Daily relationships among maternal rumination, mood and bonding with infant

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A B S T R A C T

There is little research examining the association between maternal maladaptive emotion regulation strategies such as rumination and perceived maternal bonding and mood. This study investigated the concurrent and prospective relationship of both trait and daily rumination with daily perceived maternal bonding and mood. Ninety-three mothers of infants aged between 3 and 14 months completed a ten-day diary study investigating the relationship between daily and trait ruminative self-focus, negative affect and perceived maternal bonding, or her perceived feelings of closeness with her infant. The majority of mothers reported mild to moderate depressive symptoms. The data were analysed using Hierarchical Linear Modelling. Baseline depressive symptoms and trait rumination were each positively associated with mean levels of daily ruminative self-focus and mood over the ten-day sampling period. Bonding with infant at baseline was not associated with mean levels of daily rumination, mood or bonding over the sampling period. Concurrently, daily rumination and daily bonding were negatively correlated, after accounting for daily mood. Prospectively, lower levels of daily bonding predicted increases in daily rumination and depressive mood on the subsequent day. Interestingly, daily rumination did not predict increases in depressive mood or bonding on the subsequent day, suggesting that rumination occurred in response to perceived disruptions in feelings of closeness with the infant, but did not lead to prospective decreases in these feelings of closeness. These findings hold important implications for understanding the relationship between the mother-infant relationship, and maternal rumination and depressive mood, suggesting that disruptions in the way mothers perceive they are bonding to their infants may contribute to depressongenic processes.

1. Introduction

Maternal bonding, or the mother's affectionate and responsible attachment feelings directed at maintaining her physical and psychological proximity to her child (Feldman, Weller, Leckman, Kuint, & Eidelman, 1999; Herbert, Sluckin, & Sluckin, 1982) is associated with positive child outcomes, including better child capacity for affect regulation, self-reliance, social competence and peer acceptance (Canetti, Bachar, Galili-Weisstub, De-Nour, & Shalev, 1997; O'Mahen, Boyd, & Gashe, 2015; Persico et al., 2017; Davidov & Grusec, 2006; Maas, de Cock, Vreeswijk, Vingerhoets, & van Bakel, 2016; Stroufe, 2006). Negative maternal emotional characteristics (e.g., depression) have also been shown to interfere with the development of mother-infant bonding (for a review, see Field, 2010). Further, there is considerable evidence

demonstrating that bonding mediates the relationship between maternal depression and negative cognitive and behavioural child outcomes (for a review, see Grace, Evindar, & Stewart, 2003).

However, it is unclear what mechanisms may explain the relationship between maternal negative mood and bonding. This question is important, because there is growing evidence that even when maternal depression is being successfully treated, difficulties in the mother-infant relationship can remain (e.g., Cooper, Murray, Wilson, & Romaniuk, 2003). There is also extensive empirical literature on the role that emotion regulation can play in an individual's ability to effectively respond to environmental demands (Bargh & Williams, 2007; Rottenberg & Gross, 2003; Gross & Muñoz, 1995), suggesting in turn that emotion regulation could also play a role in a mother's ability to respond to the needs of her infant. This notion is supported by evidence

demonstrating that rumination can impact how sensitively a mother responds to her infant in a play task (Tester-Jones et al., 2014). How bonded a mother feels to her infant may also play an important role in this relationship. However, in the literature pertaining to major depressive disorder (MDD), there is a surprising lack of research examining whether there are maternal emotion regulation strategies (e. g., rumination) that may mediate the effect of maternal mood on bonding outcomes in naturalistic settings. If there are, and such strategies are found to be maladaptive, these may be key targets for interventions.

1.1. Rumination

Depressive rumination, defined as a repetitive, passive focus on depressive symptoms and on the implications of these symptoms (Nolen-Hoeksema, 1999), has been robustly implicated in both the onset and maintenance of MDD ("Ruminative Response Theory," e.g., Nolen-Hoeksema, Larson, & Grayson, 1999; Nolen-Hoeksema & Morrow, 1993). The repetitive, inwardly focussed, and often over general nature of rumination on depressed mood (henceforth 'rumination') can interfere with the individual's ability to attend adequately to environmental cues, thereby inhibiting effective problem solving, and may also contribute to avoidance of the environment (Moulds, Kandris, Starr, & Wong, 2007).

1.2. Maternal rumination

The cognitive consequences of rumination have potentially negative implications for parenting an infant, including a diminished ability to attend and respond to infant cues (DeJong, Fox, & Stein, 2016; Murray et al., 2011; Tester-Jones, Karl, Watkins, & O'Mahen, 2017), decreased ability to effectively engage in parental problem-solving (O'Mahen, Boyd, & Gashe, 2015) and lower quality self-reported responsiveness to the infant when the infant did not demonstrate a difficult temperament (Tester-Jones, Watkins, Karl, & O'Mahen, 2015). Because these aspects of parenting are critical to the successful development of a healthy mother-infant relationship (Stein et al., 2014), rumination may be a particularly important cognitive process to consider in the mother-infant relationship.

Furthermore, rumination and poor bonding may have a reciprocal effect, with poor bonding promoting rumination and low mood, and rumination reducing the mother's ability to engage sensitively with her infant, leading to negative interactions and poor perceived bonding. Finally, it is also acknowledged that rumination may deplete cognitive resources that would otherwise be allocated to maternal-infant bonding and therefore, reduce bonding as a consequence (Tse & Bond, 2004).

In support of the role of rumination in the mother-infant relationship, recent correlational and experimental studies have demonstrated that maternal trait rumination and experimentally induced rumination are associated with both maternal sensitivity and self-reported maternal responsiveness. Stein et al. (2012) found that anxious mothers who were experimentally induced to ruminate were less responsive to their 10-month old infants, compared to a control group that was induced to distract. In a correlational study, Tester-Jones, O'Mahen, Watkins, and Karl (2015) found that maternal rumination mediated the association between postnatal maternal depressive mood on maternal self-reported responsiveness to the infant. A prospective study also demonstrated that ruminative thinking during pregnancy was a significant predictor of mother-reported impairments in the mother–infant relationship at three months postpartum (Müller, Teismann, Havemann, Michalak, & See-hagen, 2013). Tester-Jones, Karl, Watkins, and O'Mahen (2016) also found that regardless of daily mood, mothers who were induced to ruminate about a personally relevant goal that was unresolved demonstrated less sensitivity to their infants than mothers who were not induced to ruminate. Maternal sensitivity to the infant further decreased in those mothers who were induced to ruminate when a stressful task

was presented, but this worsening in sensitivity did not occur in mothers not induced to ruminate. Together, the results from these studies suggest that rumination has an important and causal role in maternal responsiveness to their infants.

Conversely, research that has found that distinct dimensions of rumination, brooding versus reflection, can differentially relate to depressive symptoms (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). While most extant work shows adverse effects of rumination, it is possible that rumination has not been examined in sufficient granularity, obscuring potentially protective effects. For example, while brooding is consistently predictive of depressive symptoms and maladaptive functioning, reflection has been found to be associated with greater well-being and life satisfaction (Boyraz & Kuhl, 2015; Harrington & Loffredo, 2010). Reflective rumination could therefore be more adaptive and serve a more positive purpose in the context of mother-infant bonding.

1.3. Maternal rumination and bonding

However, more ecologically valid methods are needed to understand the concurrent and prospective relationship between rumination and the mother-infant relationship in "real-world" settings. The multiple measurements taken in daily-diary designs can highlight how processes unfold over a series of days, and because measurements are taken at short time intervals, are less likely to be affected by retrospective biases. Further, a daily diary approach permits examination of the extent to which a mother's experiences of rumination and perceived bonding vary over time. This is important because previous studies in this area have primarily assumed that rumination was either (a) a trait characteristic that gives rise to the mother's ability to attend to the infant (Tester-Jones et al., 2015), or (b) something that can be experimentally manipulated (Stein et al., 2012; Tester-Jones et al., 2017). There has been no research however, investigating how daily variations of maternal rumination and maternal perceived bonding are associated with daily variations of mood and in particular the direction of the association between these variables.

The importance of examining the variability of rumination over time arises from studies that have shown that the Response Styles Questionnaire (RRS), a measure of rumination, has moderate to poor test-retest reliability in depressed samples (Just & Alloy, 1997; Kasch, Klein, & Lara, 2001). Further, in an ecological momentary assessment study of rumination, Moberly and Watkins (2008) demonstrated that although baseline ruminative style predicted overall mean levels of rumination (operationalised as focusing on one's feelings and problems), ruminative thought fluctuated from moment-to-moment, demonstrating only a moderate average moment-to-moment (within-person) correlation of $r = 0.34$. Theoretically, maternal representations of the mother-infant relationship are also thought to be malleable, changing and elaborating following birth as the mother adjusts her expectations and responds to her infant's behaviours (Stern, 1991). However, there has been little research to date investigating whether bonding varies on a daily basis, and whether it may vary in relation to rumination. Further, it is unclear whether there are individual differences in the extent to which bonding and rumination vary across time. Understanding these associations may provide insights into the maintenance of postnatal depression, and potential mechanisms explaining how postnatal depression may be related to bonding.

1.4. The present study

In this study, we aimed to examine the level of daily variability in rumination and maternal perceived bonding in a sample of mothers with mild to moderate depressive symptoms, and to investigate the concurrent and prospective relationships between daily rumination, bonding and maternal mood. We further sought to examine how baseline rumination and baseline levels of perceived bonding predicted daily levels of

maternal rumination and bonding.

Although the general adult depression literature suggests that rumination can occur in response either to negative mood, or a negative event, it is not yet clear what the temporal relationship is between rumination, bonding and maternal mood at the daily level. The present study therefore tested three hypotheses:

1. Consistent with previous research demonstrating a cross-sectional association between rumination and bonding, we predicted that daily rumination and daily bonding would be negatively correlated on the same day, after accounting for daily mood (hypothesis 1a). We also predicted that the relationship between daily rumination and daily mood would be negatively correlated after accounting for daily bonding, such that higher levels of rumination would be associated with lower mood (hypothesis 1b).
2. We hypothesized that higher daily rumination on one day (T1) would prospectively predict deterioration of daily mood and daily bonding on the next day (T2), after controlling for daily mood and bonding on the previous day (T1; hypothesis 2a). Based on the notion that problems in perceived maternal bonding may prospectively predict rumination, we also examined whether lower daily bonding on one day (T1) prospectively predicted increased daily rumination on the next day (T2), when controlling for daily mood and daily rumination on the previous day (T1; hypothesis 2b).
3. We hypothesized that higher baseline rumination (RRS brooding but not RRS reflection; Moberly & Watkins, 2008) and lower baseline bonding (PBQ) would independently predict higher mean levels of daily rumination (hypothesis 3a) and lower mean levels of daily bonding (hypothesis 3b) respectively, after controlling for depressive symptoms (EPDS).

2. Method

2.1. Participants

Participants were eligible for the study if they were 18 years or older ($M = 31.4$, $SD = 5.9$, range = 18–45) and had a child aged between 3 and 14 months ($M = 9.2$, $SD = 3.4$). The age range was chosen based on input from our Patient and Public Involvement (PPI) consultants and to account for early differences in maternal feelings of bonding that may be partially accounted for by maternal differences in breastfeeding. Exclusion criteria included active suicidality, history of psychosis, and because the study required responding to online material, non-English speakers. Participants ($n = 93$) were recruited both in the Southwest of England at children's centres and nationally via email and advertising on relevant internet notice boards and forums. Whilst mothers were informed that the study was interested in exploring the relationship between mood and bonding, recruitment was not targeted toward any particular group or clinical characteristic and study advertisements did not target individuals with depression symptoms. 49.5% of the sample reported mild to moderate depressive symptoms (n = 46) with a score of 9 or above on the EPDS (Cox, Holden, & Sagovsky, 1987). Participants who completed the study were entered into a prize draw to win gift vouchers. The majority of mothers described their ethnicity as White British (99.1%, $n = 92$), had received a university higher education degree (57.2%, $n = 53$) and were primiparous (59.9%, $n = 56$).

2.2. Measures

Baseline depressive symptoms were assessed with the 10 item Edinburgh Postnatal Depression Scale, a well-validated and reliable measure of depressive symptoms during the postnatal period (EPDS; Cox et al., 1987). Higher scores indicate greater depressive symptoms (range in this sample: 0–25, full scale range: 0–30). It demonstrated excellent internal consistency in this study (α = 0.90).

Baseline rumination: was assessed with the Response Styles

Questionnaire (Revised; RRS). The revised version (Treynor et al., 2003) allows for the assessment of two different components of rumination: reflection and brooding. The statements are rated on a 4-point Likert scale from *almost always* to *almost never* (full scale score range 22–100). The brooding subscale is composed of five items and measures passive, self-evaluative and judgmental pondering of one's sad mood, whereas the reflection subscale is composed of 5 items that measure attempts to deeply ponder problems in an attempt to resolve them (Treynor et al., 2003). Measuring both of these components allows for comparisons between the less effective, repetitive, and abstract style associated with brooding, and the theoretically more effective, contemplative, problem-focused style of reflection. Together, the subscales assessing rumination and reflection respectively within the RRS have exhibited good reliability and validity in adult samples (e.g., Grassia & Gibb, 2008, 2009; Joormann, Dkane, & Gotlib, 2006; Lee & Kim, 2014; Treynor et al., 2003). Cronbach's alpha in this study was 0.86 and 0.84 for each subscale respectively.

Baseline mother-infant bonding was assessed with the Postpartum Bonding Questionnaire (PBQ; Brockington et al., 2001). The PBQ is a 25-item scale reflecting a mother's feelings or attitudes towards her baby (e.g., "I feel close to my baby'', "My baby irritates me'') on a Likert scale of 0 (*always*) to 6 (*never*) (full scale score range: 25–150). High scores denoted poorer bonding. The PBQ has been successfully validated in previous studies (e.g., Brockington et al., 2006). Cronbach's alpha in this study was 0.93.

Daily mood and bonding were measured on two separate scales asking the participant to retrospectively rate their mood (please rate your overall mood during the day from 1 (*highest*, i.e., most positive) to 10 (*lowest*, i.e., most negative)) and how close they had felt with their infant during the day (How close did you feel with your infant today from 1 (*extremely close*) to 10 (*not close at all*)). The choice to rate mood and bonding each a single, separate scale was taken due to the nature of the population and the challenges associated with both recruitment and attrition. Given the population (new mothers with young babies), data collection was challenging, and as such we did strive to make questionnaires and the daily diary as brief and manageable as possible. This was deemed crucial for successful recruitment and completion rates.

The Daily Rumination Scale (adapted from Moberly & Watkins, 2010) asked participants to record their responses to three items (To what extent have you been focusing on your emotions today? To what extent have you been focusing on analysing and understanding things today? To what extent have you been focusing on evaluating and understanding things today? (alpha for this scale calculated by averaging across days within participants = .83). Responses were made on a 7-point Likert scale from 1 (*not at all*) to 7 (*very much*) (full scale score range: 3–21).

Demographics. Participants were asked to provide information on their age, the age of their infant, how many children they had in total, their nationality and level of education.

2.3. Procedure

All participants completed the study online using Qualtrics survey software. Participants were asked to provide informed consent prior to taking part in the study. Once consent was given, a link was made available to a questionnaire pack assessing baseline levels of mood, rumination and perceived maternal bonding. Participants were asked to complete these measures before beginning the diary portion of the study. Completion time of the questionnaire pack was approximately 45 min and could be completed in one sitting or over two or more sessions using a save and continue function.

After completion of the questionnaire pack, participants were emailed a link to day one of their daily diary questions. Participants completed items related to three different daily measures: mood, bonding with the infant, and daily rumination. Participants were emailed a link to their diary each day, and were asked to respond to the

link any time between 3pm and midnight. They also received a text message reminder to fill out their diary each evening. Participants were instructed to recall events and feelings from the previous 24 h only. They were asked to complete the diary every day for 10 consecutive days, although we provided participants with up to 14 days to complete the daily diaries to allow for times where they might forget or be too busy to respond. Similarly, the sampling period was limited to this period of time in order to make it feel both achievable and not too burdensome for participants that would already be very busy with young babies. Participants who completed fewer than 5 diary days were excluded from the study. Completion rates were good, 48%, *n* = 45, completed the full 10 days, and on average participants completed 7.98 diaries (total number of missing diaries within the sample = 196 out of 950; 20%). Ten participants completed fewer than 5 days of diaries and were excluded from the analysis. As such data from 83 (89%) participants were included. Regarding norms for completion rates, it is noted that whilst 48% completed all 10 days, overall, 89% of participants completed more than 5 days of diaries and were included in the analysis. This attrition rate is consistent with other prospective research with population samples of adults reporting depressive symptoms. (e.g., Hankin, 2010; Hankin, Abramson, Miller, & Haeffel, 2004 and 2005; Metalsky & Joiner, 1992). Of note is that those participants who completed 5 or more days of the diary had a mean age of 32.69 compared to a mean age of 28.73 for those who did not complete at least 5 days (t (73) = 2.59, p = .011). Those that did versus did not complete at least 5 days did not significantly differ on any other covariates. Following completion of the diary, participants received a written debriefing that thanked them for taking part and reminded them of the nature of the study.

2.4. Statistical data analyses

Preliminary data analyses were conducted in IBM SPSS Statistics, version 18. Data were checked for accuracy, missing data, outliers and normality. Following statistical guidelines in daily diary/experience sampling datasets (Roth, 1994), no missing data imputation was performed. The distributions for baseline mood, brooding and reflective rumination and bonding were negatively skewed, as were daily mood, bonding and daily rumination. Log transformations normalised these variables.

Our data exhibited a nested structure; in this dataset, days (Level 1) were nested within persons (Level 2), so hierarchical linear modelling (HLM) with MLwiN 2.27 was used to analyse the relationship at different levels of structure without violating standard assumptions of independence. Multilevel modelling has several advantages over traditional models for such data. Multilevel modelling can be used to examine associations involving Level 2 and Level 1 variables simultaneously in nested datasets. Multilevel models therefore take into account the clustered nature of the data and adjust for any bias in standard errors and statistical tests resulting from the nonindependence of observations (Kenny, Korchmaros, & Bolger, 2003; Krull & MacKinnon, 2001). Unlike traditional models for repeated measures data, multilevel models can also effectively manage unequal group sizes and missing data.

The analyses were conducted in four stages. Firstly, relationships between daily variables and the extent to which ruminative thought and feelings of closeness with infant vary between and within participants were explored. Secondly, to test Hypotheses 1 and 2, the model was expanded to examine (i) concurrent and (ii) prospective relationships between daily variables. Finally, to test Hypothesis 3, models were estimated to investigate whether person-level measures of depressive symptoms (EPDS), bonding (PBQ) and rumination (RRS) were associated with mean levels of daily bonding and daily ruminative self-focus (rumination).

Based on recommendations by Enders and Tofighi (2007) about centring in multilevel models, level 2 baseline predictors (EPDS, RRS, PBQ) were centred on their grand means. Level 1 daily predictors were also centred on their grand means. Following advice from Wu and Wooldridge (2005), we used theory and our specific research questions to guide our decision to grand mean centre our daily (level 1) variables, as we were interested in comparing change to overall group levels of daily variables. For each analysis, separate models were constructed using the RRS Brooding and Reflection subscale scores. Observations tend to be more similar if they are taken on the same day and from the same person and as such, in all our multilevel models the intercept was specified as randomly varying at both the day and person levels. To prevent problems associated with model convergence, all predictors were entered into the models as fixed slopes. Based on recommendations by Gelman et al. (2012) no adjustments were made for multiple comparisons because multilevel models perform partial pooling (shifting estimates toward each other) and therefore produce more efficient estimates.

3. Results

3.1. Variability in daily ruminative self-focus and daily bonding

We first checked the extent to which both daily bonding and daily rumination demonstrated variability across days, rather than just between persons, using empty multilevel models. Consistent with previous findings by Moberly and Watkins (2008) and the suggestions of Stern (1991), we predicted that there would be some variability in both daily rumination and bonding across days within persons.

An empty multilevel model partitions the variance at the person and day level without including explanatory variables. The intraclass correlation (ICC) is equivalent to the mean correlation between ratings on two randomly chosen days for a particular person (Snijders & Bosker, 1999). This indicates the level of consistency of daily rumination and daily bonding within persons. The ICC for daily rumination was 0.45, indicating a moderate level of variability in daily rumination between persons, with a moderate level of within-person variability. For the daily bonding measure, the ICC was 0.57, again showing moderate levels of between-person variability and, consistent with our hypothesis, moderate levels of within-person daily variability.

We report the means and standard deviations of each variable and their zero-order correlations in Table 1.

Hypothesis 1. Are daily rumination and daily bonding negatively correlated on the same day, after accounting for daily mood? Are daily rumination and daily mood negatively correlated on the same day after accounting for daily bonding?

To test hypothesis 1a, we next examined the concurrent relationships between daily variables at Time 1 (see Table 2 for regression coefficients). To test hypothesis 1a, daily bonding was entered as the outcome and daily rumination and daily mood were entered as the predictors. As expected, daily rumination was negatively associated with daily bonding after controlling for daily mood, while positive mood was associated with greater daily bonding.

To test hypothesis 1b, examining whether daily rumination and daily mood were negatively related, a new model was constructed with daily mood entered as the outcome and daily rumination and daily bonding entered as the predictors. As expected, daily rumination was negatively associated with daily mood after controlling for daily bonding, while greater daily bonding was associated with more positive daily mood.

Hypothesis 2. Is there a prospective relationship between daily bonding, daily ruminative self-focus and daily mood?

Next we tested hypothesis 2, whether there were prospective relationships between daily bonding, ruminative self-focus and mood (Table 3). To test hypothesis 2a, whether T1 daily rumination would separately and prospectively predict T2 daily bonding and T2 daily mood, we first created a model where we entered daily bonding at T2 as the outcome variable. We then entered T1 daily rumination, T1 daily mood and T1 daily bonding as predictors. Contrary to our hypothesis, higher daily rumination at T1 did not prospectively predict lower daily

Table 1
Pearson correlations and summary of means and standard deviations of the measured variables.

Variable	1	2	3	4	5	6	7	8	*M*	*SD*	Range
1 EPDS	–								9.60	5.90	0–25
2 RRS (Total)	.66**	–							46.80	17.90	26–93
3 RRS (Brooding)	.72**	.84**	–						10.31	4.01	5–20
4 RRS (Reflection)	.56**	.79**	.76**	–					6.90	3.10	4–14
5 PBQ	.56**	.56**	.51**	.45**	–				36.30	12.23	25–89
6 Daily Mood	.54**	.38**	.50**	.31**	.31**	–			6.90	2.10	1–10
7 Daily Bonding	.24	.15	.21	.03	.13	.14	–		8.30	2.10	1–10
8 Daily Rumination	.42**	.40**	.44**	.35**	.29**	.24*	.40**	–	8.20	3.90	3–18

Note: *p < .05, **p < .01, ***p < .001; EPDS = Edinburgh Postnatal Depression Scale; RRS = Response Styles Questionnaire (dispositional rumination); RRS (brooding) = Response Style Questionnaire brooding subscale; RRS (Reflection) = Response Styles Questionnaire reflection subscale; PBQ = Postpartum Bonding Questionnaire.

Table 2
Concurrent relationships between daily variables at T1: hypotheses 1a and b.

Outcome	Predictors	*b (SE)*	*t*	*p*
Daily bonding	Daily rumination	−.15 (.03)	5.03	<.001
	Daily mood	.36 (.03)	12.13	<.001
Daily mood	Daily bonding	.47 (.05)	9.40	<.001
	Daily rumination	−.39 (.04)	9.75	<.001
Daily rumination	Daily bonding	-. 21 (.05)	4.20	<.001
	Daily mood	−.42 (.04)	10.10	<.001

Table 3
Prospective relationships between daily variables at T1 and T2: hypotheses 2a and b.

Outcome	Predictors	*b (SE)*	*t*	*p*
Daily bonding T2	Daily rumination T1	.04 (.05)	.80	.210
	Daily mood T1	−.04 (.05)	−.80	.210
	Daily bonding T1	.17 (.04)	4.25	<.001
Daily mood T2	Daily bonding T1	.07 (.04)	1.75	.042
	Daily rumination T1	.009 (.05)	.18	.430
	Daily mood T1	.09 (.05)	1.80	.038
Daily rumination T2	Daily bonding T1	.07 (.04)	1.75	.042
	Daily mood T1	.03 (.05)	.06	.476
	Daily Rumination T1	.13 (.04)	3.25	<.001

Notes: T = time.

bonding at T2 after controlling for daily mood and bonding at T1, nor did daily mood at T1 predict daily bonding at T2. Only daily bonding at T1 predicted daily bonding at T2.

We then tested another model, entering daily mood at T2 as the outcome variable, and simultaneously entering T1 daily bonding, T1 daily rumination and T1 daily bonding. Again, contrary to expectations, T1 daily rumination did not predict T2 daily mood after controlling for T1 daily mood. However, consistent with hypothesis 2b, T1 daily bonding did predict T2 daily mood. Daily mood at T1 also predicted daily mood at T2.

Next, to examine hypothesis 2b, we tested another model, firstly entering daily rumination at T2 as the outcome. We simultaneously entered T1 daily bonding, T1 daily mood, and T1 daily rumination. Daily bonding at T1 was a significant predictor of T2 daily rumination after controlling for T1 daily rumination. Daily rumination at T1 was also a significant predictor of T2 daily rumination, but daily mood at T1 was not a significant predictor of T2 daily rumination.

Hypothesis 3. Does higher baseline rumination and lower baseline bonding predict higher mean levels of daily rumination and lower mean levels of daily bonding, independent of depressive symptoms?

We firstly constructed a multilevel model with RRS trait brooding and reflective subscales, baseline bonding (PBQ) and depressive symptoms (EPDS) entered as predictors and daily rumination included as the outcome variable (hypothesis 3a, Table 4). Baseline brooding and depressive symptoms both predicted higher mean levels of daily

Table 4
Associations between mean dispositional factors, daily bonding and daily rumination: hypotheses 3a and b.

Outcome	Predictors	*b (SE)*	*t*	*p*
Daily rumination	EPDS	.39 (.23)	1.70	.047
	RRS (Brooding)	.35 (.22)	1.59	.057
	RRS (Reflective)	−.03 (0.20)	−0.15	.440
	PBQ	.06 (.22)	0.27	.395
Daily bonding	EPDS	.51 (.42)	1.21	.115
	RRS (Brooding)	.54 (.36)	1.50	.068
	RRS (Reflective)	−.57 (.29)	−1.79	.038
	PBQ	.17 (.38)	.45	.326

Notes: EPDS = Edinburgh 0050ostnatal Depression Scale; RRS = Ruminative Response scale; PBQ = Postpartum Bonding Questionnaire.

rumination. Contrary to expectations however, neither baseline bonding nor baseline reflection predicted mean levels of daily rumination.

We then constructed a model with depressive symptoms (EPDS), baseline brooding and baseline reflection and baseline bonding (PBQ) as the predictors and daily bonding as the outcome variable (hypothesis 3b, Table 4). In partial support of hypothesis 3b, baseline reflection predicted lower mean ratings of daily bonding. Also in contradiction to the expectations of hypothesis 3, baseline brooding was positively associated with daily bonding, with a higher bonding score on the scale constituting a poorer bond, but did not reach significance in the model. Contrary to expectations. Neither depressive symptoms nor baseline bonding predicted mean levels of daily bonding.

4. Discussion

This study, using a diary approach, provided new evidence for the prospective relationship between daily perceived maternal bonding and subsequent daily rumination and mood. Congruent with Stern's (1991) position that maternal perceived bonding is malleable, we found that a mother's day-to-day feelings of bonding with her infant varied.

We found that maternal feelings of being bonded with the infant were associated both concurrently and prospectively with lower levels of rumination and more positive mood, after controlling for levels of rumination and mood either on the concurrent day or earlier day. Concurrently, mothers who reported higher levels of daily rumination also reported feeling less bonded with their infant(s). Feelings of poorer bonding on one day was associated with increases in daily rumination and negative mood the next day.

In sum, the prospective nature of this study's findings suggests that daily feelings of low bonding have both an immediate and prospective effect on both rumination and low mood. This has important implications for understanding the relationship between maternal cognitive strategies and depressive mood. Although the generalizability of these findings to mothers with more severe depression symptoms is unknown, one possible clinical implication of these findings is that therapists working with mothers with postnatal depression may wish to include

weekly assessments of perceived bonding, and address both the thoughts and contextual factors contributing to these feelings, as this may help to support reduced rumination and its associated impact on continued depressive mood.

Contrary to our predictions, we did not find evidence that daily levels of rumination predicted later bonding or mood. This finding is in contrast to previous research demonstrating prospective (e.g., Nolen--Hoeksema, 2000) and causal relationships (e.g., Lyubomirsky, Kasri, & Zehm, 2003) between rumination and mood, and rumination and the mother-infant interaction (Stein et al., 2012; Tester-Jones et al., 2015). However, the lack of this relationship in the current study may be due to the relatively low numbers of mothers with more severe depressive symptoms in our sample (although there were some participants experiencing more severe symptoms). That is, although women's rumination levels did vary day to day, the majority of our sample may not have been experiencing the same levels of uncontrollability and negativity in their ruminative thoughts as individuals with higher levels of depressive symptoms might have (Nolen-Hoeksema, 2000). Further, the way rumination impacts on the mother-infant relationship may vary by which aspect of the relationship is measured. In this study, we measured the mother's felt closeness with the infant. Previous studies that have examined the causal impact of rumination on the mother-infant relationship have assessed how sensitively and responsively the mother interacts with the infant (Stein et al., 2012, Tester-Jones, Karl, Watkins & O'Mahen, 2016). Rumination may therefore have a causal impact on maternal behaviour, but may not, in individuals with few or mild depressive symptoms, have a prospective influence on her felt closeness with her infant. Additional studies are needed to replicate these results and further test the conditions under which rumination predicts or is predicted by the mother-infant relationship. However, together these studies suggest that there may be unique and specific ways in which maternal cognitive processes such as rumination impact on different parts of the maternal-infant relationship (i.e., felt bonding versus sensitive maternal interactions/behaviours versus ability to demonstrate "mind-mindedness" and empathy for infant).

Consistent with previous literature (Moberly & Watkins, 2008), we also found that higher trait levels of brooding rumination were associated with higher mean levels of daily ruminative self-focus, even after controlling for depressive symptoms. In multilevel analyses, we found that higher levels of trait reflection, but not trait brooding, was related to greater perceived daily bonding. These findings are consistent with results that daily brooding rumination was not associating with daily bonding. Although we did not predict that trait reflection would be associated with better perceived bonding, these results are broadly consistent with research that has found reflection is associated with greater well-being and life satisfaction (Boyraz & Kuhl, 2015; Harrington & Loffredo, 2010). In comparison, brooding has been associated primarily with depressed mood. Most of our sample reported mild to moderate depressive symptoms, and this may provide one explanation as to why a relationship between brooding and bonding was not observed as hypothesized in this study. It is possible that ruminative reflection, as a neutral, analytical style of thinking with a focus on problem-solving, may support more responsive parental behaviours and fewer negative attributions for infant and/or parental behaviours that together may uphold views of bonding, even in the face of stressors. Future research is needed to test these relationships further, however there is scope to consider both bonding and reflective capacity as potential intervention targets that could be engaged in mothers with mild to moderate depressive symptoms.

A recent systematic review suggests that a range of strategies including educational and behavioural programmes, and psychosocial interventions can be effective in promoting parental bonding across and range of symptom severity (Mascheroni & Ionio, 2019). Providing social and peer mentorship at an individual level or dyadic interventions teaching parenting techniques such as infant massage and singing lullabies (e.g., Cheng, Volk, & Marini, 2011; Persico et al., 2017) may also

be viable routes to providing education about infant cues to parents, and this could be achieved through support from and engagement with community and family health service providers. Such interventions may look to specifically improve and target an increase in reflective capacity by supporting the development of parental problem-solving skills, or mindfulness techniques, which have been found to be associated with reflective rumination in healthy participants (Alleva, Roelofs, Voncken, Meevissen, & Alberts, 2014). It is noteworthy however, that such interventions may be most effective when they focus on improving bonding or increasing reflective capacity as the primary outcome (Poobalan et al., 2007), rather than being secondary to an intervention aimed at reducing depressive symptoms.

We found, unexpectedly, that a measure of general perceived bonding was not associated with mean levels of daily bonding. Although the reasons for this are not clear, this could be due to the fact that our measure of general perceived bonding may be prone to social desirability reporting biases (e.g., "the baby doesn't seem to be mine," "my baby is the most beautiful baby in the world"). Furthermore, trait bonding may not reflect a mothers day to day felt closeness with her infant in response to context specific situations. The mothers in this sample reported high levels of general bonding and there was low variability in their responses. The greater mean variability in overall reports of our daily measure of feelings of closeness to the baby indicate that it may be a more direct and context-sensitive assessment of bonding. To further evaluate the validity of daily measures of the mother-infant relationship, future research should assess the mother-infant relationship using a broader set of concepts. For example, it could assess infant behaviours and actions the mother noticed during the day, how she responded to infant behaviours, or her perceived speed of response to specific daily behaviours. Case vignettes providing normalising examples of mothers who do not always feel close and bonded to their infants could also support honest responses in both general and daily assessments of measures. New technology such as wearable head cameras may also make daily observations of mother-infant behaviour possible. Relatedly, it is important to consider that maternal depressed mood may influence the way bonding is perceived. For example, a mother who is experiencing depressive symptoms and related feelings such as guilt, self-criticism and shame, may perceive her bonding to be less effective. This is regardless of the actual quality of the bonding-related behaviours, and even if they are the same as they would be at time when her depression symptoms are lessened. It is therefore possible that depressive symptoms could bring about inaccurate, negatively biased perceptions of maternal bonding, which further emphasises the important of a broader range of measures to assess maternal bonding.

It is important to consider these findings carefully and within the context of the varying social and cultural beliefs, values, norms and knowledge which can shape and determine how a woman perceives, interprets, and deals with motherhood, her mood, her approach to bonding and her emotion regulation techniques. Uriko (2021) eloquently describes the experience of motherhood as being tied to both time, and social and cultural factors. As such, the findings of the present study would be better informed by more qualitative approaches to capture the complex interplay between the experiences of motherhood, bonding and mood at the individual level, and explore this across cultures.

4.1. Limitations

One limitation of this study is the method by which assessments of daily rumination, bonding and maternal mood were made. The daily diary method relied on retrospective reports of the entire day. Such retrospective reports of affective and cognitive daily experiences throughout the day can be vulnerable to recall bias (Stone et al., 1998). Because current mood, rumination or bonding may affect recall of the day before, this may bias the diary reports, inflating the observed associations and possibly obscuring the effects of other, unmeasured

variables. However, the period of recall is still less than occurs in other studies that use recollections over longer periods of time. Although Ecological Momentary Assessment (EMA) approaches that randomly "alert" individuals to respond to queries several times a day may further decrease problems with retrospective bias, such approaches must be weighed against the burden they pose to mothers of young infants, who already manage intensive daily caring schedules. In this study, we found that reporting once per day resulted in good rates of response, although it was achieved with regular reminders and outreach by the primary author (MTJ), suggesting we may have achieved a balance between participant burden and the ability to gather more frequent assessments. Shared method variance may also inflate the associations among variables. This risk could be ameliorated by combining observational and self-report measures, and where possible, physiological measures (i.e., wristwatches that gather heart-rate information).

A second limitation of this study is the way in which ruminative self-focus was operationalised. The three-item scale used in this study was adapted from a novel assessment of ruminative self-focus used by Moberly and Watkins (2008) and assessed key elements of rumination including a self-focus on emotions, and an evaluative and analytical thinking style. However, future research examining maternal rumination may consider also capturing the self-focused nature of repetitive thought in mothers and how this impacts on bonding. This may be best captured using Experience Sampling Methods that enhance the probability of capturing spontaneous rumination, rather than diary approaches that still rely on retrospective accounts. It is also possible in this study that reporting on rumination may have biased subsequent reports of mood and bonding, by encouraging the respondent to think specifically about those times when they were self-focusing and evaluating. However, given that the assessment of rumination was not explicitly focused on any aspects of negative affect, it was judged that the impact would be minimal.

Third, it is important to note that data was not collected on the specific content of daily ruminations. Although it is conceivable that perceived disruption in maternal bonding may lead mothers to ruminate on the perceived disruption and what they may be doing wrong, this is only one possible explanation. In this study, participants who reported daily rumination may have been ruminating about perceived disruptions in bonding or any number of other topics unrelated to bonding. Future research may consider capturing the content of rumination in order to further tease out these potential relationships.

Lastly, as the design was correlational, unmeasured covariates, such as stressful life events, infant health and temperament, and the couple relationship may also explain some of the variance in the relationships between bonding, rumination and mood. Data on a range of covariates that might have explained some of the variance were not collected due to participant burden. Given the challenges associated with data collection among this population we did strive to make questionnaires and the daily diary as brief and manageable as possible. This was crucial for successful recruitment and completion rates. Although data on infant age were collected, this was not a focus, and preliminary analysis revealed that it was not a significant predictor of rumination, perceptions of closeness with infant or maternal mood. As such, this covariate was not included in the final analysis. An associated limitation is that demographic data were collected sparsely, and the majority of our sample self-reported as white and educated to degree level. This does limit our ability to generalise the findings to an extent. It is recommended that more stringently controlled models may be used in the future with larger sample sizes and a wider demographic.

Finally, it is noted that this study does not collect data on how much time each day the mothers in this sample spend with their infants or whether they are the primary care-givers. Both of these factors, along-side the potential impacts of maternal employment, could have implications for mother-infant bonding, and its relationship with rumination (e.g. Kim & Wickrama, 2021). Future research in this area should aim to provide further insight into these potentially complicated contributing factors.

5. Conclusions

In conclusion, this study contributes to our understanding of how ruminative thinking occurs in real-life, everyday contexts and settings and in response to real emotional experiences between mother and infant. By exploring daily ratings of ruminative thought, bonding and mood, we found that self-reported difficulties in bonding with infant play a role in the daily experience of dysphoric mood and ruminative thinking. Conversely, we did not demonstrate that rumination drives poorer bonding and lower maternal mood. These findings contribute to our understanding of the temporal relationships between rumination, bonding and mood at a daily level and about how specific cognitive processes such as rumination are associated with the mother's feelings of closeness with her infant. Clinically, the results of this study suggest a potential role for the early screening of perceived difficulties in the mother-infant relationship as a preventative factor in the development of maternal dysphoric mood as well as targeting the role of ruminative thinking in mothers experiencing low mood in the postnatal period.

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CRediT authorship contribution statement

Michelle Tester-Jones: Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Visualization, Project administration. **Nicholas J. Moberly:** Methodology, Formal analysis, Visualization, Writing – review & editing. **Anke Karl:** Writing – review & editing, Supervision. **Heather O'Mahen:** Conceptualization, Methodology, Formal analysis, Writing – original draft, Visualization, Supervision.

Declaration of competing interest

None.

Data availability

The authors do not have permission to share data.

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