linear regression analyses; $N = 90$.

tensity scores. In the subsequent step, none of the predictor variables significantly increased the amount of explained variance ($\Delta R^2 = 0.059$, $p = .403$). Overall, 16% of the variance was explained in the final model.

The regression models for paternal-fetal bonding *quality* and *intensity* are listed in Table 5. For *quality*, only 0.8% of the variance was explained by the included variables, and none of the variables were significantly associated with bonding *quality* in fathers. For *intensity*, 12% of the variance was explained by the control variables, but only parity had a significant large-sized negative effect on paternal bonding *intensity* ($\eta_{part}^2 = 0.162$). In the subse-

quent step, attachment-related avoidance was the only significant predictor, with a negative association and medium-sized effect ($\eta_{part}^2 = 0.078$). Overall, 15% of the total variance was explained in the final model. Thus, men who already had children and those with higher attachment-related avoidance reported lower bonding intensity.

Sensitivity

To test the robustness of the four regression models, regression analyses were repeated with prior bootstrapping, which is used

for robust, nonparametric testing. Stability was confirmed for each model. Additionally, the results were stable when only cases without missing data points were included in the analyses. Finally, the main models were repeated, including other potentially relevant control variables. In these exploratory models, gestational age and one's own and one's partner's depressive symptoms were included but did not significantly explain additional variance in MAAS *quality* ($\Delta R^2 = 0.042$, $p = .182$), MAAS *intensity* ($\Delta R^2 = 0.021$, $p = .525$), PAAS *quality* ($\Delta R^2 = 0.017$, $p = .720$), or PAAS *intensity* ($\Delta R^2 = 0.064$, $p = .085$). For MAAS *quality*, the effect of maternal hostility was no longer significant. The remaining associations were not affected.

Discussion

The aim of this study was to investigate the association between one's own anxiety, hostility and adult romantic attachment style, as well as one's partner's anxiety and hostility, and parental-fetal bonding *quality* and *intensity*. In mothers, hostility and attachment-related avoidance predicted lower bonding *quality* but not *intensity*. Unexpectedly, higher levels of partner hostility were associated with higher maternal bonding *quality*. For fathers, none of the included variables were associated with paternal bonding *quality*. Furthermore, attachment-related avoidance was the only significant predictor for paternal bonding *intensity*, after controlling for parity. For both parents, already having children was associated with lower bonding *intensity* but not with emotional bonding to the child.

Associations with one's own mental health

The negative association between maternal hostility and maternal bonding *quality* is in line with the assumption that impaired mental health might distract the parent from developing an emotional bond to the child (Condon, 1993; Raphael-Leff, 2005). The significant negative association between maternal bonding *quality* and symptoms of generalized anxiety found in the correlation analysis was not confirmed in multiple regression analysis. One possible explanation might be that the already small effect is caused by underlying variables influencing the association between bonding *quality* and anxiety. For example, higher attachment-related avoidance might both lead to poorer emotional well-being and interfere with the bonding process. The negative association between bonding *quality* and one's own hostility is supported by results showing that high-risk women who reported higher irritability towards the fetus also reported lower maternal-fetal bonding (Pollock and Percy, 1999). Our findings highlight that it could be beneficial for professionals in perinatal care settings to actively address emotional well-being, especially related to potentially occurring negative emotional states. Overall, the distribution of scores for the assessed variables was comparable between our sample and the average of samples from the general population (Geisheim et al., 2002; Löwe et al., 2008; Ehrenthal et al., 2009). This result indicates that apparently low-risk parents might also be hindered in their bonding process due to impaired emotional well-being and might benefit from discussing these topics in prenatal care settings. When including depression as an additional control variable in the model, the effect of maternal hostility on MAAS *quality* was no longer significant, even though depression itself did not significantly explain the variance in the outcome variable. This result might be due to a so-called suppressor effect. In this case, depressive symptoms share a high amount of variance with hostility but not with MAAS *quality*. This association requires further investigation.

For fathers, in contrast to theoretical assumptions and our expectation, levels of anxiety and hostility were not associated with paternal-fetal bonding. This is in line with studies that found no association or divergent associations between parental-fetal bonding and mental health variables in men, in contrast to their pregnant partners (Colpin et al., 1998; Kunkel and Doan, 2003; Bouchard, 2011). Fathers are inherently more distant from the fetus due to the lack of a direct physical connection (Weaver and Cranley, 1983; Genesoni and Tallandini, 2009). Colpin et al. (1998) argued that fathers may therefore be personally less involved with the fetus but more oriented towards their pregnant partner and the future child, which might explain the differences in the reported associations between mothers and fathers.

Associations with one's partner's mental health

Contrary to our hypothesis, one's partner's self-reported mental health did not negatively influence the other's bonding to the fetus. Additionally, higher partner hostility was unexpectedly associated with higher maternal bonding *quality*. This association was first found to be significant during regression analysis, which can statistically be explained by a suppressor effect, in which at least one of the other included variables controls for irrelevant variance in other predictors. In this way, the partial correlation between paternal hostility and maternal bonding *quality* increases and reaches significance. The finding that higher partner hostility is associated with higher maternal bonding *quality* is in contrast to results from two studies reporting lower maternal-child bonding in the peripartum period in women with an aggressive partner (Zeitlin et al., 1999; Kita et al., 2016). One explanation for the positive association reported here might be that women with a hostile partner would rather focus on the child in their wish for a loving, warm relationship to subconsciously compensate for a tense partner relationship. Further, stronger emotional bonding to the fetus could result from the wish to protect the child from an emotionally impulsive father. This interpretation is supported by results from Levendosky et al. (2003), finding that women experiencing domestic violence reported highly effective parenting and had a stable, secure relationship with their preschool-aged children. Importantly, Levendosky et al. (2003), as well as Zeitlin et al. (1999), investigated a high-risk sample of women, and in all three of the studies reported here, the assessment of intimate partner violence included forms of strong verbal or physical violence. This limits direct comparison with our study. Clearly, more research is needed to replicate our results and to confirm our assumptions in population-based samples.

Associations with adult romantic attachment style

As expected, women with higher attachment-related avoidance reported lower emotional bonding to the fetus, which is in line with prior studies (Priel and Besser, 2000; Hjelmstedt et al., 2006; van Bussel et al., 2010; Mazzeschi et al., 2015). Avoidant women might perceive pregnancy and the fetus as a source of distress, leading to strategies of distancing and avoiding emotions directed towards the fetus (Mikulincer and Florian, 1999). For attachment-related anxiety, no significant association was found, which is in contrast with most results reported in prior literature. However, our results are in line with those of Mikulincer and Florian (1999) in that anxiously attached women in our sample might, at this point in pregnancy, have overcome the fear of loss present during earlier stages of pregnancy and, thus, the ambivalence of bonding to the child (Condon, 1993; Mikulincer and Florian, 1999).

For fathers, higher attachment-related avoidance was associated with less intense bonding, which is in line with prior results (Hjelmstedt et al., 2007). Fathers with an avoidant attachment style might generally have a more emotionally distant, less communicative relationship with their partner. Furthermore, avoidant men might also distance themselves from the fetus by avoiding

thoughts directed to or conversations about their unborn child (Mikulincer and Florian, 1999), leading to less time spent in attachment mode. For fathers, bonding *quality* was not associated with adult attachment style. Seimyr et al. (2009) suggest that fathers might focus on the future child rather than the fetus. In a qualitative analysis, most fathers reported feeling rather disconnected from the pregnancy and birth (Longworth and Kingdon, 2011). Thus, developing an emotional bond to the unborn child might stay more abstract throughout pregnancy and may be less emotionally intense for many men. Due to this rather emotionally distant position, no regulatory avoidance strategies might be activated in these fathers. Generally, more actively including partners in prenatal care contexts might be an opportunity for them to develop a representation of the fetus and to focus more on the developing child.

Limitations

This population-based sample was comparatively small and rather homogenous in terms of sociodemographic background, which might limit the generalizability of the results. Additionally, a selection bias might be possible, which potentially explains the reported differences between the subsamples. Furthermore, the data for this analysis are from cross-sectional assessments, which does not allow a causal interpretation of the effects. Both partners assessed their emotional well-being via self-report. However, each partner's perception of symptom severity might differ. Therefore, it would be interesting to assess how the subjective experience of one's partner's mental well-being affects 'one's own emotional adjustment to better understand the dyadic processes within the couple that could potentially influence prenatal bonding.

Implications

The results reported here offer more insight into the relevance of mental health and adult romantic attachment style in prenatal bonding in mothers and fathers. Longitudinal studies based on multivariate analysis and larger samples are needed to confirm our results and their interpretation. However, to our knowledge, this is the first study investigating associations between partner's anxiety and hostility and the development of prenatal bonding in a low-risk sample. Divergent relevant predictor variables for bonding *quality* and *intensity* were identified, indicating that these dimensions should be addressed individually. In particular, the emotional bond to the child was affected by the mother's own and the partner's emotional well-being and adult romantic attachment style. Since prior literature has indicated that prenatal bonding is associated with attitudes and behavior related to the child's health, childcare and the postnatal relationship with the child, low levels of bonding during later stages of pregnancy can be a sign that parents struggle with pregnancy and the expectations surrounding having the child. Birth preparation classes and individual appointments with the parents could be an ideal and intimate context for midwives to address emotional adjustment to pregnancy and bonding to the child. Identifying these problems early on gives professionals the opportunity to offer specific support, which could continue into the postpartum period. Interdisciplinary support networks, including psychologists, might be particularly helpful for these families. Comparing associations in both partners shows that different predictor variables and underlying mechanisms might influence prenatal bonding in women and men. In fathers, it might be beneficial to foster their involvement in prenatal care. Including partners more actively, for instance, in birth preparation classes and in general prenatal care, might also positively influence couples' conversations about the developing child and their future parental roles in the postnatal period. Generally, this involvement

might decrease insecurities and provide more space for the developing parent-child relationship. Visualization of the unborn child in ultrasounds accompanied by information about fetal physical, cognitive and emotional development (for example, its capability of reacting to its environment and parental touch) might increase the understanding of the fetus as a developing person in both parents. Our results may raise awareness of different forms of distress in the prenatal adjustment process, including not only anxiety and depression but also hostility and anger. These emotional states should be actively addressed in both parents as part of prenatal care with an interdisciplinary team. Overall, our findings indicate that research and clinical practice benefit from a multifaceted view of the prenatal bonding processes, including relevant dynamics in the couple relationship.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Declaration of Competing Interest

All authors declare that they have no conflict of interest.

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11 Article V

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Midwifery

Becoming a mother: Predicting early dissatisfaction with motherhood at three weeks postpartum.

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ABSTRACT

Objective: The peripartum period can go along with increased insecurity, strain or frustration, potentially leading to a dissatisfying experience of motherhood, which itself is associated with poorer postnatal adjustment. Identifying prenatal influencing factors on the early postnatal dissatisfaction with motherhood is crucial to enable specific support for parents from pregnancy on. The aim of this study was to investigate the predictive relevance of prenatal levels of anxiety and hostility as manifestations of prenatal strain, and further maternal-fetal bonding, adult attachment style and recalled parenting by the own mother on the dissatisfaction with motherhood.

Design: Data was assessed longitudinally.

Setting: The study took place at the University Medical Center Hamburg-Eppendorf, Hamburg, Germany.

Participants: N=100 pregnant women from the general population.

Measurements and findings: Pregnancy-related anxiety, hostility, maternal-fetal bonding and adult attachment style were assessed in the last trimester of pregnancy, and recalled parenting by the own mother and current dissatisfaction with motherhood at three weeks postpartum. Hierarchical regression analysis showed that lower recalled care by the own mother predicted higher dissatisfaction with overall motherhood, from the perspective as an adult and related to their child. Higher pregnancy-related anxiety predicted higher overall and child-related dissatisfaction. Higher hostility predicted higher child-related dissatisfaction.

Key conclusion: Prenatal negative emotional states and lower recalled care by the own mother can serve as indicators for maternal dissatisfaction.

Implication for practice: Shaping professional support around negative emotional states and addressing experiences of own upbringing already prenatally might prevent an early dissatisfaction with motherhood and negative consequences for mother and child.

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Introduction

Motherhood leads to changes in conceptualizations of the self, family constellations, role expectations, and new responsibilities (Mercer 2004; Nyström and Öhrling 2004; Shrestha et al. 2019). Consequently, the transition to motherhood is not only associated with positive experiences, but also with struggles, disappointments and frustrations (Raphael-Leff 2005). An experience of early motherhood as overall dissatisfying might, if not addressed properly, persist and negatively influence postnatal mood and caregiving behavior (Matthey 2011; Henshaw et al. 2014). Several factors of maternal emotional adjustment have shown stability from the pre- to the postnatal period and have been associated with the experience of hassles related to motherhood (Matthey 2011; DiPietro et al. 2015). Prenatal distress as well as maternal-fetal bonding, security in adult attachment relationships and experience in one's own upbringing have especially been discussed to be associated with attitudes towards parenting and the experience of motherhood in the peripartum period (Jones et al. 2015; Huizink et al. 2017). To the knowledge of the authors, their predictive relevance for postnatal maternal dissatisfaction when included in one multivariate analysis has not been investigated so far. However, identifying relevant prenatal predictors for postnatal dissat-

isfaction is important to gain insight into the complex dynamics in the peripartum period and to shape professional support to the individual needs of mothers.

Dissatisfaction with motherhood

For mothers, the first months after birth are focused around physical changes and recovery from pregnancy and birth itself (Hodgkinson et al. 2014). In case of a problematic or even traumatizing birth, adjustment to motherhood might be especially challenging (Simpson et al. 2018). Further, getting to know the child and developing caregiving skills (Mercer 2004; Shrestha et al. 2019), as well as settling into new family constellations and social networks along with redefining the own identity and personal roles are important aspects (Nyström and Öhrling 2004). Besides joy and feelings of fulfillment with motherhood, adjusting to motherhood can be accompanied by feelings of loss of the former life, loneliness, the experience of role conflicts and feelings of resentment, guilt and overall negative affect (Nyström and Öhrling 2004; Matthey 2011; Parfitt and Ayers 2014; Lee et al. 2019). For some women, these experiences might lead to a general dissatisfaction with motherhood. A dissatisfying experience of motherhood regarding the new living situation from the perspective as an adult, being with the child and parenting competence is understood as an independent factor that might itself be a risk for the development or persistence of postpartum mood disorders and consequently have a negative impact on the health of mother and child (Matthey 2011; Henshaw et al. 2014). Even though, having hassles while transitioning to motherhood is not untypical, a persistent dissatisfaction with motherhood has the potential to negatively influence caregiving behavior and even go along with detachment from the child (Raphael-Leff 2005). Further, emotional and cognitive adjustment and preparation are interrelated in the peripartum period (Mercer 2004) and show stability into the postnatal period (DiPietro et al. 2015). Thus, prenatal aspects of the emotional adjustment process might be indicators for the postnatal dissatisfaction with motherhood.

Pregnancy-related anxiety and hostility

Increased peripartum strain can lead to insecurities and depressive, anxious or hostile states (Durkin et al. 2001). While depressive symptoms in the peripartum period have been focus of research, anxiety and hostility as manifestations of distress need further investigation (Graham et al. 2002; Dunkel Schetter and Tanner 2012). Pregnancy-related anxiety, centering around the child's and one's own health, giving birth, and one's own bodily changes has been identified as an distinctive syndrome with influence on maternal and child outcomes (Blackmore et al. 2016; Szekely et al. 2020). Due to their specific focus, pregnancy-related anxiety might be a central indicator of worries about the capability as a caregiver in general (Standley et al. 1979; Fairlie et al. 2009) and thus an important predictor for postnatal dissatisfaction with motherhood. Evidence indicates a predictive relevance of pregnancy-related anxieties for negative perceptions of motherhood. Women with higher pregnancy-related anxiety experienced lower parenting competence, poorer overall health, felt more restricted by their maternal role and rather socially isolated and depressive (Huizink et al. 2017).

Furthermore, increased strain in the peripartum period might also manifest in other emotional states such as hostility (Durkin et al. 2001; Parfitt and Ayers 2014), characterized by responding to others with negative attitudes, resentment or suspicion (Buss 1961). Research indicates associations of prenatal maternal hostility with gender role stress (Durkin et al. 2001), consistent prenatal smoking (Eiden et al. 2011), lower maternal-fetal

bonding (Pollock and Percy 1999) and aggression in the couple relationship up to two years postpartum (Sotskova et al. 2015). These results indicate a potential clinical relevance of hostility for the couple dynamics, the child's health and the mother-child relationship. However, maternal perinatal hostility or anger has rarely been the focus of interest in the literature so far (Graham et al. 2002; Field et al. 2003; Born et al. 2008; Ou and Hall 2018). Thus, to address this gap in the literature, prenatal hostility was investigated in addition to pregnancy-related anxiety as manifestation of prenatal distress and as a predictor for postpartum maternal dissatisfaction.

Maternal-fetal bonding

Developing an emotional bond to the fetus is one important aspect during the transition to motherhood (Rubin 1976). The maternal-fetal bond intensifies as pregnancy progresses (Yarcheski et al. 2009) and is proposed to represent the parental disposition to emotionally bond to the child after birth (Condon 1993). Evidence supports the assumption that maternal-fetal bonding is interrelated with cognitive preparation and adjustment processes (Mercer 2004). Associations with pregnancy-related health practices (e.g. obtaining prenatal care, learning about pregnancy and childbirth, excercise, eating routines, Lindgren, 2003), attitudes towards pregnancy, giving birth and childcare (Stanton and Golombok 1993; van Bussel et al. 2010), as well as with the mother-infant relationship (Condon et al. 2013; Dubber et al. 2015; Tichelman et al. 2019) and interaction (Siddiqui and Hägglöf 2000; Thun-Hohenstein et al. 2008) have been reported. Further, mothers with less emotional bonding to their child also struggled with forming an identity as a mother (Koniak-Griffin 1993). These findings indicate a predictive relevance of maternal-fetal bonding also for the dissatisfaction with motherhood after birth.

Adult attachment styles

Underlying trait characteristics might further influence maternal dissatisfaction. Adult romantic attachment styles as part of the behavioral attachment system can explain individual differences in affect, cognition and behavior in stressful situations (Shaver and Hazan 1993; Mikulincer and Florian 1999; Mikulincer and Shaver 2019) and have also been associated with the adaptation to motherhood (Alexander et al. 2001; Jones et al. 2015). Prior analysis on adult romantic attachment styles pointed to two major dimensions: first, attachment-related anxiety, with a higher expectation of loss of or insufficient love in close relationships, and second, attachment-related avoidance, with avoidance of intimacy or dependence on others (Brennan and Shaver 1998; Feeney et al. 2008). While secure attachment was related to adaptive, problem-solving and support-seeking behavior, attachment-related anxiety was associated with rather maladaptive, emotion-focused coping strategies. Attachment-related avoidance is associated with strategies of distancing from the source of distress, in this case, aspects of motherhood or the developing baby (Mikulincer and Florian 1999). Further, insecure attachment styles were associated with a more negative perception of motherhood in general (Rholes et al. 1997), less satisfaction with and personal meaning of own motherhood (Rholes et al. 2006), less perceived competence in effective parenting or the ability to relate to children, more unrealistic representations of the parental role (Jones et al. 2015) and also lower prenatal bonding to the child (Mikulincer and Florian 1999; Mazzeschi et al. 2015). Thus, a trait for insecurity in current, adult romantic relationships might also influence the early adjustment to motherhood.

Recalled parenting by the own mother

Not only current, but also first relationships in one's life have been identified as influencing factors on maternal adjustment. The experiences with the own primary caregivers influence the development of one's internal working models about the nature and structure of relationships, the amount of expected attention that fulfills one's own needs, and of oneself as a person who is worthy to receive love, comfort and appreciation (Bowlby 1969; Bowlby 1973). Even though they are relatively flexible for change based on new experiences, internal working models can influence the representation of relationships up into adulthood (Grossmann 1985; Priel and Besser 2001; Grossmann et al. 2008). To avoid confusion of terms in the context of this study, the remembered experiences of own upbringing is referred to as "recalled parenting by the own mother". For many women, besides the partner, other women and especially their own mother become important support figures in the peripartum period (Martell 2001). In previous studies, memories of perceived maternal acceptance, care and love influenced prenatal bonding to the child (Priel and Besser 2001), levels of peripartum depression and sensitivity in maternal caregiving (Crockenberg and Leerkes 2003). Thus, memories of received parenting by the own mother might be especially reactivated and relevant for the maternal experience in the transition to parenthood, when women become caregivers for their own child.

Summary

The findings reported above indicate that prenatal pregnancy-related anxiety and hostility, maternal-fetal bonding, adult romantic attachment styles and recalled parenting by the own mother potentially affect dissatisfaction with motherhood. Identifying indicators that best predict the postnatal dissatisfaction with motherhood can be beneficial for developing and shaping professional support in the peripartum period to avoid negative consequences for mothers and infants. Thus, the aim of this study was to investigate the predictive relevance of these variables for the postnatal dissatisfaction with motherhood in one multivariate model. Based on theoretical assumptions and previous evidence, we expected higher levels of pregnancy-related anxiety and hostility, lower maternal-fetal bonding, higher insecurity in adult attachment relationships and less optimal recalled parenting by the own mother to be associated with higher dissatisfaction with motherhood.

Methods

Study design and sample

The data derive from the population-based prospective longitudinal pregnancy cohort study (PAULINE - 'Prenatal Anxiety and Infant Early Emotional Development') based at the University Medical Center Hamburg-Eppendorf, Hamburg, Germany. The PAULINE study comprises a prenatal assessment (T0) for maternal psychological parameters and postnatal assessments at three weeks (T1), as well as seven (T2) and twelve months (T3) postpartum for maternal psychological and child behavioral variables. Participants filled out a set of questionnaires at each study appointment. Furthermore, interviews with mothers (T0, T2) and observations of infant behavior (T1 to T3) and the mother-child interaction (T2, T3) were conducted. Data were collected from 2015 to 2019. Women in their third trimester of pregnancy and with sufficient German language skills were included in the study. Women with chronic infections, substance abuse, or severe pregnancy complications, premature birth ($< 37^{th}$ week of pregnancy) and very low birth weight

(2500g) were excluded. The study protocols were approved by the ethics committee of the Hamburg Chamber of Physicians (PV5574). Participants were recruited after being sent by their gynecologists or midwives. All participants signed informed consent forms.

For the current analysis, questionnaire-based self-report data from T0 and T1 was analyzed. Of the N=127 women included in the study at T0, N=119 handed back their questionnaire at T0. At T1, data of N=100 women was available and included in this analysis (for details on sample size and drop-outs see Fig. 1).

The age of the participants ranged from 14 to 43 ($M = 33.5$, $SD = 4.27$) and weeks of gestation ranged from 29 to 41 ($M = 36.2$, $SD = 2.22$) at study intake. The participants were overall well educated, with 69% having a university and 17% a high school degree, 11% had a main or middle school degree. Household income can be considered as average to high compared to the average household income for couples in Germany (Destatis, 2020): Four women reported an income $\leq$ 1000 €, nine women between 1001 to 2000 €. Twenty-five women reported an income between 2001 to 4000 € and 52 women an income $\geq$ 4001 €. Fifty-three percent of women were expecting their first child and 64% gave birth to a boy. The age of the child at T1 ranged from 13 to 48 days ($M = 21.7$, $SD = 4.22$).

Variables and instruments

Besides measurements for the relevant predictor variables, sociodemographic (T0) and obstetric information was assessed (T1).

Outcome: Dissatisfaction with motherhood at T1: The Being a Mother Scale (BaM-13; Matthey 2011) assesses the experience of motherhood within the last 2–3 weeks. With 13 items, scored on a 4-point scale, ranging from 0 to 3, a total score and three subscales are assessed: adult-related dissatisfaction (e.g., loneliness or boredom, missing former life, perceived support), child-related dissatisfaction (e.g., perceived caretaking competence, worries for, but also irritation with the baby) and emotional closeness (feeling confident with and emotional close to child). Higher scores indicate higher dissatisfaction with motherhood. The BaM-13 was translated into German for the purpose of this study following the recommendations by Bracken and Barona (1991). For our sample, reliability was α=.82 for the total score, α=.65 for the adult-related and α=.80 for the child-related dissatisfaction. The emotional closeness subscale with only two items showed inacceptable reliability (α=.10) and was therefore not included in further analysis.

Predictors

Pregnancy-related anxiety at T0: The 10-item version of the Pregnancy-Related Anxiety Questionnaire, revised for all pregnant women regardless of parity (PRAQ-R2; Huizink et al. 2015) focusses on current levels of fear of giving birth, worries about the child's health and about own physical appearance. Items are scored on a 5-point scale ranging from 1 to 5. Higher scores indicate higher anxiety levels. Factorial and construct validity for the German translation was confirmed in a German sample of N=360 pregnant women (Mudra et al., 2019). In this study, the PRAQ-R2 total score was used (α=.82).

Hostility at T0: The hostility subscale of the Brief Symptom Inventory (BSI; Derogatis and Spencer 1993) assesses the experience of hostile thoughts, annoyance, getting in arguments or uncontrollable anger outbursts in the last week. The subscale consists of 5 items, answered on a 4-point scale with mean scale scores ranging from 0 to 4. Higher scores indicate higher hostility levels (α=.74).

Maternal-fetal bonding at T0: The Maternal Antenatal Attachment Scale (MAAS; Condon 1993) measures the quality of the emotional bonding and the intensity of mental preoccupation with the fetus over the past two weeks during pregnancy. Items are
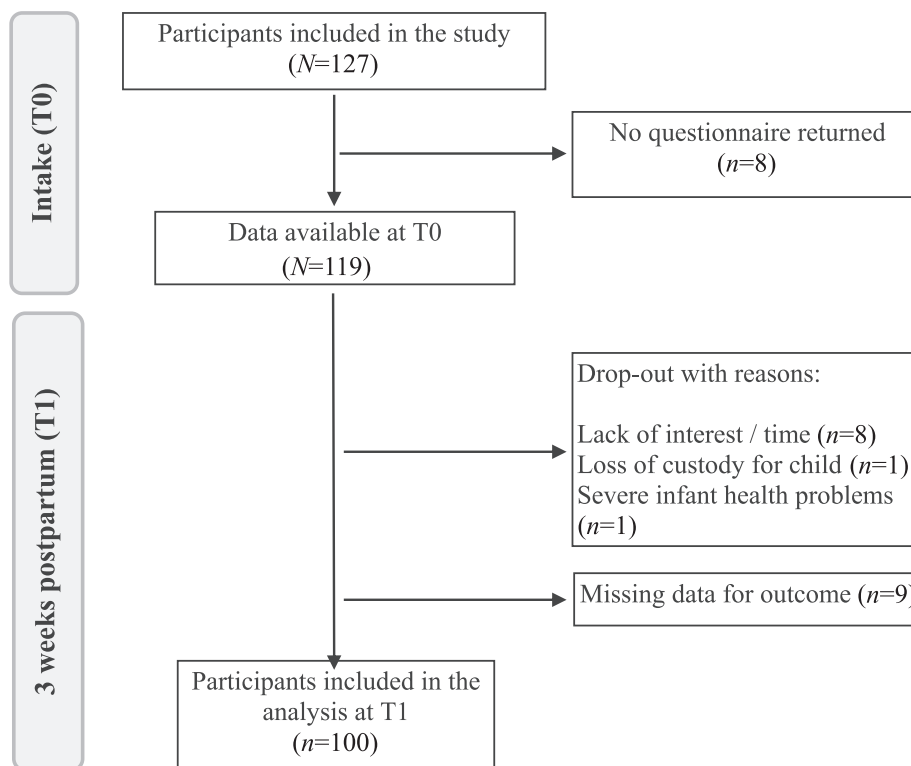
Fig. 1. Flow chart of sample sizes and drop-out

rated on a 5-point scale, scored from 1 to 5, with higher scores indicating stronger bonding. Exploratory factor analyses of the German version in a sample of $N = 263$ women led to shortened 13-item adaptations (Göbel et al., 2019), of which the quality subscale was used in this study (α=.76).

Adult romantic attachment style at T0: The revised version of the Experience in Close-Relationships (ECR-R; Sibley and Liu 2004) assesses the two dimensions attachment-related anxiety and avoidance. For each dimension, 18 items are answered on a 7-point scale, with a mean scale score ranging from 0 to 7. Higher scale scores indicate higher attachment-related anxiety (α=.94) and avoidance (α=.85).

Recalled parenting by the own mother at T0: The recalled parenting by the own mother in the first 16 years was assessed with the Parental Bonding Instrument (PBI; Parker 1989). With 25 items, the PBI assess the two dimensions recalled care and overprotection by the own mother. Higher scores indicate higher recalled care (α=.92) and higher overprotection (α=.91).

Control variable: Since the experience of motherhood might differ for women expecting their first child (primiparous) from women with at least one child (multiparous women), parity was included as a control variable (0=primiparae, 1=multiparae).

Statistical analysis

Hierarchical regression analyses with block-wise entry were used to test the hypothesis. Parity was controlled for in the first step. Subsequently, the predictors pregnancy-related anxiety and hostility (step 2), maternal-fetal bonding (step 3), attachment-related anxiety and avoidance (step 4) as well as recalled care and overprotection by the own mother (step 5) were included. Associations were considered significant at $p \leq .05$, two-tailed. Missings in the predictor variables were replaced using Expectation-

Maximization imputation. Significant effect sizes are reported with η_{part}^2, with values of η_{part}^2=.01 indicating a small, η_{part}^2=.06 a medium and η_{part}^2=.14 a large effect size. Analyses were conducted with IBM SPSS, Version 22 (SPSS 2013).

Results

Descpritive statistics and bivariate associations of the included variables

Descriptive statistics of the included variables are listed in Table 1. The distribution of scores for maternal dissatisfaction total score and subscales, pregnancy-related anxiety, hostility, attachment-related anxiety and avoidance, as well as recalled overprotection by the own mother were low to moderate. Scores in prenatal bonding and recalled care by the own mother were moderate to high. Bivariate correlations among variables are listed in in Table 2. For overall, adult- and child-related dissatisfaction with motherhood, small to moderate-sized positive correlations were

Table 1
Descriptive statistics of the included variables (N=100).

	M	(SD)	range
Overall dissatisfaction with motherhood	7.72	(5.78)	0 to 29
Adult-related dissatisfaction with motherhood	3.07	(2.46)	0 to 10
Child-related dissatisfaction with motherhood	4.31	(3.64)	0 to 16
Pregnancy-related anxiety	20.61	(6.18)	10 to 39
Hostility	0.66	(0.55)	0 to 2.8
Maternal-fetal bonding quality	18.90	(1.74)	9 to 20
Attachment-related anxiety	2.19	(1.04)	1 to 7
Attachment-related avoidance	1.89	(0.72)	1 to 5
Recalled care by the own mother	28.65	(6.47)	1 to 36
Recalled overprotection by the own mother	8.87	(7.31)	0 to 36

Table 2
Bivariate associations between the included variables.

correlations											
		1	2	3	4	5	6	7	8	9	10
1	Overall dissatisfaction with motherhood	-	.80**	.93**	.51**	.36**	-.21*	.31**	.05	-.30*	.23*
2	Adult-related dissatisfaction with motherhood		-	.53**	.34**	.23*	-.27**	.27**	.07	-.33**	.19
3	Child-related dissatisfaction with motherhood			-	.52**	.37**	-.13	.26**	.02	-.21*	.19
4	Pregnancy-related anxiety				-	.49**	-.19	.47**	.22*	-.12	.26**
5	Hostility					-	-.24*	.43**	.34**	-.09	.16
6	Maternal-fetal bonding quality						-	-.23*	-.13	.18	-.07
7	Attachment-related anxiety							-	.51**	-.32**	41**
8	Attachment-related avoidance								-	-.33**	.29**
9	Recalled care by the own mother									-	-.55**
10	Recalled overprotection by the own mother										-

Notes. **p<.01, *p<.05

found with pregnancy-related anxiety, hostility and attachment-related anxiety, while correlations with recalled care by the own mother were small-sized and negative. For both overall and adult-related dissatisfaction with motherhood, small negative associations were found with maternal-fetal bonding. Additionally, for overall dissatisfaction with motherhood, a small positive correlation with recalled overprotection by the own mother was found. Attachment-related avoidance was not significantly associated with the experience of motherhood.

Predicting overall dissatisfaction with motherhood

Results of the hierarchical stepwise regression analyses are listed in Table 3. In total, the included variables explained 41% of variance in overall dissatisfaction with motherhood. The control variable parity explained 21% of variance in the first step. Pregnancy-related anxiety and hostility additionally explained 16.4% of variance, with higher pregnancy-related anxiety predicting higher maternal dissatisfaction. Maternal-fetal bonding (step 3) and attachment-related anxiety and avoidance (step 4) did not explain additional variance in overall dissatisfaction with motherhood. In step 5, adding recalled care and overprotection by the own mother explained an additional 6% of variance, with only recalled maternal care by the own mother significantly explaining variance. In this final model, pregnancy-related anxiety and recalled care by the own mother were the only significant predictors with medium- to large-sized effects (η_{part}^2=.105 and .114, respectively). Primiparous women and women with higher pregnancy-related anxiety and lower recalled care by their own mother reported higher levels of overall dissatisfaction with motherhood.

Predicting the adult-related dissatisfaction with motherhood

The included variables explained 20% of total variance in adult-related dissatisfaction. Parity explained 5.4% of variance in step 1. Adding the variable block of pregnancy-related anxiety and hostility (step 2) significantly explained 6.3% of variance. However, for both pregnancy-related anxiety and hostility the individual effects were not significant. Maternal-fetal bonding (step 3) significantly explained 4.8% of variance, with lower bonding scores predicting higher adult-related dissatisfaction. Attachment-related anxiety and avoidance did again not significantly explain variance (step 4). In step 5, recalled care by the own mother explained an additional 8.4% in adult-related dissatisfaction with motherhood. In the final model, the significant effect of maternal-fetal bonding quality turned into a nonsignificant trend (*p*=.081). Recalled care by the own mother was the only significant variable explaining variance in adult-related dissatisfaction with motherhood, with a medium-sized effect (η_{part}^2=.100). Primiparous women and women with

lower recalled care by their own mother reported higher adult-related maternal dissatisfaction.

Predicting the child-related dissatisfaction with motherhood

The included variables explained 41% of variance in child-related dissatisfaction with motherhood. Parity explained 23.2 % of variance (step 1). Pregnancy-related anxiety and hostility explained 18.2% of variance in step 2, with higher scores in both variables predicting higher child-related dissatisfaction. Adding maternal-fetal bonding quality (step 3) and attachment-related anxiety and avoidance (step 4) did not increase the amount of explained variance. Adding recalled care and overprotection by the own mother to the model explained an additional 3.5% of variance in step 5, with only recalled maternal care by the own mother significantly explaining variance. In the final model, medium-to large-sized effects were found for pregnancy-related anxiety (η_{part}^2 = .117), hostility (η_{part}^2 = .055) and recalled care by the own mother (η_{part}^2 = .064). Primiparous women with higher levels of pregnancy-related anxiety, hostility and lower recalled care by their own mother reported higher child-related dissatisfaction with motherhood.

Sensitivity

To investigate the stability of results, analyses were repeated i) using stepwise regression with backwards entry, ii) only including cases without missing data, and iii) with bootstrapping, used for robust, non-parametric testing. Robustness of the models were confirmed. Only for the child-related experience of motherhood, the associations with recalled care by the own mother turned from significant into a trend after bootstrapping (*p* = .08, 95% CI -.272 to -.003). Finally, regression analyses were repeated to additionally test for a potential influence of maternal age and age of the child at T1. These variables did not explain additional variance in the outcome variables or influence model stability.

Discussion

The aim of this study was to investigate the simultaneous and individual predictive relevance of maternal pregnancy-related anxiety, hostility, maternal-fetal bonding as well as adult romantic attachment style and recalled care by the own mother for the dissatisfaction with motherhood at three weeks postpartum. After controlling for parity, which had overall a strong effect on dissatisfaction with motherhood, pregnancy-related anxiety and recalled care by the own mother were the strongest predictors for overall dissatisfaction with motherhood. For the specific domains of dissatisfaction different effects were identified. In the final model, adult-related dissatisfaction was significantly predicted by lower recalled

Table 3
Prediction of the overall dissatisfaction with motherhood and the dimensions adult-related dissatisfaction and child-related dissatisfaction.

Steps		Overall dissatisfaction with motherhood				Adult-related dissatisfaction with motherhood				Child-related dissatisfaction			
		B	SE B	β	p	B	SE B	β	p	B	SE B	β	p
1	Constant	9.83	0.67		.000	3.51	0.32		.000	5.79	0.42		.000
	Parity	-4.96	0.97	-0.46	.000	-1.10	0.47	-2.35	.021	-3.40	0.61	-0.49	.000
		R^2 adj = .21, p =.000				R^2 adj = .04, p = .021				R^2 adj = .23, p = .000			
2	Constant	2.95	1.76		.096	1.48	0.92	1.61	.110	1.42	1.09		.192
	Parity	-4.48	0.93	-0.42	.000	-0.91	0.49	-1.87	.065	-3.17	0.58	-0.46	.000
	Pregnancy-related anxiety	0.27	0.09	0.30	.002	0.09	0.05	1.90	.061	0.16	0.05	0.28	.003
	Hostility	1.81	1.00	0.17	0.07	0.32	0.53	0.60	.549	1.49	0.62	0.22	.018
		R^2 adj = .36, p = .000				R^2 adj = .09, p = .039				R^2 adj = .40, p = .000			
3	Constant	9.55	5.44		0.08	7.58	2.77		.007	1.64	3.39		.629
	Parity	-4.41	0.93	-0.41	.000	-0.83	0.48	-0.18	.084	-3.16	0.58	-0.46	.000
	Pregnancy-related anxiety	0.26	0.09	0.29	.003	0.08	0.04	1.79	.077	0.16	0.05	0.28	.003
	Hostility	1.54	1.02	1.50	.136	0.06	0.52	0.01	.905	1.49	0.64	0.22	.002
	Maternal-fetal bonding quality	-0.33	0.26	-0.11	.203	-0.31	0.13	-2.33	.022	-0.01	0.16	-0.01	.946
		R^2 adj = .36, p = .203				R^2 adj = .13, p = .022				R^2 adj = .40, p = .946			
4	Constant	9.23	5.61		.104	7.12	2.84		.014	2.00	3.50		.570
	Parity	-4.31	0.96	-0.40	.000	-0.82	0.49	-0.17	.100	-3.09	0.60	-5.15	.000
	Pregnancy-related anxiety	0.24	0.09	0.27	.009	0.06	0.05	0.16	.184	0.16	0.06	0.29	.005
	Hostility	1.47	1.07	0.14	.175	-0.06	0.55	-0.12	.918	1.57	0.67	0.23	.021
	Maternal-fetal bonding quality	-0.31	0.26	-0.10	.241	-0.29	0.13	-0.22	.032	-0.01	0.17	-0.01	.931
	Attachment-related anxiety	0.02	0.03	0.08	.448	0.02	0.02	0.13	.280	0.00	0.02	0.01	.914
	Attachment-related avoidance	-0.02	0.04	-0.05	.742	-0.00	0.02	-0.20	.845	-0.02	0.03	-0.58	.563
		R^2 adj = .35, p = -742				R^2 adj = .12, p = .530				R^2 adj = .39, p = .835			
5	Constant	15.70	5.70		.007	10.42	2.91		.001	4.97	3.66		.177
	Parity	-4.17	0.92	-4.54	.000	-0.78	0.47	-0.16	.110	-3.03	0.59	-0.44	.000
	Pregnancy-related anxiety	0.26	0.09	0.29	.004	0.07	0.05	0.18	.128	0.17	0.06	0.30	.003
	Hostility	1.69	1.03	0.16	.103	0.05	0.53	0.10	.920	1.68	0.66	0.25	.013
	Maternal-fetal bonding quality	-0.18	0.26	-0.06	.495	-0.23	0.13	-1.76	.081	0.05	0.16	0.03	.768
	Attachment-related anxiety	0.01	0.03	-1.12	.265	0.01	0.02	0.78	.436	-0.00	0.02	-0.01	.912
	Attachment-related avoidance	-0.05	0.04	-0.11	.265	-0.02	0.02	-0.83	.411	-0.03	0.03	-0.10	.297
	Recalled care by the own mother	-0.27	0.08	-0.32	.001	-0.13	0.04	-3.15	.002	-0.12	0.05	-0.23	.021
	Recalled overprotection by the own mother	-0.08	0.07	-0.10	.300	-0.04	0.04	-0.12	.299	-0.04	0.05	-0.07	.456
		R^2 adj = .41, p =.005				R^2 adj = .20, p = .008				R^2 adj = .41, p = .062			

care by the own mother only. Child-related dissatisfaction was on the other hand predicted by higher pregnancy-related anxiety and hostility, and lower recalled care by the own mother.

The influence of maternal negative emotional states on maternal dissatisfaction were especially strong for pregnancy-related anxiety. These results add to the growing literature on the distinctive influence of pregnancy-related anxiety on pregnancy, childbirth as well as maternal and child-related outcomes (Dunkel Schetter and Tanner 2012; Huizink et al. 2017; Szekely et al. 2020). The strong effect sizes especially for child-related dissatisfaction might be explained by a general underlying insecurity of the mother regarding her "performance" in the maternal role (Standley et al. 1979; Saisto and Halmesmaki 2003). Women reporting worries about pregnancy, giving birth and the child's health from the prenatal period on might have similar concerns regarding their competence and confidence in their role as a caregiver after birth. Since pregnancy-related anxiety is a multifaceted construct, it might be insightful to investigate the relevance of specific dimensions for predicting maternal postnatal dissatisfaction in future studies. Further, prenatal levels of hostility predicted a more dissatisfying experience when being with and caring for the child. Our results and previous studies reporting associations of hostility with consistent smoking (Eiden et al. 2011) and postpartum aggression in the couple relationship (Sotskova et al. 2015) support the assumption of hostility as a prenatal indicator for adjustment processes in the peripartum period. A potential clinical relevance of hostility in the peripartum period is especially highlighted by the fact, that it predicted the child-related experience, which includes irritation or uneasiness when being with the newborn. One explanation for this association might be that women project higher strain in the peripartum period on the child as the reason causing this distress (Raphael-Leff 2005). This assumption is supported by prior results on a negative association between irritability with the fetus or levels of general hostility and maternal-fetal bonding (Pollock and Percy 1999; Göbel et al. 2019). The sample scored comparable to other samples from the general population in pregnancy-related anxiety and hostility (Geisheim et al. 2002; Huizink et al. 2015), which highlights the relevance of these negative emotional states also in population-based samples. Since emotional states might change across pregnancy, it would be beneficial to replicate the results of this study by assessing anxiety and hostility at different stages in the prenatal period.

The stable associations found for maternal dissatisfaction with recalled care by the own mother are supported by previous results (Crockenberg and Leerkes 2003) as well as by the role of the own mother as relevant support figure in the peripartum period (Martell 2001). Adult-related dissatisfaction was in this study assessed as feeling bored, lonely, unsupported, and uncomfortable with asking for help as well as with missing the former life. Thus, women remembering their own mother as being less caring might still experience her in their current relationship as less supportive and available. Further results indicate that lower recalled care by the own mother is generally associated with higher amounts of negative self-statements like self-criticism, amotivation and interpersonal disappointment (Ingram et al. 2001). This could further influence the adult-related experience of motherhood as dissatisfying, and also affect the perception of less confidence in caregiving and uneasiness around the child. Moreover, women with less caring mothers might lack a role model or inner template for their behavior and affective relationship with their own child. Further, unresolved inner mother-daughter conflicts might be reactivated along with negative emotions and interfere with a positive experience when being with or caring for the child (Raphael-Leff 2005). These interpretations are supported by previous findings that women who perceive their mother as more caring in

their past and current relationship were less intrusive and more sensitive towards their own baby (Kretchmar and Jacobvitz 2002).

Unexpectedly, bivariate associations of the maternal dissatisfaction with maternal-fetal bonding could not be confirmed in multivariate analysis. Beyond parity, maternal well-being and adult romantic attachment style, higher maternal-fetal emotional bonding was associated with lower adult-related dissatisfaction. However, this association turned into a nonsignificant trend when recalled care by the own mother was included. This indicates that the prenatally reported emotional bonding to the fetus is of predictive relevance for the adult-related dissatisfaction with motherhood. Nonetheless, the effect of recalled maternal care by the own mother shows higher relevance at this postpartum stage.

Further, bivariate associations with attachment-related anxiety could also not be confirmed in subsequent regression analyses. Due to the significant and moderate-sized associations between attachment-related anxiety and pregnancy-related anxiety and hostility, one could speculate that the association of attachment-related anxiety and dissatisfaction with motherhood is an indirect one, with attachment-related anxiety leading to higher anxiety and hostility, which in turn is a stronger predictor than adult romantic attachment style for higher dissatisfaction at three weeks postpartum. These hypotheses should be tested in future research.

4.1. Limitations

Several limitations of this study should be highlighted. Mothers were assessed in an early stage after birth, in which most of them are potentially still settling into motherhood. Thus, we cannot exclude the possibility that the reported dissatisfaction might be a transitory experience. Further, the sample was rather homogenous and of low risk regarding socioeconomic background and living circumstances. Due to the relatively small sample size, a complex analysis of further associations among variables was not possible, which might be beneficial to better understand the complex interplay of the included variables. Also, further associations with circumstances and perception of birth were not included in this analysis. Therefore, our findings should be tested and replicated in larger sample sizes at different stages across the postpartum period also including aspects of the birth or potential traumatic experiences. Finally, out of practical reasons, recalled care by the own mother was assessed at three weeks postpartum and parallel to the outcome variable. Even though the recalled parenting style has been reported to be rather stable in adulthood (Wilhelm et al. 2005), we cannot exclude the possibility that the assessment point might have an additive effect on the reported associations, since women who just became mothers might reflect more critically or intensely on their own upbringing than before.

Implications

The findings of this study underline the importance of focusing on predictors for the postnatal dissatisfaction with motherhood already in the prenatal period. Increased distress is often part of transitioning into a new phase in one's life and pathologizing of normal reactions should be avoided. However, high maternal dissatisfaction even at such an early stage should be taken seriously, as it might be an indicator or precursor for further adjustment difficulties or mood disturbances, both known for their potential negative consequences for the parent-child relationship. More research is needed to investigate the longitudinal stability and further influence of early dissatisfaction for later stages of the postpartum period. Future research should also include the perspective of the partner in relation to their own adjustment and well-being as well as their influence on the family dynamics as partner and co-parent. Furthermore, considering the current perceived support

by the partner or family and the current quality of the couple relationship might give an additional and relevant insight into the development of dissatisfaction with motherhood. The results found for this sample from the general population further indicate that not only high-risk families, but also families with a supposed low-risk background benefit from addressing pregnancy-related anxiety and hostility as manifestations of prenatal strain, insecurity in caretaking, as well as perceived availability of support by their family and social networks as early as possible. Being sensitive for these topics already in prenatal care might support expectant parents and help reduce concerns in their confidence as a caregiver. Moreover, fostering a positive and satisfying experience of motherhood from the beginning might also enhance maternal adjustment and well-being in the postpartum period, and consequently help to avoid negative influences on the parent-child-relationship.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Declaration of Competing Interest

All authors declare that they have no conflict of interest.

CRediT authorship contribution statement

Ariane Göbel: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft, Writing - review & editing, Visualization. **Lydia Yao Stuhrmann:** Investigation, Writing - original draft, Writing - review & editing, Visualization. **Claus Barkmann:** Methodology, Formal analysis, Writing - review & editing, Visualization. **Michael Schulte-Markwort:** Conceptualization, Writing - review & editing, Funding acquisition. **Susanne Mudra:** Conceptualization, Methodology, Writing - original draft, Writing - review & editing, Supervision, Project administration, Funding acquisition.

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12   Abstracts in English and German

Abstract

Background: A central theme during pregnancy is to develop a first emotional bond to the fetus. Regarding the connection of parental-fetal bonding with associated factors and its relation to the experience of motherhood, mixed or limited results were reported in the literature so far. This dissertation addresses these gaps by investigating i) patterns in the reported associations of maternal-fetal bonding with prenatal anxiety, ii) the influence of hostility of parents as well as their own romantic attachment style on prenatal bonding, and iii) the effect of maternal-fetal bonding on postnatal dissatisfaction with motherhood.

Method: A systematic review of the available literature was conducted after searching four electronic databases. Self-report, questionnaire-based data was collected from pregnant women (total N=360) and their partners (total N=128) from Hamburg, Germany, in the second to third trimester of pregnancy. Mothers were reassessed at three weeks postpartum. Data was analyzed cross-sectionally and longitudinally via bi- and multivariate analyses. Also, the psychometric properties of German translations of two questionnaires on parental-fetal bonding and pregnancy-related anxiety were investigated using methods from classical test theory.

Results: The systematic review of 31 studies showed that especially the *quality* of the maternal-fetal bond was across studies associated with different forms of anxiety. Cross-sectional analysis of the data showed that women with higher hostility and attachment-related avoidance reported lower maternal-fetal bonding *quality*. Unexpectedly, a more hostile partner predicted higher maternal-fetal bonding quality. For fathers, no associations were found for bonding *quality*. Only the *intensity* of mental preoccupation with the fetus was negatively associated with attachment-related avoidance. In longitudinal analysis, maternal-fetal bonding did not predict postnatal dissatisfaction.

Conclusion: Overall, the reported results indicate that women with elevated levels of anxiety, hostility, and attachment-related avoidance might struggle with developing an emotional bond to the fetus. Further research on factors influencing paternal-fetal bonding is needed. Further, clinical research and practice might benefit from an approach including dynamics between family members to fully understand the development of the parent-child relationship across the peripartum period.

Zusammenfassung

Hintergrund: Der Aufbau einer emotionalen Beziehung zu dem Fetus ist ein zentrales Thema in der Schwangerschaft. Hinsichtlich des Zusammenhangs elterlich-fetaler Verbundenheit mit assoziierten Faktoren oder dem postpartalen Erleben der Elternschaft finden sich jedoch widersprüchliche oder nur vereinzelte Ergebnisse. Die vorliegende Dissertation adressiert diese Lücken in der Literatur durch die Untersuchung i) von Zusammenhängen mütterlich-fetaler Bindung mit pränataler Angst, ii) mit Feindseligkeit sowie des erwachsenen Bindungsstils in Paarbeziehungen und iii) des Einflusses mütterlich-fetaler Verbundenheit auf erlebte Unzufriedenheit drei Wochen nach der Geburt.

Methode: Eine systematische Literaturübersicht wurde basierend auf der Suche in vier elektronischen Datenbanken erstellt. Fragebogenbasierte Daten im Selbstbericht wurden von insgesamt 360 Schwangeren und 128 Partnern aus Hamburg, Deutschland, im zweiten und dritten Schwangerschaftstrimester erhoben. Die Mütter wurden drei Wochen nach der Geburt erneut befragt. Die quer- und längsschnittliche Datenanalyse erfolgte mittels bi- und multivariater Analysen. Die psychometrischen Eigenschaften zweier Fragebögen zu elterlich-fetaler Verbundenheit und schwangerschaftsbezogener Angst wurden mittels Methoden aus der klassischen Testtheorie untersucht.

Ergebnisse: Die systematische Literaturübersicht von 31 Studien ergab, dass besonders die *Qualität* der emotionalen mütterlich-fetalen Verbundenheit mit Formen von Angst assoziiert war. In der querschnittlichen Datenanalyse zeigten Frauen mit erhöhter Feindseligkeit und bindungsbezogener Vermeidung eine niedrigere *Qualität* der Verbundenheit. Unerwartet berichteten Frauen mit feindseligeren Partnern eine höhere *Qualität* der Verbundenheit. Längsschnittlich sagte mütterlich-fetaler Verbundenheit postpartale mütterlicher Unzufriedenheit nicht vorher. Für die *Qualität* der väterlich-fetalen Verbundenheit wurden keine Zusammenhänge gefunden. Lediglich die *Intensität* väterlicher Verbundenheit war negativ mit bindungsbezogener Vermeidung assoziiert.

Schlussfolgerung: Insgesamt legen die Ergebnisse nahe, dass Frauen mit höherer pränataler Angst, Feindseligkeit und bindungsbezogener Vermeidung Schwierigkeiten im Beziehungsaufbau zum Fetus zeigen. Weitere Forschung über Einflussfaktoren für väterlich-fetale Verbundenheit ist notwendig. Klinische Forschung und Praxis profitieren von einem Ansatz, der das gesamte Familiensystem einschließt, um den Beziehungsaufbau zum Ungeborenen besser zu verstehen.

13 Statement on individual contribution to the articles

Article I: I developed the research question in close exchange with Dr. med. Susanne Mudra. I further conducted the systematic literature research, screened the articles and extracted the relevant data from the full-texts of the included studies. Finally, I synthesized the data and wrote and revised the manuscript of this article. All co-authors reviewed and approved the manuscript prior to the submission.

Article II: I translated the original version of the PAAS into German in close exchange with the PAULINE team and other professionals included in the translation process. Together with Lydia Stuhrmann I was responsible for collecting the PAULINE data. I developed the research question, conducted the data analysis for MAAS and PAAS and wrote and revised the manuscript of this article. All co-authors reviewed and approved the manuscript prior to the submission.

Article III: I developed the research question together with Dr. med. Susanne Mudra. Together with Lydia Stuhrmann I was responsible for collecting the PAULINE data. In close exchange with Dana Barthel, I conducted the data analysis. Together with Dr. med. Susanne Mudra, I wrote and revised the manuscript of this article. All co-authors reviewed and approved the manuscript prior to the submission.

Article IV: I developed the research question in close exchange with Dr. med. Susanne Mudra. Together with Lydia Stuhrmann I was responsible for collecting the PAULINE data. I conducted the data analysis. Finally, I wrote and revised the manuscript of this article. All co-authors reviewed and approved the manuscript prior to the submission.

Article V: I developed the research question together with Dr. med. Susanne Mudra. Together with Lydia Stuhrmann I was responsible for collecting the PAULINE data. I conducted the data analysis. Further, I wrote and revised the manuscript of this article. All co-authors reviewed and approved the manuscript prior to the submission.

14 Acknowledgements

Curriculum vitae

Curriculum vitae was removed due to data protection laws.

15 Eidesstattliche Erklärung

Ich versichere ausdrücklich, dass ich die Arbeit selbständig und ohne fremde Hilfe verfasst, andere als die von mir angegebenen Quellen und Hilfsmittel nicht benutzt und die aus den benutzten Werken wörtlich oder inhaltlich entnommenen Stellen einzeln nach Ausgabe (Auflage und Jahr des Erscheinens), Band und Seite des benutzten Werkes kenntlich gemacht habe.

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Ich erkläre mich einverstanden, dass meine Dissertation vom Dekanat der Medizinischen Fakultät mit einer gängigen Software zur Erkennung von Plagiaten überprüft werden kann.

Unterschrift...