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Postpartum maternal sleep and mothers' perceptions of their attachment relationship with the infant among women with a history of depression during pregnancy

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Abstract

This study assessed the links between maternal sleep and mothers' perceptions of their attachment relationship with their infant among women at risk for postpartum depression by virtue of having been depressed during pregnancy. Sixty-two mothers completed sleep diaries and questionnaires at 3 and 6 months postpartum. Regression analyses, controlling for depression severity and infant temperament, revealed significant prospective correlation between maternal shorter total sleep time at 3 months and lower scores on a mother–infant attachment questionnaire at 6 months. At 6 months, the longer time mothers were awake tending to their infants the lower were their attachment scores. The findings suggest that improving sleep of mothers who suffered from prenatal depression may have a positive effect on mothers' self-reported relationship with their infants.

Keywords

attachment, depression, infant, mother, sleep

Introduction

In the present study, we aimed to examine the prospective links between mothers' sleep in the postpartum and their perceived attachment relationship with their infants in a sample of women who experienced major depressive disorder during pregnancy. The importance of studying women with prenatal depression has been highlighted through findings demonstrating that women with a history of prenatal depression are at increased risk for postnatal depression and their infants are at increased risk for various negative developmental outcomes (Field, 2011).

Prenatal depression and early infant development

A growing body of literature demonstrates the adverse effects of maternal prenatal depression on early infant development and behavior (Dunkel Schetter & Tanner, 2012; Field, 2011; Goodman & Gotlib, 1999; Kinsella & Monk, 2009). Specifically, prenatal depression has been associated with preterm delivery and with lower birth weight (Dunkel Schetter & Tanner, 2012; Grote et al., 2010). It has also been linked to infant lower vagal tone, greater relative right frontal electroencephalography (EEG) asymmetry, and less optimal scores on the Brazelton Scale (Dierckx et al., 2009; Field, 2011; Jones et al., 1998). Other studies have reported that infants of prenatally depressed mothers have more negative affect and behavioral reactivity (Davis et al., 2004; Huot, Brennan, Stowe, Plotsky, & Walker, 2004; McGrath, Records, & Rice, 2008; Zuckerman, Bauchner, Parker, & Cabral, 1990), more fussiness and sleep problems (Field et al., 2004), and a more difficult temperament overall (Davis et al., 2007). Moreover, prenatal depression has been associated with internalizing and externalizing behavior problems in infants and toddlers (de Bruijn, van Bakel, & van Baar, 2009; Field, 2011).

Among the primary mechanisms to explain the abnormal outcomes in infants of depressed pregnant women are heritability, fetal exposure to higher maternal cortisol levels, and reduced urinary artery blood flow to the fetus. It is assumed that these mechanisms may increase the risk of infants being born with dysfunctional neuro-regulatory systems (Goodman & Gotlib, 1999; Kinsella & Monk, 2009).These dysfunctional systems, in turn, may predict infant negative temperament and the development of childhood psychopathology (Field, 2011; Goodman & Gotlib, 1999).

Prenatal and postnatal depression and attachment

In addition to the effects of maternal prenatal depression on infant development and behavior, some studies found that maternal depression during pregnancy is also associated with negative

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maternal perceptions of their attachment relationships with the fetus and with the infant (McFarland et al., 2011; Perry, Ettinger, Mendelson, & Le, 2011; Yarcheski, Mahon, Yarcheski, Hanks, & Cannella, 2009). However, most studies testing these links have focused on the postpartum period. These studies demonstrate a strong link between the presence of maternal postnatal depression and increased levels of infant insecure attachment (Martins & Gaffan, 2000), increased parenting stress, more negative attachment-related cognitions, and more negative feelings towards the infant, such as anger and hostility (Cornish et al., 2006; Milgrom & McCloud, 1996).

Maternal sleep deprivation and functioning

Studies of sleep deprivation in adults have consistently shown a negative impact of sleep loss on individuals' cognitive, social, and emotional functioning and especially on functions mediated by the prefrontal cortex (Chang, Pien, Duntley, & Macones, 2010; Dahl, 1996; Dinges et al., 1997; Horne, 1985; Kahn-Greene, Killgore, Kamimori, Balkin, & Killgore, 2007; Pilcher & Huffcutt, 1996; Walker, 2009; Zohar, Tzischinsky, Epstein, & Lavie, 2005). Most sleep deprivation studies have been conducted in controlled laboratory settings. Parents of young children constitute a population that is frequently sleep-deprived, yet this population has received little scientific attention. A few studies examined sleep in parents of children with special needs or chronic illnesses (e.g., epilepsy, atopic eczema), finding that children's sleep disruptions were significantly associated with parental sleep deprivation, fatigue, stress, and depressed mood (Cottrell & Khan, 2005; Moore, David, Murray, Child, & Arkwright, 2006). Similar links between child sleep, maternal sleep, and maternal functioning were reported in a group of healthy pre-school and school-age children and their mothers (Meltzer & Mindell, 2007). Together, these studies suggest that parental sleep deprivation (resulting mainly from child sleep disruptions) may contribute to lower parental mood, parenting stress, and maladaptive caregiver functioning.

Interestingly, although parental sleep is dramatically curtailed during the first six postpartum months (Chang et al., 2010; Gay, Lee, & Lee, 2004; Hunter, Rychnovsky, & Yount, 2009; Swain, O'Hara, Starr, & Gorman, 1997), only a few studies have examined the links between parental sleep loss and parental functioning during this critical period of child development. During the first months of life, most infants wake up regularly during the night and many instances of night-waking come to parental attention and require their intervention (Anders, Halpern, & Hua, 1992; Goodlin-Jones, Burnham, Gaylor, & Anders, 2001; Mindell, 1993; Mindell, Kuhn, Lewin, Meltzer, & Sadeh, 2006; Sadeh, Tikotzky, & Scher, 2010). However, there are large individual differences between infants in the number and duration of night-wakings (Burnham, Goodlin-Jones, Gaylor, & Anders, 2002). Thus, whereas the sleep of some parents is mildly affected, the sleep of others may be severely restricted and disturbed.

A few studies have demonstrated that *maternal* sleep loss in the postpartum is significantly associated with higher levels of depressive symptoms (Chang et al., 2010; Dorheim, Bondevik, Eberhard-Gran, & Bjorvatn, 2009a; Goyal, Gay, & Lee, 2009) and that disrupted infant sleep is associated with maternal emotional distress (Dennis & Ross, 2005; Murray, 1992; Ross, Murray, & Steiner, 2005). Moreover, several studies found that infant sleep predicts maternal mood and that treating infant sleep problems reduces maternal emotional distress (Armstrong, Van Haeringen, Dadds, & Cash, 1998; Hiscock, Bayer, Hampton, Ukoumunne, & Wake, 2008; Hiscock & Wake, 2001, 2002; Wake et al., 2006). One of these studies found that the infant sleep intervention also had a positive effect on mothers' reported relationship with the child (Hiscock et al., 2008).

It has been suggested that the links between infant sleep problems and maternal low mood may be mediated by disrupted maternal sleep; that is, infant night-wakings impact maternal mood by producing maternal chronic sleep disruptions (Armstrong, O'Donnell, McCallum, & Dadds, 1998; Hall, Clauson, Carty, Janssen, & Saunders, 2006; Ross et al., 2005). For example, Hiscock and Wake (2001) reported that infant sleep problems were correlated with poorer maternal mental health, though when mothers self-rated their own sleep quality as high these links were weakened.

Whereas this growing body of evidence highlights the complex links between maternal emotional distress, maternal sleep, and infant sleep, there is a paucity of research looking at *maternal* sleep deprivation in relation to infant behavior and development (e.g., temperament) or the mother–infant relationship (e.g., attachment). In a recent study we reported that poor maternal sleep was a significant predictor of maternal perception of sadness in her infant (measured by a subscale of the Infant Behavior Questionnaire—revised; Tikotzky, Chambers, Gaylor, & Manber, 2010).

Aims and hypothesis of the study

Prenatal and postpartum psychological distress/depression have been found to adversely affect infant development and the early mother–infant relationship. However, little is known about how maternal sleep disturbances impact the mother–infant relationships and the perceptions and feelings mothers have regarding their infants. Maternal perceptions toward their infants are of great significance because they may determine the quality of the early mother–infant relationship, influence maternal behavior, and predict later child developmental outcomes (Bugental & Johnston, 2000; Cornish et al., 2006; Pauli-Pott, Mertesacker, Bade, Haverkock, & Beckmann, 2003; Teti & Towe-Goodman, 2008; Tikotzky & Sadeh, 2009). Thus, in the present study, we aimed to examine the prospective links between mothers' sleep at 3 months postpartum and their perceived attachment relationship with their infants 3 months later in a sample of women who experienced major depressive disorder during pregnancy.

We hypothesized that more disturbed maternal sleep patterns at 3 months postpartum would predict more negative perceptions of the mother–infant attachment relationship with the infant at 6 months postpartum. Although most women in the sample did not meet a diagnosis of depression during the postpartum period, we controlled for depressive symptom severity during the postpartum. Infant temperament was also included in this study as a control variable because research suggests that infant temperament and attachment are significantly related (Zeanah & Fox, 2004).

Methods

This study was a naturalistic follow-up of women who participated in a larger randomized controlled study testing the efficacy of acupuncture as a treatment for major depressive disorder during pregnancy compared to two control treatments (control

acupuncture and massage) (Manber et al., 2010). All women were depressed during pregnancy and therefore at risk for postpartum depression (Bonari et al., 2004). The parent study focused only on the pregnancy phase. The present study focused on postpartum data collected at 3 and 6 months postpartum, after study treatments were discontinued. Demographic information was collected at study entry during pregnancy. The university institutional review board of Stanford University approved the protocol and all participants signed a written informed consent at the time of enrollment.

Participants and procedure

The parent study randomized 150 expectant women who were recruited through targeted advertising in parent and baby publications and from local clinics. To be included in the parent study, participants had to have viable pregnancies, be between 12 and 30 weeks gestation, 18 years or older, meet criteria for Major Depression Disorder (MDD) according to the Diagnostic and Statistical Manual for Mental Disorders, fourth edition, text revision (DSM-IV-TR; American Psychiatric Association, 2000), determined by the Structured Clinical Interview for the DSM-IV (SCID; First, Spitzer, Gibbon, & Williams, 1995), and score at least 14 on the 17-item Hamilton Rating Scale for Depression (HRSD; Hamilton, 1967). A comprehensive description of the exclusion criteria and the treatment study findings can be found in Manber et al. (2010). Briefly, participants were excluded if they took psychoactive medications, received psychotherapy, had abnormal thyroid function, or had concomitant psychiatric or medical conditions that could impact depression.

To participate in the present study women had to have provided data for the following three measures of interest: (a) sleep (prospective sleep diaries); (b) depression severity (HRSD); and (c) perceptions of the mother–infant relationship (Maternal Postnatal Attachment Questionnaire [MPAQ]). These selection criteria were met by 62 mothers (41.3%) of the 150 who were originally randomized in the parent study. Reasons for exclusion were as follows: (a) 33 mothers did not attend the 3-month assessment visit and 17 mothers did not attend the 6-month assessment visit; and (b) 38 mothers did not complete the sleep diaries and/or the attachment questionnaire. Analysis of variance (ANOVA) revealed no significant differences between the 62 mothers who participated in the present follow-up study and the 88 who did not in baseline (during pregnancy) depression scores, number of previous depression episodes, and demographic characteristics (age, income, education, number of previous pregnancies, number of children).

Sleep and depression data were collected at 3 and 6 months postpartum. The maternal attachment questionnaire was completed only at 6 months postpartum. The attachment questionnaire and sleep diaries were mailed to participants prior to the assessment visit with the instruction to complete the sleep diaries a week before the scheduled visit. The maternal depression interviews were conducted by raters blind to treatment assignment. These raters also interviewed women to decide if MDD criteria (DSM-IV-TR) were met using the depression module of the SCID (First et al., 1995).

Of the infants, 53% of the present sample (33 boys, 29 girls) were firstborns, followed up at mean age 2.7 months ($SD = 0.4$) and 5.9 months ($SD = 0.6$). Exclusive breastfeeding was reported by 62% and 46% at the two follow-up contacts, respectively.

Measures

Depression. Depression severity was measured with the Hamilton Rating Scale for Depression (HRSD) (Hamilton, 1967). The HRSD is a semi-structured interview, commonly used to assess depression and has good psychometric properties (Ramos-Brieva & Cordero-Villafafila, 1988). In this study, the HRSD was administered by interviewers blind to treatment assignment. The intraclass correlation of raters was 0.96 for the total HRSD score. Because the three sleep items of the HRSD were significantly correlated with the sleep diary measures, we omitted the HRSD sleep items from the scale (Manber et al., 2005). Based on our data, the HRSD without the sleep items (HRSD-S) has good internal consistency, with a Cronbach's alpha coefficient of 0.89.

Sleep diaries. Maternal sleep was measured by prospective sleep diaries for a week prior to the HRSD assessment. Sleep diaries are commonly used in sleep research and have been validated relative to objective sleep measures such as polysomnography (Monk et al., 1994). Mothers were instructed to complete the diary in the morning. The derived measures included in the present study were: (a) maternal total sleep time (time from sleep onset to wake-up time, excluding wakefulness during the night); (b) maternal subjective rating of sleep quality on a 1–10 Likert scale, anchored at the two extremes ("rate the quality of your sleep last night: 1 = *excellent*; 10 = *very poor*"); (c) number of times the mother woke up to attend to her infant during the night; and (d) length of time in minutes the mother attended to her infant during the night. Each of the sleep diary variables was averaged across the 1-week assessment period.

Maternal Postnatal Attachment Questionnaire (MPAQ). The Maternal Postnatal Attachment Questionnaire (MPAQ; Condon & Corkindale, 1998) assesses self-rated maternal feelings toward her infant and perceptions of the mother–infant relationship. It includes 19 items scored on a five-point scale. Thus the possible range of scores for the general scale is 19 to 95. The MPAQ assesses four dimensions: pleasure in proximity (a desire for proximity, enjoyment of interaction); acceptance (lack of resentment about the impact of the infant upon parent's lifestyle); tolerance (absence of feelings of anger and hostility towards the infant); and (parental) competence. As suggested by Condon and Corkindale (1998), we combined the acceptance and tolerance subscales into a single subscale. Higher scores on each subscale indicate more intense positive perceptions and feelings towards the infant. The MPAQ has acceptable levels of internal consistency and test–retest reliability (Condon & Corkindale, 1998) and it is significantly associated with the Attachment Q-Set (an observer-rated scale of attachment; Feldstein, Hane, Morrison, & Huang, 2004). Cronbach's alphas for the present sample were: general scale .88; proximity subscale .68; acceptance/tolerance subscale .83; and competence subscale .65.

Infant temperament. Infant temperament was assessed with the Infant Behavior Questionnaire Revised (IBQ-R; Gartstein & Rothbart, 2003). In this study, we used the negative affectivity factor, which is based on the following subscale: sadness, distress to limitation, fear, falling reactivity (see Gartstein & Rothbart, 2003, for a detailed description). The falling reactivity scale includes five nighttime sleep items, which were omitted from the analysis to

Table 1. Descriptive statistics of main study variables

	Mean	*SD*	Min.	Max.
3 months PP				
Total sleep time (hours)	7.73	1.19	4.98	11.12
Min. awake for infant	50.0	36.6	0	192.5
N. of night-wakings	2.27	1.54	0	10.43
Sleep quality	4.67	1.93	1.00	9.00
HRSD	5.31	4.63	0	20.00
6 months PP				
Total sleep time (hours)	7.61	1.24	4.08	12.5
Min. awake for infant	34.0	32.0	0	161.0
N. of night-wakings	2.08	1.76	0	8.71
Sleep quality	5.16	1.92	1.00	8.57
HRSD	5.75	5.60	0	25.00
MPAQ general-S	80.52	9.48	56.32	93.00
MPAQ proximity	35.29	3.48	24.33	40.00
MPAQ acceptance/tolerance	22.65	4.66	13.00	30.00
MPAQ competence	22.58	2.39	14.99	25.00

Notes. PP = postpartum; HRSD = Hamilton Rating Scale for Depression; Min. awake for infant = maternal minutes awake at night to attend to the infant; N. of night-wakings = number of times mother woke up to attend to the infant; Sleep quality = subjective sleep quality (higher numbers representing poorer sleep quality); MPAQ = Maternal Postnatal Attachment Questionnaire.

avoid multicolinearity because of overlap with the maternal sleep variables.

Results

Descriptive statistics and preliminary analyses

Demographic background. Mean age of the mothers during intake was 33.3 ($SD = 4.5$). Self-reported racial distribution was as follows: 70% Caucasian; 10% Asian; 1.7% African American; 18.3% other. Highest education level obtained was as follows: 3.2% completed high school; 14.5% achieved some college education; 46.8% achieved a college degree; 35.5% finished graduate school. Household income distribution at intake: 11.3% earned less than US$20,000; 21% earned between US$20,000 and US$70,000; 67.7% had an income higher than US$70,000.

All mothers met criteria for MDD during pregnancy at study baseline. However, only four of the 62 mothers (6.5%) met DSM-IV-TR criteria for MDD at the 3 months postpartum assessment and seven (11.3%) met MDD criteria at the 6 months postpartum assessment, based on the SCID. Women who met MDD criteria at the follow-up assessments had higher HRSD scores than women who did not (HRSD $M = 19.2$, $SD = 2.2$ vs. $M = 5.3$, $SD = 4.0$ at 3 months postpartum; and $M = 18.4$, $SD = 5.7$ vs. $M = 5.4$, $SD = 4.0$ at 6 months postpartum). Overall, the range of HRSD scores in our sample was wide (Table 1).

Comparison between randomization groups on MPAQ scores. We examined whether there were any differences in our primary outcome variables (the attachment questionnaire scores) as a function of the original randomization group during pregnancy. No significant differences were found on any of the attachment scale scores between women who during pregnancy received acupuncture specifically designed to address depression and women who received the control treatments (control acupuncture or massage). Therefore the randomization group was not entered into subsequent analysis.

Descriptive statistics of main study variables. Means and standard deviations of the main variables are described in Table 1. The average number of reported infant night-wakings and the scores of perceived mother–infant attachment found in our sample of mothers who were depressed during pregnancy are comparable to previous reports in community samples (Condon & Corkindale, 1998; Sadeh, 2004; Scher, 1991; Tikotzky & Sadeh, 2009).

Changes in sleep patterns and depression severity over time. Repeated measures ANOVAs were conducted to examine change over time in the depression and sleep variables from 3 to 6 months postpartum (Table 1). The only significant change observed was a decrease in the length of time mothers spent attending to the infant at night, Wilks' Lambda = .85, $F(1, 56) = 10.24$, $p < .005$.

There were significant correlations between: (a) HRSD at 3 and 6 months ($r = .61$, $p < .0005$); (b) total sleep time at 3 and 6 months ($r = .47$, $p < .0005$); (c) maternal self-rated sleep quality at 3 and 6 months ($r = .36$, $p < .005$); (d) number of times mothers woke up to attend to their infant at 3 and 6 months ($r = .56$, $p < .0005$); and (e) length of time mothers attended to their infant during the night at 3 and 6 months ($r = .46$, $p < .005$).

Correlations between the sleep measures, HRSD, and MPAQ scores

Table 2 presents Pearson correlations between the sleep measures and HRSD scores at 3 and 6 months postpartum, and MPAQ scores at 6 months postpartum.

Shorter total sleep time at 3 months postpartum was significantly associated with lower scores on the MPAQ general scale at 6 months and with lower scores on the proximity subscale and the acceptance/tolerance subscale. In addition, there were significant positive concomitant correlations between total sleep time and the MPAQ general scale and the proximity subscale at 6 months. Moreover, the longer the mother spent tending the infant at night at 6 months postpartum, the lower were the scores on the MPAQ general scale and on the proximity and acceptance/tolerance subscales at 6 months (Table 2).

There were also significant negative prospective correlations between HRSD (depression severity) scores at 3 months postpartum and maternal perception of attachment at 6 months postpartum: Higher HRSD scores at 3 months postpartum were significantly associated with lower MPAQ scores on the general scale and lower scores on the three MPAQ subscales (proximity, acceptance-tolerance, and competence) at 6 months postpartum. There were also concomitant negative associations between maternal depression scores and perceived attachment scores at 6 months postpartum (Table 2).

Partial correlations controlling for depression

Because HRSD scores were significantly associated with the MPAQ scores, partial correlations (controlling for depression severity) were calculated to examine whether depression severity mediates the associations between maternal sleep and perceived

Table 2. Pearson correlation between depression scores, sleep variables, and the MPAQ

	MPAQ general scale	MPAQ proximity	MPAQ acceptance/tolerance	MPAQ competence
HRSD 3 m	−.42***	−.36***	−.36***	−.42***
HRSD 6 m	−.52***	−.42***	−.49***	−.48***
TST (3 m)	.35**(^)	.31*(^)	.35***(^)	.23
Min awake (3 m)	−.01	.01	.02	−.09
N. of NW (3 m)	−.03	−.01	−.08	.05
Sleep quality (3 m)	−.04	−.03	−.07	.03
TST (6 m)	.27*	.36**(^^)	.21	.11
Min. awake (6 m)	−.33*(^^)	−.32*(^^)	−.31*(^^)	−.23
N. of NW (6 m)	−.08	−.07	−.13	.02
Sleep quality (6 m)	−.19	−.16	−.17	−.19

Notes. (^) identifies correlations that remained significant after controlling for HRSD scores at 3 and 6 months postpartum; (^^) identifies correlations that remained significant after controlling for HRSD scores at 6 months postpartum; MPAQ = Maternal Postnatal Attachment Questionnaire; HRSD 3 m = Hamilton Rating Scale for Depression at 3 months postpartum; TST 3 m = total sleep time 3 months postpartum; Min. awake = minutes awake at night to attend to the infant; N. of NW = number of times mother woke up to attend to her infant; Sleep quality = subjective sleep quality.
*$p < .05$; **$p < .01$; ***$p < .005$.

Table 3. Multiple regression analysis

	MPAQ general scale		MPAQ proximity		MPAQ acceptance/tolerance	
Predictors	β	Explained variance	β	Explained variance	β	Explained variance
Infant NA	−.29*	7.3%	−.18	2.8%	−.33**	9.0%
HRSD 3 m	−.03	0.0%	−.01	0.3%	.002	.00%
HRSD 6 m	−.26	4.0%	−.19	2.1%	−.24	3.5%
TST 3 m	.28*	5.3%	.21.7	3.1%	.30*	6.1%
TST 6 m	−.09	0.1%	5.4	0.2%	−.12	0.9%
Min awake 6 m	−.27*	5.1%	−.15.5	1.7%	−.31*	6.9%

Notes. MPAQ = Maternal Postnatal Attachment Questionnaire; infant NA = infant negative affectivity; HRSD 3 m = Hamilton Rating Scale for Depression 3 months postpartum; TST = total sleep time; Min. awake = minutes awake at night to attend to the infant.
*$p < .05$; **$p < .01$.

mother–infant attachment. Most of the correlations between maternal sleep and MPAQ scores remained significant even after controlling for depression severity. After controlling for HRSD at 3 and 6 months postpartum, significant prospective partial correlations were found between maternal total sleep time at 3 months postpartum and the MPAQ general score ($r = .28$, $p < .05$), MPAQ acceptance/tolerance subscale ($r = .30$, $p <. 05$), and the MPAQ proximity subscale ($r = .26$, $p < .05$), measured at 6 months postpartum. Moreover, shorter total sleep time at 6 months postpartum was associated with lower scores on the MPAQ proximity subscale ($r = .34$, $p < .05$). In addition, after controlling for 6 months' HRSD, significant negative concomitant partial correlations were found between the time the mother attended to her infant at night and the MPAQ general score ($r = -.33$, $p < .05$), the acceptance/tolerance subscale ($r = -.31$, $p < .05$), and the proximity subscale ($r = -.31$, $p < .05$). Thus the longer the mothers were awake attending to their infants, the lower were their perceived attachment scores, even after controlling for depression severity.

Multiple regression analysis

In order to assess which of the variables that were significantly correlated with the MPAQ scores contributed uniquely to the variability in perceived mother–infant attachment, we conducted multiple regression analysis. We conducted separate standard multiple regression analysis for the MPAQ general scale, the proximity subscale, and the acceptance-tolerance subscale. (We did not test a model for the MPAQ competence subscale because its correlations with the sleep variables were not significant.) The models included HRSD scores at 3 and 6 months postpartum and the sleep variables that were significantly associated with the MPAQ (total sleep time at 3 and 6 months postpartum and the length of time the mother tended to her infant at night at 6 months postpartum).

To examine whether infant temperament should be included as a control variable in the model we first computed Pearson correlations between the IBQ-R negative affectivity and each of the MPAQ scales. Higher scores on infant negative affectivity (e.g., more difficulty) were significantly associated with lower scores on the general MPAQ scale ($r = -.45$, $p < .0005$), on the acceptance/tolerance subscale ($r = -.44$, $p < .0005$), on the proximity subscale ($r = -.34$, $p < .01$) and on the competence subscale ($r = -.41$, $p < .001$). Therefore infant negative affectivity was controlled for in the regression analyses.

The regression models explained (adjusted R square) 40.3% of the variance in the MPAQ general scale ($F = 6.19$, $p < .0005$), 44.5% of the variance in the acceptance/tolerance subscale ($F = 7.34$, $p < .0005$), and 23.7% of the variance in the proximity subscale ($F = 2.84$, $p < .05$). The following variables were significant predictors of the MPAQ general scale and of the acceptance/tolerance subscale: (a) negative affectivity score at 6 months; (b) total sleep time at 3 months; and (c) time awake attending to the infant at night at 6 months. The proximity subscale was not significantly predicted by the different variables (see Table 3 for standardized beta and percent of variance explained by the different predictors).

Discussion

Previous studies have highlighted the complex links between maternal emotional distress, maternal sleep, and infant sleep (Dennis & Ross, 2005; Hiscock et al., 2008; Murray, 1992; Ross et al., 2005). However, the question whether poor maternal sleep might negatively affect mother–infant relationship has previously received little attention. To our knowledge, the present study is the first to investigate the links between maternal sleep patterns in the postpartum period and mothers' perceptions of their attachment relationship with the infant in women who have been depressed during pregnancy.

The findings revealed that shorter maternal sleep duration at 3 months postpartum was significantly associated with a more negative mother–infant relationship at 6 months postpartum, as perceived by the mother, even after controlling for maternal depression severity and infant temperament. The prospective (3 months to 6 months) nature of this link supports the possibility that maternal sleep loss leads to a more negative subjective experience of attachment to the infant. We also found significant concomitant links between the duration of time mothers were tending to their infants at night at 6 months postpartum and their perceived attachment relationship, after controlling for maternal depression severity and infant temperament. The longer the mothers were awake at night to care for their infants the lower were their perceived attachment scores.

In order to understand which particular aspects of the mother–infant relationship were related to maternal sleep, we examined the links with the four subscales of the MPAQ. Shorter sleep duration at 3 months postpartum predicted lower scores on the acceptance/tolerance subscale at 6 months. This finding suggests that mothers who had been sleep deprived earlier in the postpartum period were more likely to later report having lower levels of tolerance and patience when interacting with their infants, and were more likely to feel that the infant interferes with their personal life and interests. These results are consistent with past observations of a negative impact of experimental sleep deprivation on emotional regulation (mainly irritability, affective volatility, expression of frustration; Dinges et al., 1997; Kahn-Greene, Lipizzi, Conrad, Kamimori, & Killgore, 2006; Walker, 2009; Zohar et al., 2005).

Little is known about the mechanisms underlying the links between sleep loss and affect management. However, it may be possible that, in women with prenatal depression, the general fatigue, irritability, low energy levels, and frustration tolerance associated with sleep deprivation interfere with the sleep-deprived mothers' ability to interact calmly and patiently with their infant. It could be that minor disruptive interactions with the infant (e.g., infant crying, feeding difficulties) are emotionally amplified when the mother is sleep deprived, and positive signals (e.g., infant smiling) are not experienced as strongly pleasant under conditions of sleep deprivation. These possibilities are in line with Zohar et al. (2005), who suggested that "sleep loss amplifies the negative emotive effects of disruptive events while reducing the positive effect of goal-enhancing events" (p. 47). Under the circumstances of sleep loss, the infant's demands and needs may be experienced as a burden and may lead to feelings of anger and even resentment. Of course, these speculative explanations need to be tested, ideally using direct observations of mother–infant interactions.

Our findings may also suggest that, at 6 months postpartum, the mother's need to tend to her infant for prolonged time during the night may have led to resentment and anger about the infant's negative impact on her personal life and free time. However, because of the concomitant nature (6 months to 6 months) of this finding, the opposite direction of explanation is also plausible—that is, mothers who had more negative perceptions of their relationship with their infants might have been more likely to overestimate the time they were awake at night to tend to the infant.

The fact that only the acceptance/tolerance subscale was significantly predicted by maternal sleep may suggest that attachment subscales that are closer to the concept of emotional regulation (i.e., acceptance/tolerance) are more likely to be associated with sleep loss than other attachment subscales. Moreover, although Pearson correlations between maternal depression scores and the MPAQ scores were stronger than the correlations between maternal sleep and the MPAQ scores, depression severity was not a significant predictor of the MPAQ in the regression analyses. Because infant temperament did significantly predict the variance of the general MPAQ score and the acceptance/tolerance subscale, it is possible that the link between maternal depression severity and perceived attachment is mediated by infant temperament. Future controlled studies are needed to test these assertions in normative and larger samples of mothers.

It is not clear if our results will generalize to women without a history of depression during pregnancy. A large literature has demonstrated the negative effect of prenatal depression on infant outcomes (Davis et al., 2007; Field, 2011; Jones et al., 1998) and some studies have demonstrated that prenatal depression is associated with lower mother–infant attachment (McFarland et al., 2011; Perry et al., 2011; Yarcheski et al., 2009). Although most of the women in the present study were not depressed during the postpartum assessment, we cannot rule out the possibility that their history of depression influenced their sleep, behavior, and perceptions of their relationships with the infants. To test whether our results generalize to women without a history of depression during pregnancy, future research should focus on a normative sample of women and with assessments conducted at similar postpartum stages. Because the prevalence of depression during pregnancy is high and similar to its prevalence during the postpartum (3–14%; Eberhard-Gran, Tambs, Opjordsmoen, Skrondal, & Eskild, 2004; Heron, O'Connor, Evans, Golding, & Glover, 2004), we believe that our results are clinically relevant even if they are not generalizable to normative samples.

An important strength of this study is the use of a longitudinal design enabling the assessment of the predictive relationships between maternal sleep and her perceived relationship with the infant. Another strength of the study is that the assessment of maternal depression was based on a structured clinical interview, and not on a self-rating scale, thereby reducing the problem of shared method variance. Our study also has some limitations that need to be considered. One limitation of the study is that the sample consisted mainly of middle- to high-income, primarily Caucasian women. Another limitation is that we did not collect body mass index (BMI) data which could have been related to sleep duration. Others are the absence of objective measures of sleep (e.g., actigraphy; Dorheim, Bondevik, Eberhard-Gran, & Bjorvatn, 2009b; Tikotzky & Sadeh, 2001) and the absence of observational assessment of the mother–infant attachment (Seifer, Sameroff, Barrett, & Krafchuk, 1994). Thus it could be that sleep loss is associated "only" with a perceptual bias of the emotional quality of the relationships and not with their "objective" quality. However, a growing body of research on normative and clinical samples suggests that maternal perceptions may serve as early markers of later mother–infant relational and behavioral outcomes and should

therefore be considered as important constructs to study (Bugental & Johnston, 2000; Teti & Gelfand, 1997; Teti & Towe-Goodman, 2008; Tikotzky & Sadeh, 2009).

Conclusions and clinical implications

Previous studies have demonstrated: (a) prospective links between maternal prenatal depression and infant negative outcomes; (b) links between maternal depressive symptoms and negative maternal perception of the mother–infant relationship; (c) a negative impact of sleep loss on mood and emotion regulation in adults; (d) associations between child sleep disruptions and poor parental sleep, fatigue, mood, and stress.

The present study suggests that, among those who have been depressed in pregnancy, the amount of sleep mothers get during the postpartum may be related to mothers' perception of their relationship with their infant and therefore deserves further attention. Because maternal sleep loss is common and to some degree inevitable during the early postpartum months, future research will need to explore the extent and persistence of sleep loss that is detrimental to maternal–infant attachment in mothers with prenatal depression and in normative samples. These studies will inform the field when and with whom to intervene.

Clinicians working with depressed pregnant women and mothers who are at risk for depression should be aware of the possible negative implications of insufficient sleep and take steps to address the problem. Previous studies have suggested that improving sleep of mothers who are depressed may have a positive effect on both mothers' mood and their perceptions of their relationship with the infant (Hiscock et al., 2008). Our findings further suggest that this may be true also for women who suffered from major depression during pregnancy and are at risk for postpartum depression. Given the correlational nature of our study and the absence of a control group, these clinical implications are not definitive.

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References

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.

Anders, T. F., Halpern, L. F., & Hua, J. (1992). Sleeping through the night: A developmental perspective. *Pediatrics*, *90*, 554–560.

Armstrong, K. L., O'Donnell, H., McCallum, R., & Dadds, M. (1998). Childhood sleep problems: Association with prenatal factors and maternal distress/depression. *Journal of Paediatrics and Child Health*, *34*, 263–266.

Armstrong, K. L., Van Haeringen, A. R., Dadds, M. R., & Cash, R. (1998). Sleep deprivation or postnatal depression in later infancy: Separating the chicken from the egg. *Journal of Paediatrics and Child Health*, *34*, 260–262.

Bonari, L., Pinto, N., Ahn, E., Einarson, A., Steiner, M., & Koren, G. (2004). Perinatal risks of untreated depression during pregnancy. *Canadian Journal of Psychiatry*, *49*, 726–735.

Bugental, D. B., & Johnston, C. (2000). Parental and child cognitions in the context of the family. *Annual Review of Psychology*, *51*, 315–344.

Burnham, M. M., Goodlin-Jones, B. L., Gaylor, E. E., & Anders, T. F. (2002). Nighttime sleep–wake patterns and self-soothing from birth to one year of age: A longitudinal intervention study. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *43*, 713–725.

Chang, J. J., Pien, G. W., Duntley, S. P., & Macones, G. A. (2010). Sleep deprivation during pregnancy and maternal and fetal outcomes: Is there a relationship? *Sleep Medicine Review*, *14*, 107–114.

Condon, J. T., & Corkindale, C. J. (1998). The assessment of parent-to-infant attachment: Development of a self-report questionnaire instrument. *Journal of Reproductive and Infant Psychology*, *16*, 57–76.

Cornish, A. M., McMahon, C. A., Ungerer, J. A., Barnett, B., Kowalenko, N., & Tennant, C. (2006). Maternal depression and the experience of parenting in the second postnatal year. *Journal of Reproductive and Infant Psychology*, *24*, 121–132.

Cottrell, L., & Khan, A. (2005). Impact of childhood epilepsy on maternal sleep and socioemotional functioning. *Clinical Pediatrics*, *44*, 613–616.

Dahl, R. E. (1996). The regulation of sleep and arousal: Development and psychopathology. *Development and Psychopathology*, *8*, 3–27.

Davis, E. P., Glynn, L. M., Schetter, C. D., Hobel, C., Chicz-Demet, A., & Sandman, C. A. (2007). Prenatal exposure to maternal depression and cortisol influences infant temperament. *Journal of the American Academy of Child and Adolescent Psychiatry*, *46*, 737–746.

Davis, E. P., Snidman, N., Wadhwa, P. D., Glynn, L. M., Schetter, C. D., & Sandman, C. (2004). Prenatal maternal anxiety and depression predict negative behavioral reactivity in infancy. *Infancy*, *6*, 319–331.

de Bruijn, A. T. C. E., van Bakel, H. J. A., & van Baar, A. L. (2009). Sex differences in the relation between prenatal maternal emotional complaints and child outcome. *Early Human Development*, *85*, 319–324.

Dennis, C. L., & Ross, L. (2005). Relationships among infant sleep patterns, maternal fatigue, and development of depressive symptomatology. *Birth: Issues In Perinatal Care*, *32*, 187–193.

Dierckx, B., Tulen, J. H., van den Berg, M. P., Tharner, A., Jaddoe, V. W., Moll, H. A., … Tiemeier, H. (2009). Maternal psychopathology influences infant heart rate variability: Generation R Study. *Psychosomatic Medicine*, *71*, 313–321.

Dinges, D. F., Pack, F., Williams, K., Gillen, K. A., Powell, J. W., Ott, G. E., … Pack, A. I. (1997). Cumulative sleepiness, mood disturbance, and psychomotor vigilance performance decrements during a week of sleep restricted to 4–5 hours per night. *Sleep*, *20*, 267–277.

Dorheim, S. K., Bondevik, G. T., Eberhard-Gran, M., & Bjorvatn, B. (2009a). Sleep and depression in postpartum women: A population-based study. *Sleep*, *32*, 847–855.

Dorheim, S. K., Bondevik, G. T., Eberhard-Gran, M., & Bjorvatn, B. (2009b). Subjective and objective sleep among depressed and non-depressed postnatal women. *Acta Psychiatrica Scandinavica*, *119*, 128–136.

Dunkel Schetter, C., & Tanner, L. (2012). Anxiety, depression and stress in pregnancy: Implications for mothers, children, research, and practice. *Current Opinion in Psychiatry*, *25*, 141–148.

Eberhard-Gran, M., Tambs, K., Opjordsmoen, S., Skrondal, A., & Eskild, A. (2004). Depression during pregnancy and after delivery: A repeated measurement study. *Journal of Psychosomatic Obstetrics and Gynaecology*, *25*, 15–21.

Feldstein, S., Hane, A. A., Morrison, B. M., & Huang, K. Y. (2004). Relation of the postnatal attachment questionnaire to the attachment Q-set. *Journal of Reproductive and Infant Psychology*, *22*, 111–121.

Field, T. (2011). Prenatal depression effects on early development: A review. *Infant Behavior and Development*, *34*, 1–14.

Field, T., Diego, M., Dieter, J., Hernandez-Reif, M., Schanberg, S., Kuhn, C., … Bendell, D. (2004). Prenatal depression effects on the fetus and the newborn. *Infant Behavior & Development*, *27*, 216–229.

First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. W. (1995). *Structured clinical interview for DSM-IV axis I disorders—Patient edition (SCID-I/P, Version 2.0)*. New York, NY: Biometrics Research Department, New York State Psychiatric Institute.

Gartstein, M. A., & Rothbart, M. K. (2003). Studying infant temperament via the revised infant behavior questionnaire. *Infant Behavior & Development*, *26*, 64–86.

Gay, C. L., Lee, K. A., & Lee, S. Y. (2004). Sleep patterns and fatigue in new mothers and fathers. *Biological Research for Nursing*, *5*, 311–318.

Goodlin-Jones, B. L., Burnham, M. M., Gaylor, E. E., & Anders, T. F. (2001). Night waking, sleep–wake organization, and self-soothing in the first year of life. *Journal of Developmental and Behavioral Pediatrics*, *22*, 226–233.

Goodman, S. H., & Gotlib, I. H. (1999). Risk for psychopathology in the children of depressed mothers: A developmental model for understanding mechanisms of transmission. *Psychological Review*, *106*, 458–490.

Goyal, D., Gay, C., & Lee, K. (2009). Fragmented maternal sleep is more strongly correlated with depressive symptoms than infant temperament at three months postpartum. *Archives of Women's, Mental Health*, *12*, 229–237.

Grote, N. K., Bridge, J. A., Gavin, A. R., Melville, J. L., Iyengar, S., & Katon, W. J. (2010). A meta-analysis of depression during pregnancy and the risk of preterm birth, low birth weight, and intrauterine growth restriction. *Archives of General Psychiatry*, *67*, 1012–1024.

Hall, W. A., Clauson, M., Carty, E. M., Janssen, P. A., & Saunders, R. A. (2006). Effects on parents of an intervention to resolve infant behavioral sleep problems. *Pediatric Nursing*, *32*, 243–250.

Hamilton, M. (1967). Development of a rating scale for primary depressive illness. *British Journal of Social and Clinical Psychology*, *6*, 278–296.

Heron, J., O'Connor, T. G., Evans, J., Golding, J., & Glover, V. (2004). The course of anxiety and depression through pregnancy and the postpartum in a community sample. *Journal of Affective Disorders*, *80*, 65–73.

Hiscock, H., Bayer, J. K., Hampton, A., Ukoumunne, O. C., & Wake, M. (2008). Long-term mother and child mental health effects of a population-based infant sleep intervention: Cluster-randomized, controlled trial. *Pediatrics*, *122*, E621–E627.

Hiscock, H., & Wake, M. (2001). Infant sleep problems and postnatal depression: A community-based study. *Pediatrics*, *107*, 1317–1322.

Hiscock, H., & Wake, M. (2002). Randomised controlled trial of behavioural infant sleep intervention to improve infant sleep and maternal mood. *British Medical Journal*, *324*, 1062–1065.

Horne, J. A. (1985). Sleep function, with particular reference to sleep deprivation. *Annals of Clinical Research*, *17*, 199–208.

Hunter, L. P., Rychnovsky, J. D., & Yount, S. M. (2009). A selective review of maternal sleep characteristics in the postpartum period. *Journal of Obstetric, Gynecologic and Neonatal Nursing*, *38*, 60–68.

Huot, R. L., Brennan, P. A., Stowe, Z. N., Plotsky, P. M., & Walker, E. F. (2004). Negative affect in offspring of depressed mothers is predicted by infant cortisol levels at 6 months and maternal depression during pregnancy, but not postpartum. *Annals of the New York Acadamy of Sciences*, *1032*, 234–236.

Jones, N. A., Field, T., Fox, N. A., Davalos, M., Lundy, B., & Hart, S. (1998). Newborns of mothers with depressive symptoms are physiologically less developed. *Infant Behavior & Development*, *21*, 537–541.

Kahn-Greene, E. T., Killgore, D. B., Kamimori, G. H., Balkin, T. J., & Killgore, W. D. (2007). The effects of sleep deprivation on symptoms of psychopathology in healthy adults. *Sleep Medicine*, *8*, 215–221.

Kahn-Greene, E. T., Lipizzi, E. L., Conrad, A. K., Kamimori, G. H., & Killgore, W. D. S. (2006). Sleep deprivation adversely affects interpersonal responses to frustration. *Personality and Individual Differences*, *41*, 1433–1443.

Kinsella, M. T., & Monk, C. (2009). Impact of maternal stress, depression and anxiety on fetal neurobehavioral development. *Clinical Obstetrics and Gynecology*, *52*, 425–440.

Manber, R., Blasey, C., Arnow, B., Markowitz, J. C., Thase, M. E., Rush, A. J., … Keller, M. B. (2005). Assessing insomnia severity in depression: Comparison of depression rating scales and sleep diaries. *Journal of Psychiatric Research*, *39*, 481–488.

Manber, R., Schnyer, R. N., Lyell, D., Chambers, A. S., Caughey, A. B., Druzin, M., … Allen, J. J. B. (2010). Acupuncture for depression during pregnancy: A randomized controlled trial. *Obstetrics and Gynecology*, *115*, 511–520.

Martins, C., & Gaffan, E. A. (2000). Effects of early maternal depression on patterns of infant–mother attachment: A meta-analytic investigation. *Journal of Child Psychology and Psychiatry*, *41*, 737–746.

McFarland, J., Salisbury, A. L., Battle, C. L., Hawes, K., Halloran, K., & Lester, B. M. (2011). Major depressive disorder during pregnancy and emotional attachment to the fetus. *Archives of Women's Mental Health*, *14*, 425–434.

McGrath, J. M., Records, K., & Rice, M. (2008). Maternal depression and infant temperament characteristics. *Infant Behavior & Development*, *31*, 71–80.

Meltzer, L. J., & Mindell, J. A. (2007). Relationship between child sleep disturbances and maternal sleep, mood, and parenting stress: A pilot study. *Journal of Family Psychology*, *21*, 67–73.

Milgrom, J., & McCloud, P. (1996). Parenting stress and postnatal depression. *Stress Medicine*, *12*, 177–186.

Mindell, J. A. (1993). Sleep disorders in children. *Health Psychology*, *12*, 151–162.

Mindell, J. A., Kuhn, B., Lewin, D. S., Meltzer, L. J., & Sadeh, A. (2006). Behavioral treatment of bedtime problems and night wakings in infants and young children—An American academy of sleep medicine review. *Sleep*, *29*, 1263–1276.

Monk, T. H., Reynolds, C. F., Kupfer, D. J., Buysse, D. J., Coble, P. A., Hayes, A. J., … Ritenour, A. M. (1994). The Pittsburgh sleep diary. *Journal of Sleep Research*, *3*, 111–120.

Moore, K., David, T. J., Murray, C. S., Child, F., & Arkwright, P. D. (2006). Effect of childhood eczema and asthma on parental sleep and well-being: A prospective comparative study. *British Journal of Dermatology*, *154*, 514–518.

Murray, L. (1992). The impact of postnatal depression on infant development. *Journal of Child Psychology and Psychiatry*, *33*, 543–561.

Pauli-Pott, U., Mertesacker, B., Bade, U., Haverkock, A., & Beckmann, D. (2003). Parental perceptions and infant temperament development. *Infant Behavior & Development*, *26*, 27–48.

Perry, D. F., Ettinger, A. K., Mendelson, T., & Le, H. N. (2011). Prenatal depression predicts postpartum maternal attachment in low-income Latina mothers with infants. *Infant Behavior & Development*, *34*, 339–350.

Pilcher, J. J., & Huffcutt, A. I. (1996). Effects of sleep deprivation on performance: A meta-analysis. *Sleep*, *19*, 318–326.

Ramos-Brieva, J. A., & Cordero-Villafafila, A. (1988). A new validation of the Hamilton rating scale for depression. *Journal of Psychiatric Research*, *22*, 21–28.

Ross, L. E., Murray, B. J., & Steiner, M. (2005). Sleep and perinatal mood disorders: A critical review. *Journal of Psychiatry & Neuroscience*, *30*, 247–256.

Sadeh, A. (2004). A brief screening questionnaire for infant sleep problems: Validation and findings for an Internet sample. *Pediatrics*, *113*, E570–E577.

Sadeh, A., Tikotzky, L., & Scher, A. (2010). Parenting and infant sleep. *Sleep Medicine Review*, *14*, 89–96.

Scher, A. (1991). A longitudinal study of infant night waking in the first year. *Child: Care, Health and Development*, *17*, 295–302.

Seifer, R., Sameroff, A. J., Barrett, L. C., & Krafchuk, E. (1994). Infant temperament measured by multiple observations and mother report. *Child development*, *65*, 1478–1490.

Swain, A. M., O'Hara, M. W., Starr, K. R., & Gorman, L. L. (1997). A prospective study of sleep, mood, and cognitive function in postpartum and nonpostpartum women. *Obstetrics and Gynecology*, *90*, 381–386.

Teti, D. M., & Gelfand, D. M. (1997). The preschool assessment of attachment: Construct validity in a sample of depressed and nondepressed families. *Development and Psychopathology*, *9*, 517–536.

Teti, D. M., & Towe-Goodman, N. (2008). Postpartum depression, effects on child. In M. M. Haith & J. B. Benson (Eds.), *Encyclopedia of infant and early childhood development* (pp. 562–572). London, UK: Elsevier.

Tikotzky, L., Chambers, A. S., Gaylor, E., & Manber, R. (2010). Maternal sleep and depressive symptoms links with infant negative affectivity. *Infant Behavior & Development*, *33*, 605–612.

Tikotzky, L., & Sadeh, A. (2001). Sleep patterns and sleep disruptions in kindergarten children. *Journal of Clinical Child Psychology*, *30*, 579–589.

Tikotzky, L., & Sadeh, A. (2009). Maternal sleep-related cognitions and infant sleep: A longitudinal study from pregnancy through the first year. *Child Development*, *80*, 860–874.

Wake, M., Morton-Allen, E., Poulakis, Z., Hiscock, H., Gallagher, S., & Oberklaid, F. (2006). Prevalence, stability, and outcomes of cry-fuss and sleep problems in the first 2 years of life: Prospective community-based study. *Pediatrics*, *117*, 836–842.

Walker, M. P. (2009). The role of sleep in cognition and emotion. *Annals of the New York Acadamy of Sciences*, *1156*, 168–197.

Yarcheski, A., Mahon, N. E., Yarcheski, T. J., Hanks, M. M., & Cannella, B. L. (2009). A meta-analytic study of predictors of maternal–fetal attachment. *International Journal of Nursing Studies*, *46*, 708–715.

Zeanah, C. H., & Fox, N. A. (2004). Temperament and attachment disorders. *Journal of Clinical Child and Adolescent Psychology*, *33*, 32–41.

Zohar, D., Tzischinsky, O., Epstein, R., & Lavie, P. (2005). The effects of sleep loss on medical residents' emotional reactions to work events: A cognitive-energy model. *Sleep*, *28*, 47–54.

Zuckerman, B., Bauchner, H., Parker, S., & Cabral, H. (1990). Maternal depressive symptoms during pregnancy, and newborn irritability. *Journal of Developmental and Behavioral Pediatrics*, *11*, 190–194.