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A longitudinal study on the association between trait mindfulness and maternal bonding across the perinatal period

Myrthe G. B. M. Boekhorst[a*], Noor de Waal[a*], Lisanne Smit[a], Lianne P. Hulsbosch[b,c], Marion I. van den Heuvel[b], Inga Schwabe[d], Victor Pop[a] and Ivan Nyklíček[a]

[a]Center of Research on Psychological and Somatic Disorders (CoRPS), Department of Medical and Clinical Psychology, Tilburg University, Tilburg, The Netherlands; [b]Department of Cognitive Neuropsychology, Tilburg University, Tilburg, The Netherlands; [c]Department of Developmental Psychology, Tilburg University, Tilburg, The Netherlands; [d]Department of Methodology and Statistics, Tilburg University, Tilburg, The Netherlands

ABSTRACT

Aims/background: The mother-to-infant is important for healthy child development. The current study focused on the association between maternal trait mindfulness and the course of maternal bonding from pregnancy to one year postpartum.

Design/Methods: Women participating in a prospective perinatal cohort study ($n = 1003$) completed online questionnaires on maternal bonding (Pre- and Post-natal Bonding Scale) at 28 weeks of pregnancy, and at 8 weeks, 6 months and 12 months postpartum. At 20 weeks of pregnancy, women completed the Three Facet Mindfulness Questionnaire – Short Form. Multilevel analyses were used to analyse 1) changes in maternal bonding over time and 2) the relationship of these changes with different facets of trait mindfulness measured once during pregnancy. Demographics, obstetrics, and depressive symptoms were controlled for.

Results: Results showed that maternal bonding first increased from pregnancy to 8 weeks postpartum and then remained relatively stable throughout the first-year postpartum. On average, women with high scores on *acting with awareness* and *non-judging* also scored higher on maternal bonding, but demonstrated a smaller increase in maternal bonding scores over time when compared to women with medium and low scores on these mindfulness facets. Furthermore, *non-reacting* was also positively associated with the level of maternal bonding but was not related to the course of bonding over time. The main effects of non-reacting and non-judging were not significant after adjusting for covariates. Depressive symptoms and a high educational level were negatively associated with bonding.

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CONTACT Myrthe G. B. M. Boekhorst m.g.b.m.boekhorst@tilburguniversity.edu Department of Medical and Clinical Psychology, Tilburg University, Warandelaan 2, Tilburg 5037 AB, The Netherlands

*M. G. B. M. Boekhorst and N. de Waal contributed equally to this work.

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Conclusion: Mindfulness-based interventions may be helpful in supporting expectant mothers who are at risk for suboptimal bonding.

Introduction

Mother-infant bonding involves the unidirectional feelings and emotions experienced by a mother towards her (unborn) child (Bicking Kinsey & Hupcey, 2013). The maternal bond typically starts to develop during pregnancy, strengthens as gestational age increases, and tends to stay stable or increase after the child is born (Cuijlits et al., 2016; De Cock et al., 2016; Klabbers et al., 2020; Rossen et al., 2017). During pregnancy, this maternal bond can refer to the affection women have towards the foetus (Condon, 1993). Women with higher levels of prenatal bonding have been shown to engage in more healthy behaviours in an effort to improve pregnancy outcomes, such as abstaining from alcohol, tobacco, and other drugs, and obtaining regular prenatal care (Lindgren, 2001). In turn, the postpartum maternal bond has been associated with positive child outcomes, such as social-emotional development, social competence, better temperament, more positive mood and fewer behavioural problems (de Waal et al., 2023; Fuchs et al., 2016; Joas & Mohler, 2021; Le Bas et al., 2020; Mason et al., 2011).

When considering risk factors for suboptimal maternal bonding postpartum, the link with postpartum depressive symptomatology has been well-established. Studies have shown that higher levels of postpartum maternal depression are associated with poorer postnatal bonding scores (Cuijlits et al., 2019; Tichelman et al., 2019). Reduced emotional availability, the inconsistency between expectations and the reality of motherhood, as well as doubts about maternal competency are hypothesised to influence the bonding process in mothers with heightened levels of postpartum depression (Cuijlits et al., 2019; Hornstein et al., 2006). On the other hand, findings from the systematic review by Tichelman et al. (2019) showed that the relationship between maternal depressive symptoms and bonding *during* pregnancy are still inconclusive, with only a small majority of the studies finding a relationship.

This previous research on the relationship between higher levels of perinatal depression and poorer maternal bonding raises the question to which factors provide *resilience* in the development of this maternal bond. One of these factors may be trait mindfulness, defined as one's full attention to experiences in the present, in a non-judging and accepting approach (Kabat-Zinn, 1990). One can speak of trait mindfulness when referring to someone's predisposition to be mindful, which tends to be stable over time (Kiken et al., 2015). Intuitively, one could reason that when being more mindful, a mother is more present in the moment and is able to focus her attention on her (unborn) child, which in turn, could increase the bond towards her (unborn) child. Research on the association between trait mindfulness and maternal bonding is limited, but several recent studies indeed show a positive correlation between trait mindfulness and prenatal bonding in 82 expectant parents (Hicks et al., 2018), postnatal bonding at 3–6 months in 149 mothers (McDonald et al., 2022), and bonding at 18 months postpartum in 32 mothers (Brassel et al., 2020). Furthermore, Khoramirad et al. (2021) found a positive association between

trait mindfulness and postpartum bonding (2–5 days) among 140 mothers of children admitted to the neonatal intensive care unit. Moreover, mindfulness-based interventions and care have been found to positively affect maternal bonding prenatally (Shreffler et al., 2019) and in postpartum mothers with premature infants (Khoramirad et al., 2020). These studies can be seen as first evidence that trait mindfulness may contribute to more optimal maternal bonding. However, they only included one measurement of maternal bonding and the majority was limited by low statistical power due to a relatively small sample size. Furthermore, as previous studies have demonstrated the variability in maternal bonding from pregnancy to postpartum, it is important to consider the course of this bond over time when examining its association with trait mindfulness, as this can help with implementing more targeted interventions.

Therefore, the current study explored the association between maternal trait mindfulness and the course of maternal bonding from the third trimester of pregnancy until 12 months postpartum in a large prospective cohort study. The primary aim of the study was to examine the course of maternal bonding over time in the perinatal period. The secondary aim of the study was to examine the association between maternal trait mindfulness and the course of maternal bonding in the perinatal period, after adjusting for maternal depressive symptoms and other covariates. We hypothesised that the maternal bonding scores at all time points are correlated, but that levels of maternal bonding will increase after the child is born up to 12 months postpartum. In addition, we expected that maternal trait mindfulness would be positively related to bonding scores throughout the perinatal period.

Materials and methods

Participants

The current study included 1003 women. This is a subsample of women who participated in the Brabant Study, a large prospective perinatal cohort study among pregnant women examining the biopsychosocial well-being of women from pregnancy until 8 weeks postpartum ($N = 2865$) (Meems et al., 2020). Pregnant women were recruited by their community midwife at their first appointment during pregnancy from 2018 to 2022. To be eligible to participate in the study, pregnant women had to be above the age of 18, understand the Dutch language sufficiently, and have access to the internet. Exclusion criteria were a multiple pregnancy (twins, triplets, or more), diabetes type I, known endocrine disorders before pregnancy (other than problems in thyroid function), severe psychiatric disorder (such as schizophrenia, borderline personality disorder, or bipolar disorder), rheumatoid arthritis, HIV, drug or alcohol addiction, or any other diseases that require drug treatment that could be potentially harmful to the foetus. Starting in June 2023 women who did not object to being approached for future research were invited for a follow-up study, starting at six months postpartum. Of the approached women, 1206 agreed to participate and were included in the current study. Out of these women, 2 did not complete any bonding questionnaires and 203 did not complete the mindfulness assessment. This resulted in a sample of 1003 women to be included in the current study. The included women had a mean age of 31.7 ($SD = 3.8$, range 18–45). The majority of women completed a Bachelor's degree or higher (78.4%), had a Dutch

ethnicity (89.6%), were married and/or cohabiting (97.7%) and were employed (94.5%). Furthermore, 50.3% of the participating women were primiparous, 91% had a planned pregnancy, and 26.4% had experienced previous pregnancy loss. Women had an average pregnancy duration of 39.5 weeks (SD = 1.8, range = 25–43 weeks) and 54 children (5.4%) were born premature. At birth, children weighed on average 3456.9 grams (SD = 548.2, range 860–5360). Approximately half of the children were girls (n = 490, 48.9%). Demographics were missing for 37 participants (3.7%).

The Brabant study was approved by the Medical Ethical Committee of the Maxima Medical Center Veldhoven (protocol number NL64091.015.17). The follow-up study was approved by the Ethics Review Board of Tilburg University (protocol number RP41). All participating women provided informed consent for both studies.

Procedure

Participants completed various questionnaires at each trimester of pregnancy (12, 20, 28 weeks) and at 8 weeks, 6 months and 12 months postpartum. Demographics were collected at 12 weeks of pregnancy. Maternal bonding and depressive symptoms were assessed at 28 weeks of pregnancy and 8 weeks, 6 months and 12 months postpartum. Trait mindfulness was assessed only at 20 weeks of pregnancy. Questionnaires were sent via email using Qualtrics (www.qualtrics.com) and could be completed on a computer or smartphone.

Measures

Maternal trait mindfulness

Participants completed the Three Facet Mindfulness Questionnaire – Short Form (TFMQ-SF; Truijens et al., 2016) to assess maternal trait mindfulness. This scale contains 12 items that were originally derived from the Five Facet Mindfulness Questionnaire (Baer et al., 2006) and its short form (Bohlmeijer et al., 2011). The TFMQ-SF consists of three subscales with four items each, namely, (1) *acting with awareness* (being attentive to current experiences), (2) *non-judging* (refrain from judgments about own feelings and thoughts), and (3) *non-reacting* (experiencing emotions without directly acting upon it). Respondents were asked to rate how true the statements were for them on a five-point Likert-type scale (1 = never or very rarely true to 5 = very often or always true). Total subscale scores were used in the current study, ranging from 4 to 20, with higher scores indicating more mindfulness skills. The TFMQ-SF has been previously validated in a pregnant sample where it showed adequate reliability and validity when assessed around 20 weeks of gestation (Truijens et al., 2016). Cronbach's alphas in the current sample were $\alpha = .85$ for acting with awareness, $\alpha = .78$ for non-judging, and $\alpha = .77$ for non-reacting.

Maternal bonding

Maternal bonding was assessed using the Pre- and Post-natal Bonding Scale (PPBS; Cuijlits et al., 2016). This scale consists of 5 positively formulated statements, which are answered on a 4-point Likert scale (0 = not at all to 3 = very much). The items describe maternal feelings towards their (unborn) child (e.g. loving, extraordinary) in the past four weeks. Total scores ranged from 0 to 15, with higher scores

indicating more positive maternal bonding. This instrument has shown good psychometric properties in pregnant and postpartum women (Cuijlits et al., 2016) and has been evaluated as sufficient regarding structural validity and internal consistency in a systematic review evaluating bonding measures (Wittkowski et al., 2020). Cronbach's alphas in the current study were good, with α = .87, α = .86, α = .83, and α = .85, at 28 weeks of pregnancy, and 8 weeks, 6 months, and 12 months postpartum, respectively.

Covariates

Maternal symptoms of depression. Women completed the 10-item Edinburgh Postnatal Depression Scale (EPDS; Cox et al., 1987) at 28 weeks of pregnancy, and 8 weeks, 6 months, and 12 months postpartum to assess depressive symptoms over the preceding 7 days. Items are rated on a four-point scale that ranges from 0 to 3. Total scores on the EPDS range from 0 to 30, with higher total scores indicative of more depressive symptoms. This scale has shown good psychometric properties in a sample of Dutch women during pregnancy (Bergink et al., 2011) and postpartum (Pop et al., 1992). Cronbach's alphas in the current study were α = .83, α = .84, α = .86, and α = .85, at 28 weeks of pregnancy, and 8 weeks, 6 months, and 12 months postpartum, respectively.

Demographics and obstetrics. Data regarding demographics and obstetrics were collected using a questionnaire that was filled out at 12 weeks of pregnancy. The demographic variables were age (years), level of education (high = bachelor's degree or higher), and marital status (partnered/single). The obstetric variables were parity (primiparous/multiparous) and unplanned pregnancy (yes/no).

Statistical analyses

Analyses were performed in SPSS version 29.0. Pearson correlations were calculated between the scores reflective of the three dimensions of trait mindfulness (independent variable), the four measurements of maternal bonding (dependent variables), and the four measurements of depressive symptoms (covariates). A Benjamini–Hochberg correction was conducted to control for multiple testing (Benjamini & Hochberg, 1995), with a false discovery rate of 25%. Next, multilevel analyses were used to analyse 1) changes in maternal bonding over time and 2) the relationship between the three facets of trait mindfulness (measured as a time-invariant variable). Multilevel analyses enabled us to consider both between- (i.e. level 2) and within-participant (i.e. level 1) effects. To arrive at the most parsimonious model (e.g. best balance between model fit and numbers of parameters) we tested different models including both fixed and random effects (see below for more detail). Using full information maximum likelihood (FIML) allowed the inclusion of all cases in the analyses, even those with missing data at one or more timepoints (Bagiella et al., 2000). Participants who completed at least one assessment of maternal bonding ($N = 1003$) were included in the analyses. Of these 1003 women, 544 (54%) completed all four bonding assessments, 382 (38%) completed three assessments, 64 (6%) completed two assessments, and 13 (1%) completed one assessment.

Model selection

We first created a baseline model that only included a random intercept (no predictors) to fit the individual trajectories of mother-to-infant bonding (in the literature often referred to as 'null model' or 'unconditional means model'). Next, this model was extended by adding 'time' as level-1 predictor through allowing random slopes (in the literature often referred to as 'unconditional growth model'). 'time' corresponds to the four measurements of maternal bonding from pregnancy to one year postpartum. An unstructured (UN) covariance matrix (e.g. no restrictions on variances or covariances) turned out to be the best fitting covariance structure for these data based on Akaike's Information Criterion (AIC) and Schwarz's Bayesian Criterion (BIC). Next, a predictor model was created by adding the three trait mindfulness facet scores (acting with awareness, non-judging, non-reacting) as time-invariant level-2 (e.g. measured at a single point, at 20 weeks of pregnancy) independent variables to the model (between-subjects variable). A different model was created for each trait mindfulness facet. Lastly, the quadratic effect of time (time x time) was added to the model to analyse a possible non-linear change in maternal bonding scores over time (expected based on research by Klabbers et al., 2020). We also added an interaction between the trait mindfulness facets and time (trait mindfulness x time) to investigate if the different slopes in bonding can be predicted by a woman's score on any of the three dimensions of mindfulness. In the subsequent model, covariates were added, including the four perinatal depression scores were added as time-varying independent variables. Following the procedure recommended by Bell et al. (2019), this was done by adding both mean scores as well as centred (within women) scores. Furthermore, the general demographics (age, level of education, marital status) and obstetrics-related covariates (parity, unplanned pregnancy) were added to this model. Next to a fixed intercept, the model included random intercepts for all women (to account for differences in baseline bonding), a random slope of time, time-invariant independent variable trait mindfulness (acting with awareness, non-judging, non-reacting), covariates (including time-varying depressive symptoms), trait mindfulness facets x time, time x time.

Results

The variables were all normally distributed, with appropriate skewness and kurtosis values. Assumptions for multilevel analyses were not violated. First, to check for inclusion bias, it was examined whether the current sample ($N = 1003$) differed in characteristics compared with the remainder of the sample (e.g. women who did not participate in the follow-up study or did not complete mindfulness assessment) ($N = 1804$). The results showed that the current sample was slightly older ($M = 31.68$) compared to the excluded sample ($M = 31.11$, $p < .001$, Cohen's $d = 0.16$). Women in the included sample were more often highly educated ($p < .001$, phi coefficient = 0.11) and more often of Dutch ethnicity ($p < .001$, phi coefficient = 0.08). Effect sizes were small for all significant differences. The two samples did not differ regarding employment status, marital status, pregnancy intention, parity, and history of pregnancy loss.

Correlations

Next, Pearson correlation analyses were conducted to assess the association between the trait mindfulness facets, depression, and maternal bonding scores (Table 1). All bonding measures were significantly and positively associated with one another (medium to large effect sizes). The mindfulness facets *acting with awareness* and *non-judging* were significantly and positively associated with maternal bonding at 28 weeks of pregnancy, and 8 weeks, 6 months and 12 months postpartum (small effect sizes). The mindfulness facet *non-reacting* was significantly and positively associated with maternal bonding at 28 weeks of pregnancy (small effect size), but not with maternal bonding at 8 weeks, 6 months, and 12 months postpartum. All timepoints of depressive symptoms (28 weeks of pregnancy, and 8 weeks, 6 months, and 12 months postpartum) were significantly and negatively associated with all maternal bonding measures (small-to-medium effect sizes). A Benjamini–Hochberg correction demonstrated that significant correlations remained significant after controlling for multiple testing with a false discovery rate of 25%.

Trajectory of mother-infant bonding

Next, multilevel analysis was used to evaluate the course of maternal bonding over time during the perinatal period. All models showed a significant and positive effect of time ($p < .001$), with the positive (unstandardised) regression coefficient indicating that the maternal bonding scores tended to increase over time. The quadratic effect of time (time x time) was negative and significant ($p < .001$), see Tables 2–4. Figure 1 visually displays this quadratic effect, showing the mean maternal bonding scores from pregnancy to 12 months postpartum, and illustrates that maternal bonding increases from pregnancy to 8 weeks postpartum after which this increase flattens during the postnatal period.

Mother-infant bonding and trait mindfulness

Next, associations between trait mindfulness (assessed at 20 weeks of pregnancy), and the course of maternal bonding over time during the perinatal period were measured. Results of the first multilevel model showed that the mindfulness facet *acting with awareness* was a significant positive predictor of maternal bonding scores across time ($\beta = .10$, $p < .001$) (Table 2, step 1), also after adjusting for depression and covariates ($\beta = .04$, $p = .040$) (Table 2, step 2). The interaction term acting with awareness x time ($\beta = -.02$, $p = .041$) was significant, but not after adjusting for covariates and depression. Figure 2a visualises this interaction and shows that women scoring high on acting with awareness report higher bonding scores throughout the perinatal period, but demonstrated a smaller increase, compared to women with average and low acting with awareness scores.

Results of the second model showed that the mindfulness facet *non-judging* was a significant positive predictor of maternal bonding scores across time ($\beta = .11$, $p < .001$) (Table 3, step 1), but not after adjusting for depression and covariates (Table 3, step 2). The interaction term non-judging x time ($\beta = -.025$, $p = .001$) was significant, also after adjusting for covariates and depression ($\beta = -.018$, $p = .018$). Figure 2b shows that women scoring high on non-judging report higher bonding scores throughout the perinatal

Table 1. Correlations between facets of mindfulness, maternal bonding and depressive symptoms ($N = 1003$).

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. TFMQ-SF: acting with awareness	1										
2. TFMQ-SF: non-judging	.39**	1									
3. TFMQ-SF: non-reacting	−.07*	−.00	1								
4. PPBS: 28 weeks of pregnancy	.13**	.18**	.08*	1							
5. PPBS: 8 weeks postpartum	.11**	.12**	.06	.45**	1						
6. PPBS: 6 months postpartum	.10**	.08*	.03	.41**	.54**	1					
7. PPBS: 12 months postpartum	.10*	.10*	.07	.42**	.51**	.60**	1				
8. EPDS: 28 weeks of pregnancy	−.28**	−.48**	−.14**	−.28**	−.16**	−.16**	−.16**	1			
9. EPDS: 8 weeks postpartum	−.17**	−.36**	−.13**	−.16**	−.47**	−.31**	−.24**	.44**	1		
10. EPDS: 6 months postpartum	−.19**	−.37**	−.14**	−.16**	−.23**	−.32**	−.21**	.48**	.57**	1	
11. EPDS: 12 months postpartum	−.20**	−.34**	−.14**	−.12**	−.21**	−.18**	−.29**	.48**	.52**	.59**	1
Mean (SD)	14.28 (3.17)	15.50 (3.22)	14.02 (3.59)	12.87 (2.37)	13.63 (2.04)	13.79 (1.75)	13.56 (1.92)	4.72 (4.09)	4.98 (4.60)	4.81 (4.40)	4.62 (4.21)
Range	5–20	4–20	4–20	2–15	3–15	6–15	5–15	0–22	0–30	0–26	0–23

*$p < .05$, **$p < .01$, ***$p < .001$ (two-tailed); TFMQ-SF, Three Facet Mindfulness Questionnaire – Short Form (20 weeks of pregnancy); PPBS, Pre- and Post-natal Bonding Scale; EDS, Edinburgh Postnatal Depression Scale; SD, standard deviation.

Table 2. Multilevel analyses with mindfulness facet acting with awareness predicting maternal bonding over the course of the perinatal period.

					95% CI	
	B	*SE*	*t*	*p*	LL	UL
Step 1						
Time	1.80	0.14	8.46	<.001	0.91	1.45
TFMQ-SF: acting with awareness	0.10	0.02	4.66	<.001	0.06	0.14
Time*time	−0.24	0.03	−9.41	<.001	−0.29	−0.19
Time*acting with awareness	−0.02	0.01	−2.04	.041	−0.03	−0.00
Step 2						
Time	1.17	0.14	8.66	<.001	0.91	1.43
TFMQ-SF: acting with awareness	0.04	0.02	2.06	.040	0.00	0.08
Time*time	−0.26	0.02	−10.87	<.001	−0.31	−0.21
Time*acting with awareness	−0.01	0.01	−1.41	.159	−0.03	0.00
EPDS mean	−0.16	0.01	−11.43	<.001	−0.18	−0.13
EPDS deviation	−0.15	0.01	−16.53	<.001	−0.17	−0.13
Maternal age	−0.01	0.01	−0.85	.396	−0.04	0.02
Low education	0.46	0.12	3.95	<.001	0.23	0.69
Unplanned pregnancy	−0.24	0.17	−1.38	.169	−0.58	−0.10
Single marital status	−0.06	0.47	−0.14	.893	−0.98	0.85
Primiparous	0.11	0.10	1.10	.271	−0.08	0.30

TFMQ-SF, Three Facet Mindfulness Questionnaire – Short Form (20 weeks of pregnancy); EPDS, Edinburgh Postnatal Depression Scale; EPDS deviation reflect the centred scores within women; SE, standard error; CI, confidence interval; LL, lower level; UL, upper level; low level of education: lower than Bachelor's degree.

Table 3. Multilevel analyses with mindfulness facet non-judging predicting maternal bonding over the course of the perinatal period.

					95% CI	
	B	*SE*	*t*	*p*	LL	UL
Step 1						
Time	1.33	0.15	9.09	<.001	1.05	1.62
TFMQ-SF: non-judging	0.11	0.02	5.51	<.001	0.07	0.15
Time*time	−0.24	0.03	−9.39	<.001	−0.29	−0.19
Time* non-judging	−0.03	0.01	−3.18	.001	−0.04	−0.01
Step 2						
Time	1.29	0.14	9.11	<.001	1.01	1.57
TFMQ-SF: non-judging	0.01	0.02	0.40	.688	−0.03	0.05
Time*time	−0.26	0.02	−10.83	<.001	−0.31	−0.21
Time* non-judging	−0.02	0.01	−2.36	.018	−0.03	−0.00
EPDS mean	−0.17	0.02	−11.34	<.001	−0.20	−0.14
EPDS deviation	−0.15	0.01	−16.38	<.001	−0.17	−0.13
Maternal age	−0.01	0.01	−0.71	.477	−0.04	0.02
Low education	0.48	0.12	4.09	<.001	0.25	0.70
Unplanned pregnancy	−0.23	0.17	−1.35	.176	−0.57	−0.11
Single marital status	−0.09	0.47	−0.19	.849	−1.00	0.83
Primiparous	0.11	0.10	1.18	.238	−0.08	0.30

TFMQ-SF, Three Facet Mindfulness Questionnaire – Short Form (20 weeks of pregnancy); EPDS, Edinburgh Postnatal Depression Scale; EPDS deviation reflect the centred scores within women; SE, standard error; CI, confidence interval; LL, lower level; UL, upper level; low level of education: lower than Bachelor's degree.

period, but also demonstrated a smaller increase, compared to women with medium and low non-judging scores.

Results of the last model showed that non-reacting was significantly associated with maternal bonding scores over time (β = .040, p = .028), but not after adjusting for depression and covariates (β = .03, p = .113) (Table 4, step 2). The interaction term non-reacting x time was not significant, indicating that the course of maternal bonding over time did not differ according to levels of non-reacting.

Table 4. Multilevel analyses with mindfulness facet non-reacting predicting maternal bonding over the course of the perinatal period.

					95% CI	
	B	*SE*	*t*	*p*	LL	UL
Step 1						
Time	1.05	0.13	8.15	<.001	0.80	1.30
TFMQ-SF: non-reacting	0.04	0.02	2.20	.028	0.00	0.08
Time*time	−0.24	0.03	−9.42	<.001	−0.29	−0.19
Time* non-reacting	−0.01	0.01	−1.03	.302	−0.02	0.01
Step 2						
Time	1.16	0.12	9.35	<.001	0.92	1.41
TFMQ-SF: non-reacting	0.03	0.02	1.58	.113	−0.01	0.06
Time*time	−0.26	0.02	−10.89	<.001	−0.31	−0.21
Time* non-reacting	−0.01	0.01	−1.55	.120	−0.02	0.00
EPDS mean	−0.16	0.01	−11.95	<.001	−0.19	−0.13
EPDS deviation	−0.15	0.01	−16.56	<.001	−0.17	−0.13
Maternal age	−0.01	0.01	−0.78	.435	−0.04	0.02
Low education	0.49	0.12	4.13	<.001	0.26	0.73
Unplanned pregnancy	−0.23	0.17	−1.32	.187	−0.57	−0.11
Single marital status	−0.08	0.47	−0.18	.857	−1.00	0.83
Primiparous	0.11	0.10	1.17	.243	−0.08	0.30

TFMQ-SF, Three Facet Mindfulness Questionnaire – Short Form (20 weeks of pregnancy); EPDS, Edinburgh Postnatal Depression Scale; EPDS deviation reflect the centred scores within women; SE, standard error; CI, confidence interval; LL, lower level; UL, upper level; low level of education: lower than Bachelor's degree.

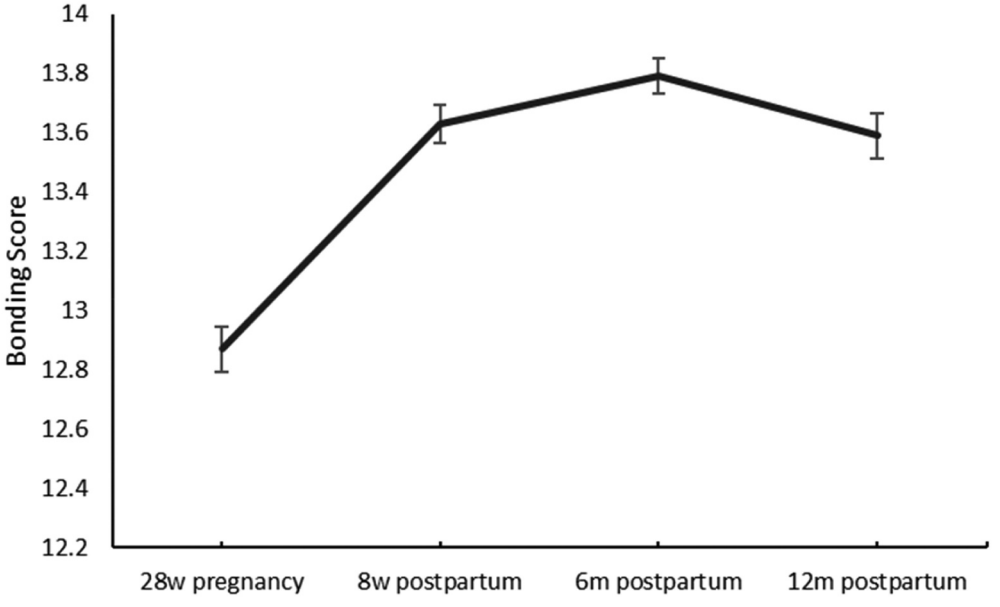

Figure 1. Maternal bonding scores from 28 weeks of pregnancy to 12 months postpartum.

Mother-infant bonding and covariates

Results of all models showed that depression scores (measured at 28 weeks of pregnancy, and 8 weeks, 6 months and 12 months postpartum) were significantly negatively associated with maternal bonding. We specifically tested the effect of the mean depression scores over time (e.g. being reflective of differences among

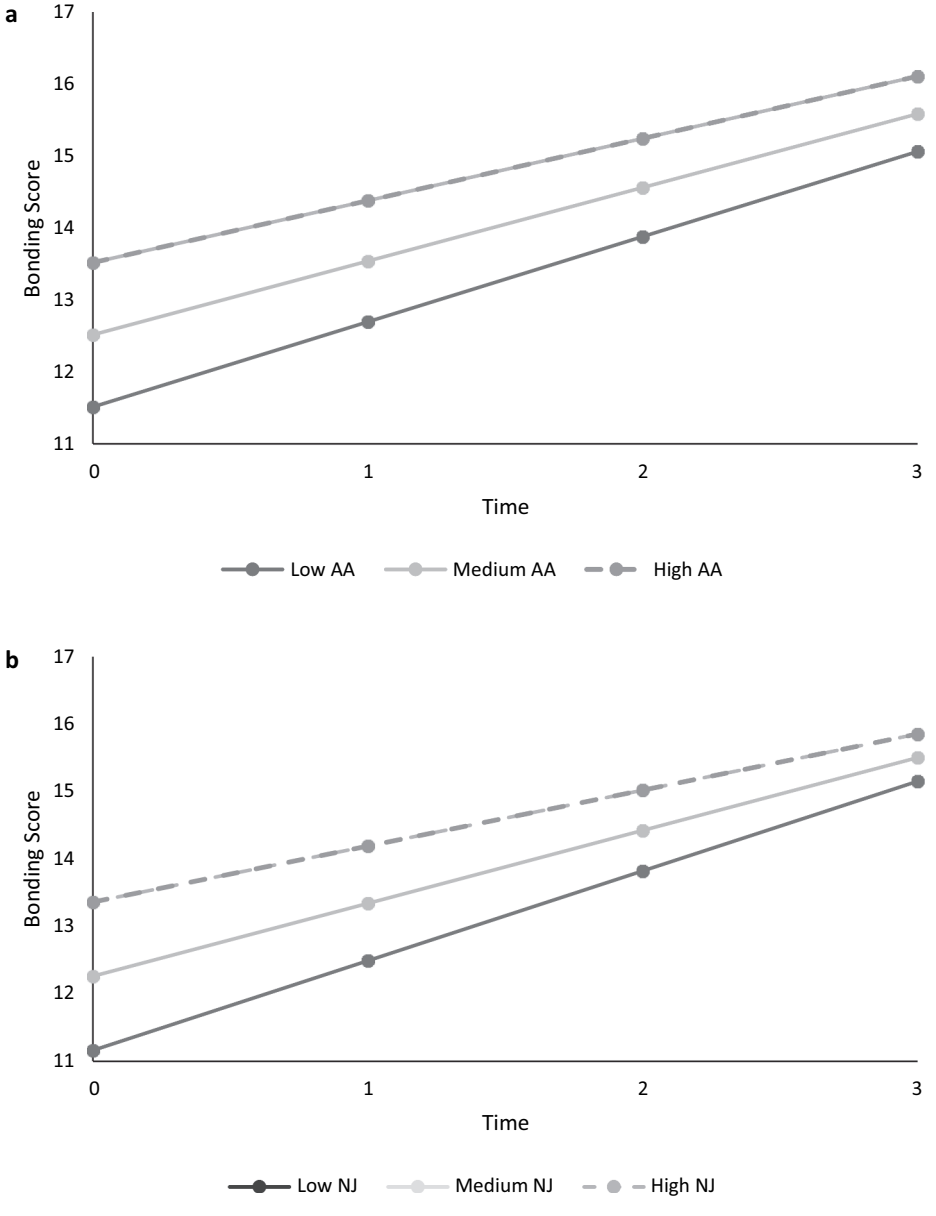

Figure 2. Interaction between acting with awareness and time (Panel A) and non-judging and time (Panel B), predicting maternal bonding scores. *Note*: Time: 0 = 28 weeks of pregnancy, 1 = 8 weeks postpartum, 2 = 6 months postpartum, 3 = 12 months postpartum; AA: Acting with Awareness; NJ: Non-Judging

women in depression over time, $p < .001$) and specific depression scores measured at every single timepoint, which were deviations from the overall woman's mean ($p < .001$) (Tables 2–4). With regard to the covariates, women with a lower level of education ($p = <.001$), had higher maternal bonding scores throughout the perinatal period.

Discussion

The aim of the current study was to examine the longitudinal course of maternal bonding from the third trimester of pregnancy until 12 months postpartum, and to explore its association with maternal trait mindfulness. Analyses revealed that maternal bonding increased from pregnancy to 8 weeks postpartum, after which this increase flattened and remained relatively stable during the postnatal period. Women with high scores on the mindfulness facets acting with awareness and non-judging scored higher on maternal bonding throughout the perinatal period, but demonstrated a smaller increase in maternal bonding scores over time when compared to women with medium and low scores on these mindfulness facets. The mindfulness facet non-reacting was also positively associated with maternal bonding scores, but the course of bonding (i.e. pattern over time) was not influenced by different levels of non-reacting. The main effects of both non-judging and non-reacting, as well as the interaction of acting with awareness with time, were unrelated to maternal bonding after adjusting for covariates, including depressive symptoms. Finally, women who reported more depressive symptoms and who had a higher education demonstrated lower levels of maternal bonding throughout the perinatal period.

In line with the hypothesis, maternal bonding scores at all time points were associated with one another. This indicates that feelings of bonding originate during pregnancy and that bonding towards the foetus is predictive for feelings of bonding towards the child throughout the first year postpartum. Consistent with previous literature (Cuijlits et al., 2016; De Cock et al., 2016; Klabbers et al., 2020; Rossen et al., 2017), levels of bonding increased from pregnancy to 8 weeks postpartum after which this increase flattened, and levels of bonding remained relatively stable until 12 months postpartum. These findings suggest that maternal feelings of bonding develop throughout the perinatal period, with childbirth and the first weeks postpartum marking important stages in this development. Skin-to-skin contact after birth, breastfeeding, and getting to know the child might explain the steeper increase in maternal feelings of bonding right after birth (Roth et al., 2021; Wada et al., 2020; Widstrom et al., 2019).

Consistent with our hypothesis and the results of previous studies (Brassel et al., 2020; Hicks et al., 2018; McDonald et al., 2022), higher levels of trait mindfulness were associated with more optimal mother-infant bonding throughout the entire perinatal period. More mindful awareness (i.e. acting with awareness) may facilitate engagement with foetal movements during pregnancy as well as interactions with the child after birth, which may be beneficial for the development of an emotional connection to the child. Moreover, refraining from self-criticism and harsh judgements (i.e. non-judging) may be essential for mental wellbeing (Hulsbosch, Boekhorst, et al., 2022; Hulsbosch, van de Poel, et al., 2022; Krusche et al., 2019) and might thereby support positive feelings towards the child (Faisal-Cury et al., 2020; Rolle et al., 2020). Additionally, being able to carefully consider the circumstances and continuously select an appropriate response without getting caried away by own negative thoughts (i.e. non-reacting), may also be important for the maternal bond. However, it should be noted that on a bivariate level, the non-reacting facet was only significantly related to prenatal bonding, and that there was no longer an association with the course of maternal bonding after adjusting for covariates.

In the present study, the trait mindfulness facets acting with awareness and non-judging also predicted the course of maternal bonding, with women with high scores on acting with awareness and non-judging demonstrating a smaller increase over time compared to women with medium and low scores on these facets. Thus, women who scored higher on acting with awareness and non-judging demonstrated a stronger bond with their child earlier in the perinatal period, whereas women with lower scores on these trait mindfulness facets did not experience such feelings up until a later stage. Possibly, mindful awareness and self-regulation of attention (i.e. acting with awareness) may be particularly helpful during pregnancy, as this enables women to connect emotionally to the foetus that is still relatively abstract at this time, and to disengage from pregnancy-related disruptive and stressful thoughts (e.g. about foetal health, the upcoming delivery or future parenthood) (i.e. non-judging) that may hinder bonding with the unborn child (Bishop et al., 2004; Hollis-Walker & Colosimo, 2011). Alternatively, we cannot exclude a possible ceiling effect of high bonding levels associated with mindfulness facets prenatally, not being able to increase further as much as in those women scoring lower on mindfulness with concomitant lower bonding levels.

Nonetheless, it should be noted that the mindfulness facets non-judging and non-reacting were no longer significant after adjusting for depressive symptoms and additional covariates, nor was the effect of acting with awareness on the course of maternal bonding. These findings may suggest that depressive symptoms mediate the association between trait mindfulness and maternal bonding, which should be further addressed in future studies. Previous studies have related higher levels of trait mindfulness during pregnancy to fewer prenatal and postnatal depressive symptoms (Hulsbosch, Boekhorst, et al., 2022; Hulsbosch, van de Poel, et al., 2022; Krusche et al., 2019). Moreover, in the present study, depressive symptoms were negatively associated with maternal bonding scores throughout the perinatal period, which was in line with previous research that related these constructs in the postpartum (Cuijlits et al., 2019; Tichelman et al., 2019).

Strengths of the study include the longitudinal research design, the relatively large sample size, and the inclusion of different dimensions of trait mindfulness as separate constructs. Additionally, using multilevel analyses allowed for examining both between- and within-mothers effects. However, the current study also has limitations. First, differences were found in characteristics between the current sample and the sample that was excluded from the present study. However, the effect sizes were small and therefore clinically not relevant. Moreover, participants were overall highly educated, and only few had an ethnic minority background. Therefore, cautiousness is required when generalising the results to the general population. Future research may include a more diverse sample that is more representative for the general population. Second, trait mindfulness was assessed only once and even though it is thought that this construct is relatively stable over time (Kiken et al., 2015), it could have been interesting to include multiple measurements in our study. Third, the research design does not allow for drawing conclusions on the causality of the found associations. Future studies may address this limitation by using a different research design. Finally, future studies may examine whether promoting mindfulness during pregnancy may be beneficial for bonding quality throughout the perinatal period, since trait mindfulness has been found to increase

in individuals that demonstrated a greater increase in state mindfulness following a mindfulness-based intervention (Kiken et al., 2015).

In sum, results of the current study add to the evidence that maternal bonding develops during pregnancy and increases after childbirth, after which it remains rather stable throughout the first year postpartum. Findings also suggest that women who reported more trait mindfulness (acting with awareness and non-judging) during pregnancy experienced more positive feelings of bonding towards their child throughout the perinatal period, and that they feel an emotional connection to the child earlier compared to women with lower levels of trait mindfulness. Mindfulness skills may therefore be specifically relevant during pregnancy, enabling women to adequately cope with stressors related to pregnancy. Trait mindfulness could also serve as a protective factor against suboptimal maternal bonding with the child. Mindfulness-based interventions may be helpful in supporting expectant mothers who are at risk for suboptimal perinatal bonding, such as women who experience elevated levels of depressive symptoms.

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