HHS Public Access

Author manuscript

J Fam Psychol. Author manuscript; available in PMC 2017 June 01.

Published in final edited form as:

J Fam Psychol. 2016 June ; 30(4): 431–441. doi:10.1037/fam0000198.

Bidirectional Associations between Bedtime Parenting and Infant Sleep: Parenting Quality, Parenting Practices, and their Interaction

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Abstract

In keeping with transactional conceptualizations of infant sleep development (Sadeh et al., 2010), the present study examined longitudinal, bidirectional linkages between bedtime parenting (direct observations of parenting practices and quality) and infant sleep across the first six months postpartum. In doing so, we also drew from Darling and Steinberg's (1993) conceptual model to examine parenting quality as a moderator of linkages between specific bedtime practices and infant sleep. Multilevel model analyses revealed that the strongest increases in infant nighttime sleep across the first six months occurred among infants of mothers who engaged in low levels of nursing at bedtime. Within-person linkages between mothers' emotional availability (EA) at bedtime, infant distress, and infant sleep were found, such that at time points when mothers were more emotionally available, infants were less distressed and slept more throughout the night. Several moderating effects of maternal EA on linkages between parenting practices and infant sleep were obtained that were consistent with predictions from Darling and Steinberg (1993). Higher maternal EA in combination with less close contact at bedtime was associated with more infant sleep across the night on average, and higher EA in combination with fewer arousing bedtime activities predicted more rapid increases in infant sleep with age. Finally, there was evidence of infant-driven effects, as higher infant nighttime distress predicted lower EA at subsequent time points. Results showcased the complex, reciprocal interplay between parents and infants in the development of infant sleep patterns and parenting behavior during the first six months postpartum.

Keywords

Parenting; infants; sleep; emotional availability; bedtime

Better quality of sleep is associated with improved cognitive and behavioral development in childhood (Jenni & Dahl, 2008). However, between one-quarter to one-third of infants have sleep difficulties (Mindell, Kuhn, Lewin, Meltzer, & Sadeh, 2006), and infant distress during night wakings represents a common parental concern (Bayer, Hiscock, Hampton, & Wake,

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2007). Previous research indicates that parenting quality and parental strategies used during bedtime both have important influences on infant nighttime sleep. Furthermore, transactional models suggest that infant sleep quality may influence parents' behavior at bedtime (Sadeh, Tikotzky, & Anat, 2010). However, only one study to-date has simultaneously examined both parenting quality and practices in this context (Teti, Kim, Mayer, & Countermine, 2010), and no study has addressed how their interaction may predict infant sleep. The current study used observational measures to study how parenting quality and practices at bedtime are uniquely and interactively associated with infant nighttime sleep across the first six months, and further, how infant nighttime sleep may predict parenting behaviors and quality. As mothers were the primary caregiver at bedtime in most study families, we specifically examined mothers' parenting.

Infant Sleep and Developmental Outcomes

During the first six months, sleep patterns undergo dramatic changes. Generally newborns do not have a pattern to their sleep and it is equally distributed across both day and night (Davis, Parker, & Montgomery, 2004). By six months most infants have consolidated nighttime sleep, which is defined by a reduction in the length and frequency of night wakings as well as the ability to sleep from bedtime to morning without requiring parental intervention (Galland, Taylor, Elder, & Herbison, 2012; Henderson, France, Owens, & Blampied, 2010). In many cases, infants are not actually in a sleep state throughout the entire nighttime, however. They have developed self-regulated sleep, which is the ability to fall back asleep on their own without signaling to their parents (Henderson et al., 2010). Although many infants establish these sleep patterns, there is substantial individual variability (Galland et al., 2012).

Sleep quality has been found to be a critical predictor of developmental outcomes in early childhood (Jenni & Dahl, 2008). Sleep promotes neural development and facilitates an alert daytime state that allows for learning (Sadeh, 2007). Better quality of sleep has been associated with higher scores on the mental development portion of the Bayley Scales (Scher, 2005) and less daytime irritability (DeLeon & Karraker, 2007) in infancy as well as better executive functioning in toddlerhood (Bernier, Carlson, Bordeleau, & Carrier, 2010). Together, this work highlights the importance of sleep in laying a foundation for later development.

Parenting Practices at Bedtime and Infant Sleep

Parents play an important role in helping their children to develop healthy sleeping patterns, and a number of studies have identified specific bedtime parenting practices that are predictive of sleep quality in infants. Several studies have found that parental presence at bedtime and at night predicts more frequent infant night waking (Cronin, Halligan, & Murray, 2008). In particular, longer time spent in contact with the infant, such as for feeding or co-sleeping, has been associated with more frequent and longer night wakings (Mao, Burnham, Goodlin-Jones, Gaylor, & Anders, 2004). The working hypothesis behind these findings is that when infants consistently fall asleep with their parents present, they may not learn how to settle to sleep on their own (Cronin et al., 2008). Thus, these infants may become reliant on parental intervention upon waking during the night. Nursing has also been linked to more frequent infant night waking because breastmilk is digested more quickly than formula. Breastfed infants, therefore, wake up more often in part because they become hungry more often (Sadeh et al., 2010). Thus, the association between feeding and infant sleep must be examined separately for nursing and bottle-feeding. Finally, there is evidence that infants' ability to sleep is compromised in stimulating environments, although this work has not examined parent-created stimulation (Fajardo, Browning, Fisher, & Patton, 1990). Drawing from these literatures, we examined close contact, nursing, bottle-feeding, and arousing activities at bedtime as predictors of infant sleep.

In addition to studying concurrent relations between parenting practices and infant sleep, the present study is unique in examining how parenting predicted change in infant sleep quality over time, as well as how within-person variation in a mother's bedtime practices was linked to her infant's sleep. Specifically, we investigated whether infants slept better on nights when their mothers used less close contact, feeding, and arousing activities at bedtime. To our knowledge, no prior study has examined how observational measures of parenting predicted change in infant sleep and how variation within a mother's parenting are linked to variations in infant sleep.

Parenting Quality at Bedtime and Infant Sleep

In contrast to the amount of published work on parenting practices and infant sleep, comparatively few studies have examined linkages between parenting quality and infant sleep. Work examining the association between maternal sensitivity during free play and infant sleep has been mixed, with some studies finding a significant association (Priddis, 2009) and others not (Scher, 2001). Additionally, a recent cross-sectional study found that more emotionally available parenting at bedtime predicted fewer mother-reported infant night wakings (Teti et al., 2010). Parental sensitivity at bedtime in particular may be critical for helping infants prepare for nighttime sleep. Because infants are tired at bedtime, they may require more parental assistance in regulating their arousal and emotions. Furthermore, as argued by Teti et al. (2010), falling asleep requires trust in the safety of the environment. Thus, by using comforting and soothing bedtime routines, mothers may promote better nighttime sleep. This study sought to further develop this idea by examining parenting quality at bedtime longitudinally and in concert with parenting practices. Within-person variation in parenting quality was also studied in order to test whether infants tended to sleep better on nights when parenting quality at bedtime was higher.

The current study examined parenting quality at bedtime via maternal emotional availability (EA). EA assesses the overall quality of emotional attunement and communication with the child and has been shown to be a reliable, valid measure of the quality of the parent-child relationship in numerous studies (Biringen, Derscheid, Vliegen, Closson, & Easterbrooks, 2014). With its emphasis on the emotional quality of the interaction, maternal EA may be particularly relevant to the bedtime context, which can be stressful for both parents and infants.

Interactive Influences of Parenting Quality and Practices

The work reviewed above highlights that research examining parenting quality and practices generally has not been integrated. However, theoretical and empirical support exists for examining their interactive influences. Darling and Steinberg (1993) argued that the emotional quality of a parent's interactions with their child moderates the influence of specific practices on developmental outcomes. Thus, in the context of a responsive, loving relationship with their child, a parent's practices may be more effective in promoting their socialization goals. Although few studies have tested this hypothesis, prior work with older children has found that mothers' use of power assertive discipline techniques was linked to greater child competence when mothers were more emotionally responsive to their children (Towe-Goodman & Teti, 2008) and to poorer outcomes in the context of lower maternal emotional support (McLoyd & Smith, 2002; Towe-Goodman & Teti, 2008). Applying this framework to infant bedtime, we suggest that reduced close contact and feeding at bedtime may better guide the infant to sleep when accompanied by soothing, sensitive parental responses to infant signals. In the absence of parental sensitive responsiveness, infants may be more distressed by parental termination of contact at bedtime. On the other hand, more arousing activities may exacerbate infant difficulty falling asleep when coupled with less sensitive parental responses to infant cues.

Infant Sleep Predicting Parenting

Although most research on parenting and infant sleep has focused on parenting as a predictor of infant sleep, transactional models suggest that poor infant sleep may predict the very parenting behaviors (e.g., feeding, close contact) that perpetuate more frequent infant waking (Sadeh et al., 2010). Infants who have trouble sleeping may elicit more parental presence at bedtime, which is thought to compromise an infant's ability to develop self-regulated sleep. Furthermore, frequent infant night waking can lead to sleep disruption that places parents at risk for increased distress and poorer parenting quality. For example, more frequent infant night waking is predictive of higher maternal depressive symptoms, and this association is likely attributable to mothers' sleep loss (Bayer et al., 2007). The parenting of mothers who are depressed, in turn, has been shown to be characterized by flat affect, intrusiveness, low contingent responsivity, and inattentiveness (Gelfand & Teti, 1990). Further, child sleep problems have been found to predict lower maternal sensitivity in a sample of older children (Bell & Belsky, 2008). In the current study, infant nighttime sleep was examined as a predictor of maternal close contact, feeding, and emotional availability at bedtime.

Current Study

The current study examined how bedtime parenting practices and quality were associated with infant sleep quality across the first 6 months. This study adds to the existing literature in several ways. First, parenting and infant sleep quality were assessed via behavioral coding of video recordings, rather than parental report. Additionally, parenting and infant sleep quality were studied longitudinally, which allowed for examination of bidirectional linkages between parenting and infant sleep and of within-person associations between variations in parenting and in infant sleep. We also incorporated a measure of arousing activities at bedtime, which has not been studied previously. Finally, the present study examined theoretically based (Darling & Steinberg, 1993) interactive influences of parenting practices and quality on infant sleep quality.

In order to isolate the associations between parenting and infant sleep quality, three covariates were also considered. Maternal depressive symptomology was entered in all analyses because it has been linked to more intrusive nighttime parenting behavior (Teti & Crosby, 2012) well as lower parenting sensitivity (Gelfand & Teti, 1990). Infant co-sleeping with a parent was considered as a covariate in the analyses predicting infant sleep because co-sleeping has been associated with more infant nighttime awakenings (Mao et al., 2004). Lastly, maternal sleep was examined as a covariate in the analyses predicting parenting because poorer sleep quality or duration may compromise parents' ability to be responsive and sensitive to their infants.

Hypotheses

The following hypotheses were proposed:

Hypothesis 1: Controlling for covariates, higher maternal emotional availability (EA) at bedtime will be associated with less infant distress and more sleep across the night concurrently and longitudinally, at both the within and between-person levels.

Hypothesis 2: Controlling for covariates, less maternal feeding, close contact, and arousing activities at bedtime will be associated with less infant nighttime distress and more sleep concurrently and longitudinally, at both the within and between-person levels.

Hypothesis 3: Controlling for covariates, the combination of higher maternal EA and less feeding, close contact, or arousing activities at bedtime will be associated with the least infant nighttime distress and most sleep concurrently and longitudinally. The combination of lower EA and more feeding, close contact, or arousing activities will be associated with the most nighttime distress and least sleep.

Hypothesis 4: Controlling for covariates, less infant nighttime distress and more sleep will predict higher maternal EA and less feeding and close contact at bedtime at later time points. There is no theory suggesting that poorer infant sleep quality would predict more arousing activities; thus, this relationship was not tested.

Methods

Participants

Participants were part of a longitudinal study of parenting, infant sleep, and infant development at a university in the Northeast U.S. All procedures were reviewed and approved by the Institutional Review Board. Mothers were recruited from local hospitals following the birth of their infants. Parents provided informed consent at the first home visit. One hundred sixty seven infants and their parents participated in the study when they were 1 month old (M_{age}=1.21, SD=.16). Follow-up assessments took place when infants were 3

(M_{age}=3.10, *SD*=.31) and 6 months (M_{age}=6.14, *SD* =.41). Due to the labor intensiveness of the parenting practices and infant sleep quality coding, a representative subsample of approximately 70% of the participants (116 families) from the original sample was coded. Because we originally intended to score the entire sample prior to the decision to reduce the coding burden, there were 7 families for whom nighttime sleep data was coded but who did not provide scorable bedtime data at any of the time points. This resulted in a final sample of 109 mothers and infants (46% male) who had data for at least one time point on all study variables and therefore could be included in the analyses. Infants were firstborns in 31% of the families. Eighty-four percent of mothers were married and living with their infant's father. Mothers' average age was 29.9 years old (*SD* = 5.4), and they ranged in age from 19 to 43 years old. Eighty percent of mothers were White, 6% were African-American, 6% were Latino, 4% were Asian-American, and 4% identified themselves as “Other.” Ninety percent of mothers completed some post-secondary education, and 57% were employed outside the home. Median yearly family income was $60,000 (*SD* = $53,000). The sub-sample did not significantly differ from the original sample on any demographic or study variables.

Videos

Video collection—At each time point project staff set up video equipment in the families' homes for one night in order to capture parent-infant interactions at bedtime and nighttime. Cameras were placed in locations where the infant was taken to prepare for bed, where the infant slept, and where the infant was taken upon awakening at night. Up to four cameras could be set up in the home. If the family indicated that an unusual event took place during the night (e.g., if the infant became ill), a new night of video of collected. For specific details regarding the video equipment and camera locations, please see Kim & Teti (2014). Three separate coding teams scored bedtime parenting practices, bedtime maternal EA, and nighttime infant state.

Maternal emotional availability coding—Maternal emotional availability during infant bedtime was coded using the Emotional Availability Scales (EAS; Biringen Robinson, & Emde, 1998). This system consists of four scales (sensitivity, structuring, nonintrusiveness, nonhostility) that are intended to capture the emotional quality of parental interactions with the child. Coders began scoring maternal EA once mothers and infants appeared on camera, and considered the bedtime to be complete following 5 consecutive minutes of infant sleep. EA is more often coded in parent-infant play contexts; thus, EA in this study was scored using the adaptations to the bedtime context described by Teti et al. (2010). Interrater reliability was established between two coders. Intraclass correlations (ICC's) for the scales ranged from .70-.99. A composite maternal EA score was created by converting the scores for each scale to *z* scores and taking the mean. The ICC for composite EA ranged from .98-.99. Internal consistency for EA was good (α = .74-.77). Eight percent of the sample was double-coded at each age.

Bedtime parenting practices coding—Feeding (breast or bottle), close contact, and arousing activities with the infant were scored for presence/absence for each 30 seconds of the bedtime video. Close contact was defined as the mother holding the infant on her chest.

Arousing activities were defined as interactions with the infant that increased his/her arousal level, such as tickling or physical stimulation (e.g., twirling the infant around). Summary codes reflecting the number of 30 second intervals mothers spent engaging in these practices were totaled for analysis. Coders began scoring videos once the infant appeared on screen and concluded when the infant was asleep for 5 consecutive minutes. Interrater reliability was established between 4 coders. Coders were required to code at least 15 reliability tapes and achieve an ICC above .70 for every code before they could code tapes on their own. Average ICC's for nursing, bottle-feeding, close contact, and arousing activities were .99, 1.00, .97, and .89, respectively. Ten percent of the sample was double-coded at 1 and 3 months and 8% at 6 months.

Nighttime infant sleep coding—Infant distress and sleep states and whether the infant was co-sleeping with a parent were scored for each 30 seconds of the nighttime video. Distress was defined by infant fussing or crying. Infants were scored as asleep when their eyes were closed and they were not making any gross motor movements. Co-sleeping was scored when infants were sleeping on the same surface as a parent. Summary codes representing the total number of intervals spent distressed, asleep, and co-sleeping were created from this coding. Coders began the nighttime coding during the 30 second epoch following the conclusion of bedtime coding and completed coding when infants were out of bed the following morning. This method of assessing infant sleep-wake state during the night, labeled videosomnography (Anders & Sostek, 1976), has some advantages compared to other measures. It is more objective than parental report and has greater specificity than actigraphy because the observer uses infant eye opening and vocalizations in addition to movement to determine state (Sitnick, Goodlin-Jones, & Anders, 2008). Prior work has found quality of infant sleep as measured from one night of videosomnography to be associated with parenting at bedtime (Anders, Halpern, & Hua, 1992).

Infant nighttime sleep quality coding was an intensive process that required between 5-10 hours per video, in addition to substantial time training on the coding scheme. Thus, there were over 30 coders for this project. Coders were required to code at least 8 reliability tapes and achieve an ICC above .70 for every code before they could code tapes on their own. Average ICC's for infant distress, infant sleep, and co-sleeping were .82, .93, and 1.0, respectively. Fifteen percent of the sample was double-coded at 1 and 3 months and 8% at 6 months.

Questionnaires

Maternal depression—At each time point mothers completed the depressive symptoms subscale of the Symptom Checklist-90-Revised, which has well-established reliability and validity (SCL-90-R; Derogatis, 1994). The questionnaire consists of 13 items that ask mothers about their symptoms within the past two weeks. Examples of items include “feeling hopeless about the future” and “feelings of worthlessness.” Participants respond on a 5-point Likert-type scale (0 = “not at all”; 4 = “extremely.”) A total was created by summing mothers' responses.

Maternal Sleep Quality

Actigraphy—Mothers' sleep quality was assessed across 7 days at each time point using Mini-Mitter Actigraphy wristwatches (Model AW-64), which contain accelerometers that measure activity and accompanying software that is used to determine sleep and wake states from the raw data. In the current study we examined the percent of time mothers spent asleep at night as well as sleep fragmentation index as potential predictors of bedtime parenting. The sleep fragmentation index is produced by an algorithm that takes into account the individual's activity level during sleep as well as how frequently sleep was interrupted by activity.

Results

Preliminary Analyses

In order to control for variation in bedtime and nighttime length, the summary codes for the bedtime parenting practices and nighttime infant sleep quality variables were divided by the total number of intervals coded. Bivariate correlations, means, and standard deviations for the main study variables are provided in Table 1.

Primary Analyses

To test study hypotheses, multilevel model analyses were run in SAS 9.4 using Proc Mixed. Two-level models were run. The models testing Hypotheses 1-3 predicted infant nighttime distress and infant sleep from the parenting variables and included time as the level 1 unit of analysis that was nested within each mother at level 2. Using multilevel models allowed us to account for the dependency in the data resulting from repeated observations of the same individuals. The models testing Hypothesis 4 predicted maternal EA and parenting practices from the infant variables and included time as the level 1 unit and infant as level 2. All analyses used maximum likelihood estimation to account for missing data in the dependent variables. Twenty seven infants were missing nighttime data for at least one time point because there was not sufficient data to score. However, 88% of the sample had data for at least two time points. Sixty-six mothers were missing parenting data for at least one time point because there was not sufficient data. Sixty percent of the sample had parenting data for at least two time points. Although this is a substantial proportion of missing data, simulation work indicates that in samples such as ours with more than 50 level 2 units, having only one measurement at level 1 does not considerably influence parameter estimates (Bell, Ferron, & Kromrey, 2008). Families with missing data did not differ from the larger sample.

Models predicting infant nighttime distress and infant sleep quality from parenting variables—The nested nature of the data required that we separate within-person associations from between-person associations. Estimates of within-person associations indicated how deviations in mothers' parenting were associated with their infant's sleep quality. Estimates of between-person associations represented how the parenting variables were associated with average infant sleep quality. Interaction terms with infant age were created in order to examine how parenting quality and practices were associated with change in infant sleep quality over time. The between- person estimates for the parenting practices variables were also multiplied by the between-person estimates for maternal EA in order to test whether maternal EA moderated the influence of parenting practices on infant sleep quality. These interactions were multiplied by infant age in order to test whether maternal EA moderated the influence of parenting practices on infant sleep quality over time. We examined both linear and quadratic change in the infant sleep variables. Lastly, we entered between-person and within-person effects for the percent of nighttime spent co-sleeping variable (M = .15, SD = .30) and maternal depressive symptoms variable (M = 7.05, SD = 7.16) into the models predicting infant sleep and distress. We also tested whether these covariates predicted change in infant sleep or distress over time by multiplying them by infant age.

The equations for the model predicting infant distress are depicted below. The equations for the model predicting infant sleep were identical.

Level 1

$$
\begin{aligned}
\mathrm{Distress}_{ai} = {} & \beta_{0i} + \beta_{1i}\mathrm{Age}_{ai} + \beta_{2i}(\mathrm{Age}_{ai} * \mathrm{Age}_{ai}) \\
& + \beta_{3i}\mathrm{EA}_{ai} + \beta_{4i}\mathrm{Close\ \ contact}_{ai} \\
& + \beta_{5i}\mathrm{Arousing\ \ acts}_{ai} \\
& + \beta_{6i}\mathrm{Nursing}_{ai} \\
& + \beta_{7i}\mathrm{Bottle\ \ feeding}_{ai} \\
& + \beta_{8i}\mathrm{Cosleeping}_{ai} \\
& + \beta_{9i}\mathrm{Maternal\ \ depression}_{ai} + e_{ai}
\end{aligned}
$$

Level 2

$$
\begin{aligned}
\beta_{0i} = {} & \gamma_{00} + \gamma_{01}\mathrm{EA}_{i} + \gamma_{02}\mathrm{Close\ \ contact}_{i} \\
& + \gamma_{03}\mathrm{Arousing\ \ acts}_{i} \\
& + \gamma_{04}\mathrm{Nursing}_{i} + \gamma_{05}\mathrm{Bottle\ \ feeding}_{i} \\
& + \gamma_{06}(\mathrm{EA}_{i} * \mathrm{Close\ \ contact}_{i}) \\
& + \gamma_{07}(\mathrm{EA}_{i} * \mathrm{Arousing\ \ acts}_{i}) + \gamma_{08}(\mathrm{EA}_{i} * \mathrm{Nursing}_{i}) \\
& + \gamma_{09}(\mathrm{EA}_{i} * \mathrm{Bottle\ \ feeding}_{i}) \\
& + \gamma_{10}\mathrm{Cosleeping}_{i} \\
& + \gamma_{11}\mathrm{Maternal\ \ depression}_{i} + \mu_{0i}
\end{aligned}
$$

$$\begin{aligned}\beta_{1i}=&\gamma_{10}+\gamma_{11}\text{EA}_i+\gamma_{12}\text{Close contact}_i\\&+\gamma_{13}\text{Arousing acts}_i\\&+\gamma_{14}\text{Nursing}_i+\gamma_{15}\text{Bottle feeding}_i\\&+\gamma_{16}(\text{EA}_i*\text{Close contact}_i)\\&+\gamma_{17}(\text{EA}_i*\text{Arousing acts}_i)+\gamma_{18}(\text{EA}_i*\text{Nursing}_i)\\&+\gamma_{19}(\text{EA}_i*\text{Bottle feeding}_i)\\&+\gamma_{20}\text{Cosleeping}_i\\&+\gamma_{21}\text{Maternal depression}_i+\mu_{1i}\end{aligned}$$

$$\begin{aligned}\beta_{2i}=&\gamma_{20}+\gamma_{21}\text{EA}_i+\gamma_{22}\text{Close contact}_i\\&+\gamma_{23}\text{Arousing acts}_i\\&+\gamma_{24}\text{Nursing}_i+\gamma_{25}\text{Bottle feeding}_i\\&+\gamma_{26}(\text{EA}_i*\text{Close contact}_i)\\&+\gamma_{27}(\text{EA}_i*\text{Arousing acts}_i)+\gamma_{28}(\text{EA}_i*\text{Nursing}_i)\\&+\gamma_{29}(\text{EA}_i*\text{Bottle feeding}_i)\\&+\gamma_{30}\text{Cosleeping}_i\\&+\gamma_{31}\text{Maternal depression}_i+\mu_{2i}\end{aligned}$$

Model predicting infant distress: The first model predicted the percent of the night the infant spent distressed. An unconditional model examining linear and quadratic change in distress was tested first. The results indicated that nighttime distress decreased with age, B = -.003, p < .0001. The quadratic component was also significant, B = .001, p < .001, and suggested that across the sample there was a decline in infant distress from 1 to 3 months with a small uptick from 3 to 6 months. Next, a conditional model including the parenting variables was fit to the data. At time points when infants co-slept with a parent more than their average, they were less distressed, B = -.012, p = .058. Additionally, there was a trend for infants of mothers who were more emotionally available on average to be less distressed on average, B = -.006, p = .06. At time points when mothers were more emotionally available than their average, infants were less distressed, B = -.008, p < .001. The estimates for close contact, arousing activities, nursing, bottle-feeding, and maternal depressive symptoms variables did not approach significance.

The results provided some evidence suggesting that maternal EA moderated the influence of maternal parenting practices on change in infant distress over time. There was a significant interaction between maternal EA, nursing, and quadratic change over time, B = -.006, p < .05 (Figure 1), which demonstrated that regardless of amount of nursing at bedtime, infants of more emotionally available mothers showed a decline in nighttime distress from 1 to 3 months with a small uptick at 6 months. However, infants of less emotionally available mothers who nursed more at bedtime showed the highest levels of distress over time. They showed a similar quadratic pattern to the infants of more emotionally available mothers though, with a decline in nighttime distress from 1 to 3 months and an increase from 3 to 6 months. Infants of less emotionally available mothers who nursed less at bedtime showed higher levels of distress but a linear decline with age. There were no other significant results and non-significant terms were removed from the model. The final conditional model (Table 2) showed better fit to the data than the unconditional model, (χ^2 (13, N = 109) = 61.8, p < .001).

Model predicting infant sleep: The second model predicted the percent of nighttime the infant spent asleep. An unconditional model examining how infant sleep percentage tended to change across age was fit to the data first. The linear estimate indicated that infant sleep increased over time, B = .039, p < .001. However, the quadratic estimate indicated that amount of infant sleep increased sharply from 1 to 3 months and then leveled off, B = -.009, p < .001. Next, a conditional model was fit that included all of the parenting variables described previously in order to test the study hypotheses. Arousing activities at bedtime were associated with less sleep, B = -.188, p < .05, and there were trends for infants to sleep less on average when they spent more time co-sleeping with a parent, B = -.040, p = .10 and when they spent more time in close contact with their mother at bedtime, B = -.076, p = .07. In addition, at specific time points when infants spent more time in close contact with their mother at bedtime there was a trend for them to sleep less, B = -.070, p = .08, and at specific time points when mothers were more emotionally available, infants slept more, B = .052, p < .01. Terms for bottle-feeding, nursing, and maternal depressive symptoms did not approach significance.

Several interactions between quality of mothers' bedtime parenting and specific parenting practices were significant. Less close contact at bedtime on average predicted more sleep for infants whose mothers were more emotionally available, but infants of less emotionally available mothers slept less regardless of how much close contact they received, B = -.099, p < .05 (Figure 2). There was also some evidence that parenting at bedtime predicted change in infant sleep over time. Infants whose mothers nursed them less on average at bedtime showed a steeper increase in the percentage of nighttime they spent asleep over time than infants who nursed more, B = -.056, p < .01 (Figure 3a). There was also a significant interaction between maternal EA, arousing activities, and quadratic change, B = .389, p = .05 (Figure 3b). This interaction demonstrated that infants of mothers who were more emotionally available and who used fewer arousing activities at bedtime tended to show a steeper increase in nighttime sleep over time than other infants. There were no other significant results and non-significant terms were removed from the model. The final conditional model (Table 3) showed better to the fit to the data than the unconditional model, (χ^2 (19, N = 109) = 40.6, p < .01).

Models predicting parenting from infant nighttime distress and infant sleep quality—The next set of analyses examined whether the percent of nighttime the infant spent distressed or asleep predicted later parenting practices and EA (Hypothesis 4). Within- and between-person estimates were created for infant nighttime distress and sleep. The within-person variables were then lagged in order to test whether infant distress and sleep at a given age point predicted later parenting. We also created within- and between-person effects for mothers' average percent of sleep per night (M = 84.25, SD = 6.00), sleep fragmentation (*M* = 33.25, *SD* = 10.39), and depressive symptoms (*M* = 7.05, *SD* = 7.16) in order to examine these variables as covariates.

The equations for this model predicting maternal EA are depicted below. The equations for the models predicting the parting practices variables were identical.

Level 1

$$\begin{aligned}\mathrm{EA}_{am}=&\beta_{0m}+\beta_{1m}\mathrm{Infant\ \ distress}_{am}\\&+\beta_{2m}\mathrm{Lagged\ \ infant\ \ distress}_{am}\\&+\beta_{3m}\mathrm{Infant\ \ sleep}_{am}\\&+\beta_{4m}\mathrm{Lagged\ \ infant\ \ sleep}_{am}\\&+\beta_{5-6m}\mathrm{Maternal\ \ sleep\ \ variables}_{am}\\&+\beta_{7m}\mathrm{Maternal\ \ depression}_{am}+e_{am}\end{aligned}$$

Level 2

$$\begin{aligned}\beta_{0m}=&\gamma_{00}+\gamma_{01}\mathrm{Infant\ \ distress}_{m}\\&+\gamma_{02}\mathrm{Infant\ \ sleep}_{m}\\&+\gamma_{03-4}\mathrm{Maternal\ \ sleep\ \ variables}_{m}\\&+\gamma_{05}\mathrm{Maternal\ \ depression}_{m}+\mu_{0m}\end{aligned}$$

The results indicated that neither infant distress nor sleep predicted parenting practices. However, there were significant effects for the model predicting maternal EA. A conditional model including the covariates and the lagged, within-person, and between-person effects for infant nighttime distress and sleep was fit. Higher infant distress predicted lower maternal EA at the following time point, $B = -10.89$, $p < .01$. There was also a significant within-person effect for infant nighttime distress, $B = -14.89$, $p = .05$, and the effect for between-person distress approached marginal significance, $B = -14.82$, $p = .10$. There was a trend-level association between more infant sleep and higher maternal EA, $B = 1.93$, $p = .07$. Terms for lagged infant sleep as well as mothers' sleep quality and depressive symptoms did not approach significance and therefore were not included in the final model. The fit of the conditional model (Table 4) was significantly better than that of an empty model, (χ^2 (5, N = 109) = 17.2, $p < .01$).

Discussion

Overall, these results suggest that the quality of maternal interactions as well as the activities mothers engage in with their infants at bedtime are associated with nighttime distress and sleep in early infancy. Parenting quality also appears to moderate the effect of parenting practices on infant distress and sleep in the manner theorized by Darling & Steinberg (1993). However, the findings also suggest that infant nighttime distress is linked to later parenting quality. These results have important implications for recommendations that are made to parents for how to promote healthy sleep development in early infancy, and for understanding the role that infant nighttime behavior may play in influencing parenting.

Maternal EA and Infant Nighttime Distress and Sleep

First, the results supported Hypothesis 1 that higher maternal EA would be associated with less infant distress and more sleep. At time points when mothers were more emotionally available than their average, infants spent more of the nighttime asleep and less of it distressed. To our knowledge, this is the first study to show a within-person association between maternal care and infant sleep quality. These results demonstrate that there is an association between maternal EA and objective measures of infant sleep patterning and therefore replicate and extend earlier work identifying an association between EA and maternal report of infant sleep quality (Teti et al., 2010). Maternal sensitivity and responsiveness in the bedtime context may best promote a sense of security and comfort in the infant that allows for deeper and more restful sleep and lessens the likelihood that the infant calls out to the parent in distress.

Parenting Practices and Infant Nighttime Distress and Sleep

In Hypothesis 2, we predicted that infants of mothers who engaged in less feeding, close contact, and arousing activities at bedtime would show less nighttime distress and more sleep. This hypothesis was partially supported. There were no direct linkages between parenting practices and infant nighttime distress, but one direct and two trend-level associations between parenting practices and infant nighttime sleep. First, infants of mothers who used fewer arousing activities at bedtime spent more of the nighttime asleep. This was consistent with our expectation that when mothers engage in more stimulating activities at bedtime, it may be more challenging for infants to achieve a restful state throughout the night. Similarly, we found a trend for infants who spent more of bedtime in close contact with their mothers to sleep less, supporting theory suggesting that when infants spend more time before bed in close contact with their parents they become reliant upon parental contact to return to sleep upon awakening at night. These infants may be awake longer, therefore, because they have more difficulty self-soothing to sleep. This effect was also seen at the within-person level, as there was a trend for infants to sleep less at time points when mothers engaged in more close contact than their average at bedtime.

We found one longitudinal association between parenting practices and infant sleep. This finding showed that less time spent nursing at bedtime on average was associated with more rapid improvement in infant sleep over time. This result also supports theory suggesting that when infants spend more time in contact with parents, such as for feeding, they may begin to rely on parental contact to return to sleep. Furthermore, this result is consistent with prior work showing that breastmilk is digested more quickly and therefore infants who are breastfed rather than bottle-fed wake up more often to eat as a result (Sadeh et al., 2010). The relative lack of direct effects for parenting practices may be because the emotional quality of mother-infant interaction was a more critical determinant of how well the infant slept. Several interactive effects detected in our study, to which we turn next, support this premise.

Interactive Effects on Infant Nighttime Distress and Sleep

Hypothesis 3 concerned interactive effects between parenting practices and quality predicting infant nighttime distress and sleep. We found support for this hypothesis via several interactions. Less close contact at bedtime on average was associated with more infant sleep when mothers were more emotionally available, whereas infants of less emotionally available mothers slept less regardless of close contact. There was an identical interaction between maternal EA and arousing activities, but it was qualified by a three-way interaction with change over time that we will discuss next. These results support earlier findings suggesting that less close contact at bedtime is related to better infant sleep. They also support Darling and Steinberg's (1993) theory that parenting practices are most effective in the context of loving, responsive parenting. However, these two interactions did not support the idea that the combination of lower EA and more feeding, close contact, or arousing activities would predict the poorest infant sleep quality. Rather, lower maternal EA on its own was linked to less sleep and there was not an addictive effect of close contact or arousing activities.

We found two significant interactions between parenting practices and developmental change in infant distress and sleep. First, infants of mothers who were more emotionally available and used less arousing activities at bedtime showed the steepest increase in the percent of nighttime spent asleep, compared to other infants. Thus, infants whose mothers were more emotionally available and engaged in fewer arousing activities developed consolidated sleep earlier in development. Arousing activities seemed to negate any benefit of higher maternal EA. The other significant interaction showed that infants of less emotionally available mothers who nursed more at bedtime showed the highest levels of distress over time, although similar to infants of more emotionally available mothers these infants showed a decline in distress from 1 to 3 months and a slight uptick from 3 to 6. These results support our earlier findings that higher EA is associated with better sleep quality and suggest that the combination of more nursing with lower EA is linked to more infant nighttime distress. This may be because infants come to rely on being nursed back to sleep and become distressed to elicit parental nighttime intervention, and also because infants of less emotionally available mothers may not achieve the same level of comfort, safety, and security for sleep as infants of more emotionally available mothers.

Infant Nighttime Distress and Sleep Predicting Parenting

We found evidence in support of Hypothesis 4, that infant nighttime distress and sleep would predict parenting. When infants were more distressed than their average, mothers were less emotionally available at the following time point. This is in line with prior work indicating that young children who experience higher distress may be challenging to care for (van den Bloom, 1994). Furthermore, it suggests that mothers are sensitive to variations in their infants' distress. Infant sleep, however, did not predict later maternal EA. Infant nighttime distress may be more salient to mothers than infant sleep because distress typically recruits a parental response. Finally, neither infant nighttime distress nor sleep predicted parenting practices, and thus there was no evidence supporting an infant-driven model of bedtime parenting practices.

Implications

Altogether, the results suggest that maternal parenting quality and practices at bedtime are associated with infant nighttime distress and sleep. Understanding how parents may influence the development of infant sleep patterns, as well as which infants may be at risk for lower parenting quality, has important implications for promoting healthy behavioral and cognitive outcomes in children. The findings could inform early intervention, as they suggest that infants are sensitive to variation in their mother's care and that mothers are sensitive to variation in infant distress. This indicates that infants would be responsive to positive changes in their mother's parenting behavior, and that teaching mothers ways to reduce infant nighttime distress may have a compounding effect that benefits parenting further over the long term. In addition to promoting parental sensitivity to infants at bedtime, clinicians could encourage reduction of physically stimulating activities in this context at all ages. However, it may be more difficult for parents to reduce feeding at the earlier ages in particular. Instead infants may benefit from feeding earlier within the bedtime routine such that feeding directly to sleep is less likely. Furthermore, the results support the use of observational methods of parents and infants in the bedtime and nighttime contexts and suggest that meaningful measures of parenting and child regulation can be captured from one night of video. In particular, they highlight the usefulness of studying arousing activities at bedtime as a predictor of infant sleep quality.

Limitations and Future Directions

There are several limitations of our study. First, the sample was largely Caucasian Americans. Parenting practices and sleep arrangement choices are strongly linked to culture and therefore it is likely that the results would be different across other cultural groups. Further work examining these research areas in other groups is imperative for determining the type of parenting that best supports infant sleep in the cultural context in which the infant is growing up. We must also knowledge the role that genetics may have played in the results; it is possible that genetically-based characteristics passed down from the mother to the child account for the link between parenting and infant sleep. Additionally, because paternal involvement at bedtime was limited at this young age, we focused on mothers. However, it is likely that fathers also influence infant sleep, and potentially in different ways from mothers. This will be an important avenue for future research, particularly when children are older and fathers may be more involved. A substantial portion of the sample also did not have bedtime data at every time point because the parents did not turn on the cameras in time. In future studies more cameras may be set up and could be left on by project staff so that families do not need to remember to do this.

In addition, in order to reduce the burden both on the families and on behavioral coders, the parenting and infant sleep data were collected across one rather than multiple nights at each time point. Future work may benefit from data collection across multiple nights at each age in order to better account for individual variability in both parenting and sleep. Data collection across multiple nights would also allow for the opportunity to study potential mediators of the associations between infant distress and parenting the following day, such as parental sleep deprivation, mood, and affect. Studying these factors on a daily scale rather than across months may allow for a more precise examination of lagged associations.

Conclusions

Our results shed further light on potential determinants of change in infant sleep quality across the first 6 months of life. Maternal parenting quality, parenting practices, and their interaction emerged as important predictors of infant nighttime distress and sleep across time, and infants were sensitive to variation within their mother's caregiving. However, infant nighttime distress also predicted quality of maternal parenting, highlighting the complex interplay between mothers and infants in the development of infant sleep patterns. Future investigations into these mutual influences should help clarify how parenting and infant sleep operate in concert to predict cognitive and behavioral outcomes in childhood.

Acknowledgments

This investigation is part of Project SIESTA, a NICHD-funded longitudinal study of parenting, infant sleep, and infant development (R01-HD052809), awarded to the second author. We would like to thank the families who participated in this study, the SIESTA staff who have assisted in data collection and coding, and Corey Whitesell, Cori Reed, and Renee Stewart, who have coordinated this project.

References

Anders TF, Halpern LF, Hua J. Sleeping through the night: A developmental perspective. Pediatrics. 1992; 90:554–560. Retrieved from http://pediatrics.aappublications.org/. [PubMed: 1408509]

Anders TF, Sostek AM. The use of time lapse video recording of sleep-wake behavior in human infants. Psychophysiology. 1976; 13:155–158. DOI: 10.1111/j.1469-8986.1976.tb00092.x [PubMed: 176676]

Bayer JK, Hiscock H, Hampton A, Wake M. Sleep problems in young infants and maternal mental and physical health. Journal of Paediatrics and Child Health. 2007; 43:66–73. DOI: 10.1111/j. 1440-1754.2007.01005.x [PubMed: 17207059]

Bell BG, Belsky J. Parents, parenting, and children's sleep problems: Exploring reciprocal effects. British Journal of Developmental Psychology. 2008; 26:579–593. DOI: 10.1348/026151008X285651

Bell, BA.; Ferron, JM.; Kromrey, JD. JSM Proceedings, Survey Research Methods Section. Alexandria, VA: American Statistical Association; 2008. Cluster size in multilevel models: The impact of sparse data structures on point and interval estimates in two-level models; p. 1122-1129.Retrieved from http://www.amstat.org/sections/srms/Proceedings

Bernier A, Carlson SM, Bordeleau S, Carrier J. Relations between physiological and cognitive regulatory systems: Infant sleep regulation and subsequent executive functioning. Child Development. 2010; 81:1739–1752. DOI: 10.1111/j.1467-8624.2010.01507.x [PubMed: 21077861]

Biringen Z, Derscheid D, Vliegen N, Closson L, Easterbrooks A. Emotional availability (EA): Theoretical background, empirical research using the EA scales, and clinical applications. Developmental Review. 2014; 34:114–167. DOI: 10.1016/j.dr.2014.01.002

Biringen, Z.; Robinson, J.; Emde, RN. Emotional availability scales. 3rd. Fort Collins: Department of Human Development and Family Studies, Colorado State; 1998.

Cronin A, Halligan SL, Murray L. Maternal psychosocial adversity and the longitudinal development of infant sleep. Infancy. 2008; 13:469–495. DOI: 10.1080/15250000802329404

Darling N, Steinberg L. Parenting style as context: An integrative model. Psychological Bulletin. 1993; 113:487–496. DOI: 10.1037//0033-2909.113.3.487

Davis KF, Parker KP, Montgomery GL. Sleep in infants and young children: Part one: Normal sleep. Journal of Pediatric Health Care. 2004; 18:65–71. DOI: 10.1016/s0891-5245(03)00149-4 [PubMed: 15007289]

DeLeon CW, Karraker KH. Intrinsic and extrinsic factors associated with night waking in 9-month old infants. Infant Behavior & Development. 2007; 30:596–605. DOI: 10.1016/j.infbeh.2007.03.009 [PubMed: 17416420]

Derogatis, LR. SCL-90-R Symptom Checklist-90-R: Administration, scoring, and procedures manual. Minneapolis, MN: National Computer Systems; 1994.

Fajardo B, Browning M, Fisher D, Paton J. Effects of nursery environment on state regulation in very-low-birth-weight premature infants. Infant Behavior & Development. 1990; 13:287–303. DOI: 10.1016/0163-6383(90)90036-8

Galland BC, Taylor BJ, Elder DE, Herbison P. Normal sleep patterns in infants and children: A systematic review of observational studies. Sleep Medicine Reviews. 2012; 16:213–222. DOI: 10.1016/j.smrv.2011.06.001 [PubMed: 21784676]

Gelfand DM, Teti DM. The effects of maternal depression on children. Clinical Psychology. 1990; 10:329–353. DOI: 10.1016/0272-7358(90)90065-I

Henderson JMT, France KG, Owens JL, Blampied NM. Sleeping through the night: The development of self-regulated nocturnal sleep during infancy. Pediatrics. 2010; 126:e1081–1087. DOI: 10.1542/peds.2010-0976 [PubMed: 20974775]

Jenni, OG.; Dahl, RE. Sleep, cognition, and emotion: A developmental view. In: Nelson, CA.; Luciana, M., editors. Handbook of Developmental Cognitive Neuroscience. Cambridge, MA: MIT Press; 2008. p. 807-817.

Kim BR, Teti DM. Maternal emotional availability during infant bedtime: An ecological framework. Journal of Family Psychology. 2014; 28:1–11. DOI: 10.1037/a0035157 [PubMed: 24377731]

Mao A, Burnham MM, Goodlin-Jones BL, Gaylor EE, Anders TF. A comparison of the sleep-wake patterns of co-sleeping and solitary-sleeping infants. Child Psychiatry and Human Development. 2004; 35:95–105. DOI: 10.1007/s10578-004-1879-0 [PubMed: 15577276]

McLoyd VC, Smith J. Physical discipline and behavior problems in African American, European American, and Hispanic children: Emotional support as a moderator. Journal of Marriage and Family. 2002; 64:40–53. DOI: 10.1111/j.1741-3737.2002.00040.x

Mindell JA, Kuhn B, Lewin DS, Meltzer LJ, Sadeh A. Behavioral treatment of bedtime problems and night wakings in infants and young children. Sleep. 2006; 29:1263–1276. Retrieved from http://www.journalsleep.org/. [PubMed: 17068979]

Priddis LE. Tuned in parenting and infant sleep patterns. Early Child Development and Care. 2009; 179:259–269. DOI: 10.1080/03004430600912132

Sadeh A. Consequences of sleep loss or sleep disruption in children. Sleep Medicine Clinics. 2007; 2:513–520. DOI: 10.1016/j.jsmc.2007.05.012

Sadeh A, Tikotzky L, Anat S. Parenting and infant sleep. Sleep Medicine Reviews. 2010; 14:89–96. DOI: 10.1016/j.smrv.2009.05.003 [PubMed: 19631566]

Scher A. Mother-child interaction and sleep regulation in one-year olds. Infant Mental Health Journal. 2001; 22:515–528. DOI: 10.1002/imhj.1015

Scher A. Infant sleep at 10 months of age as a window to cognitive development. Early Human Development. 2005; 81:289–292. DOI: 10.1016/j.earlhumdev.2004.07.005 [PubMed: 15814211]

Sitnick SL, Goodlin-Jones BL, Anders TF. The use of actigraphy to study sleep disorders in preschoolers: Some concerns about detection of nighttime awakenings. Sleep: Journal of Sleep and Sleep Disorders Research. 2008; 31:395–401. Retrieved from http://www.journalsleep.org/.

Teti DM, Crosby B. Maternal depressive symptoms, dysfunctional cognitions, and infant night waking: The role of maternal nighttime behavior. Child Development. 2012; 83:939–953. DOI: 10.1111/j.1467-8624.2012.01760.x [PubMed: 22506917]

Teti DM, Kim BR, Mayer G, Countermine M. Maternal emotional availability at bedtime predicts infant sleep quality. Journal of Family Psychology. 2010; 24:307–315. DOI: 10.1037/a0019306 [PubMed: 20545404]

Towe-Goodman NR, Teti DM. Power assertive discipline, maternal emotional involvement, and child adjustment. Journal of Family Psychology. 2008; 22:648–651. DOI: 10.1037/a0012661 [PubMed: 18729679]

van den Bloom DC. The influence of temperament and mothering on attachment and exploration: An experimental manipulation of sensitive responsiveness among lower class mothers with irritable infants. Child Development. 1994; 65:1457–1477. DOI: 10.2307/1131511 [PubMed: 7982362]

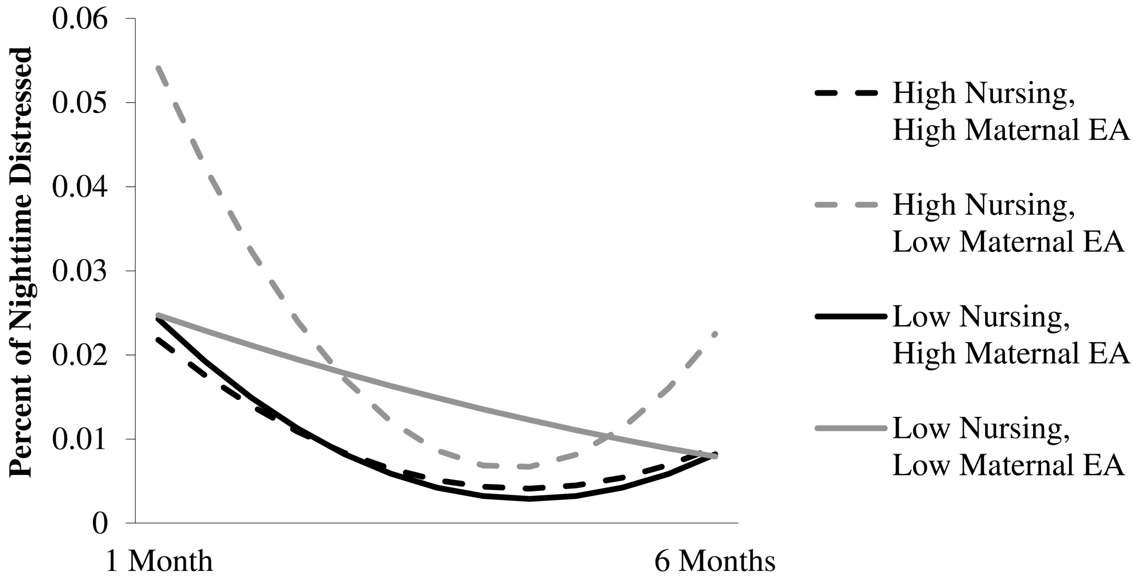


Figure 1. Interaction between nursing, maternal EA, and infant age predicting change in infant nighttime distress over time

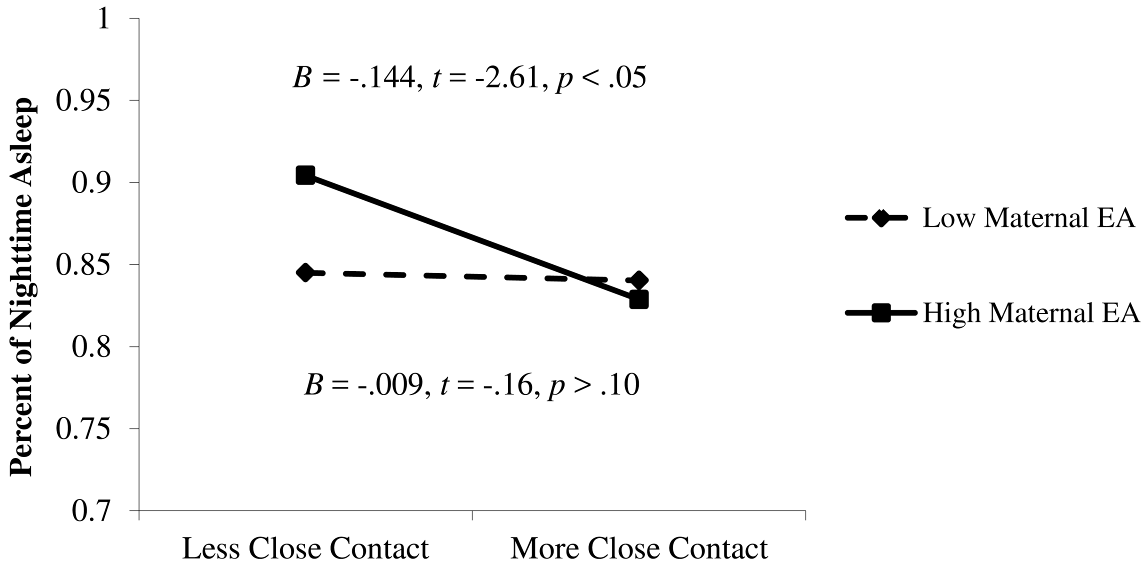
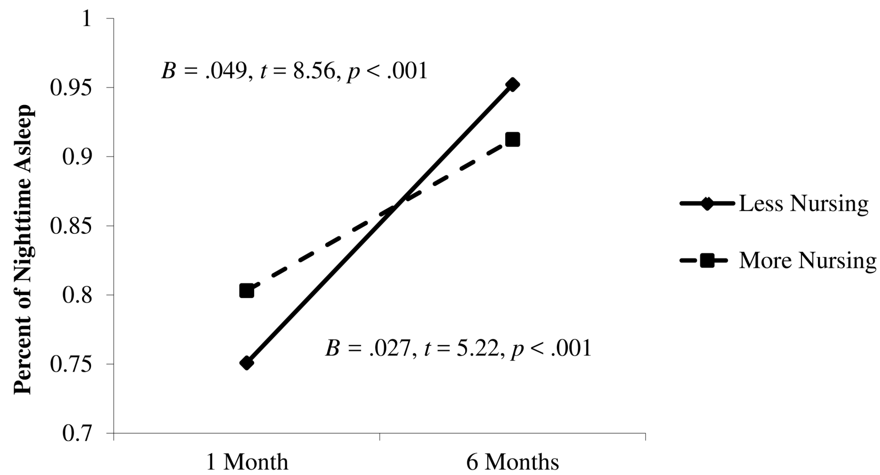


Figure 2. Interaction between close contact and maternal EA predicting average infant nighttime sleep

3a.



3b.

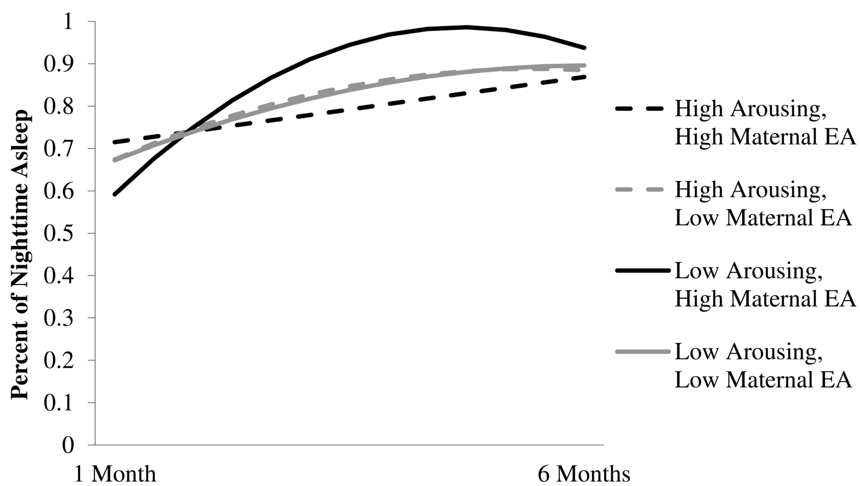


Figure 3. Interactions between nursing and infant age *(a)* and between arousing activities, maternal EA, and infant age *(b)* predicting change in infant nighttime sleep over time

Table 1

Bivariate correlations, means, and standard deviations for main study variables

	1. EA 1mo	2. EA 3mos	3. EA 6mos	4. CC 1mo	5. CC 3mos	6. CC 6mos	7. AA 1mos	8. AA 3mos	9. AA 6mos	10. Nurs 1mo	11. Nurs 3mos	12. Nurs 6mos	13. Bott 1mo	14. Bott 3mos	15. Bott 6mos	16. Dist 1mo	17. Dist 3mos	18. Dist 6mos	19. Asl 1mo	20. Asl 3mos	21. Asl 6mos
1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2	.60**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3	.42**	.61**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4	-.04	-.04	-.09	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5	-.02	-.18	.03	.33**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
6	.05	.17	.05	.09	.19	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7	-.14	.28*	-.06	.03	.30**	-.10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
8	.09	-.26*	-.02	.06	.47**	-.14	.31**	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9	-.01	-.17	-.33**	.04	.12	.19	-.09	-.04	--	--	--	--	--	--	--	--	--	--	--	--	--
10	-.15	-.07	-.04	.73**	.12	.19	-.02	-.09	-.17	--	--	--	--	--	--	--	--	--	--	--	--
11	-.05	-.04	.12	.26*	.56**	.35**	-.11	-.01	-.01	.39**	--	--	--	--	--	--	--	--	--	--	--
12	-.11	.08	.01	.30*	.18	.76**	-.09	-.09	-.05	.49**	.45**	--	--	--	--	--	--	--	--	--	--
13	.07	.04	-.07	.29**	.09	-.17	.20*	.13	.13	-.21*	-.29*	-.24	--	--	--	--	--	--	--	--	--
14	.08	.05	-.07	-.04	.26*	-.16	.40**	.12	.29*	-.27*	-.23*	-.24	.39**	--	--	--	--	--	--	--	--
15	-.28*	.26	.31*	-.19	.01	.20	-.11	-.09	.05	-.30*	-.06	-.18	.22	.17	--	--	--	--	--	--	--
16	-.26**	-.17	.01	-.02	.09	.14	-.06	-.00	-.03	.06	.05	.19	-.07	-.11	-.02	--	--	--	--	--	--
17	-.05	-.11	-.02	-.06	-.06	-.14	-.05	.16	.06	-.15	-.11	-.08	.11	.07	-.02	.36**	--	--	--	--	--
18	-.15	-.06	-.12	.04	.01	.23*	-.08	.15	.03	.12	.07	.27*	-.14	-.19	-.07	.28**	.32**	--	--	--	--
19	-.03	.12	.09	-.12	.02	.06	.03	.07	.03	.04	.13	.10	-.21*	-.16	.07	-.05	-.01	.02	--	--	--
20	.02	.29**	.24*	.01	-.16	.14	.01	-.19	-.23*	.20	.05	.23*	-.06	-.09	.12	-.05	-.16	.03	.35**	--	--
21	.08	.12	.04	.05	.09	.09	-.04	.11	.18	-.09	.02	-.02	.20	.06	.21	-.13	-.19	-.35**	.08	.14	--
M	.00	.00	.00	0:25	0:18	0:14	0:01	0:01	0:01	0:10	0:09	0:06	0:03	0:02	0:02	0:13	0:07	0:07	6:41	8:04	9:09
SD	.80	.77	.77	0:24	0:22	0:14	0:03	0:04	0:02	0:14	0:14	0:11	0:06	0:05	0:04	0:13	0:10	0:08	1:40	1:44	1:42

Note. The amount of time spent asleep at each age point is comparable to other studies using videosomnography (e.g., Hanft, Burnham, Goodlin-Jones, & Anders, 2006).

EA = emotional availability; CC = close contact; AA = arousing activities; Nurs = nursing; Bott = bottle-feeding; Dist = Infant distress; ASL = Infant sleep

** $p < .01$

* $p < .05$

Table 2
Estimates for model predicting infant nighttime distress percentage

	Estimate	*S.E.*	*t* (N =109)
Fixed Effects			
Intercept	.008	.002	4.53 **
Linear Change	-.004	.001	-6.94 **
Quadratic Change	.001	.000	4.59 **
Mean Co-sleeping	-.006	.004	-1.37
Deviations in Co-sleeping	-.012	.006	-1.92 †
Mean Maternal EA	-.006	.003	-1.90 †
Deviations in Maternal EA	-.008	.002	-3.87 **
Mean Nursing	-.008	.009	-.87
Deviations in Nursing	.001	.006	.20
Mean Maternal EA × Mean Nursing	.011	016	.72
Mean Maternal EA × Linear Change	.002	.001	2.51 *
Mean Nursing × Linear Change	-.003	.003	-1.29
Mean Maternal EA × Mean Nursing × Linear Change	.006	.004	1.42
Mean Maternal EA × Quadratic Change	-.000	.001	-.55
Mean Nursing × Quadratic Change	.004	.002	2.52 *
Mean Maternal EA × Mean Nursing × Quadratic Change	-.006	.003	-2.23 *
Random Effects			
Intercept	.0001	.0000	2.38 **
Residual	.0001	.0000	7.01 **

Note.

** Significant at $p \leq .01$

* Significant at $p \leq .05$

† Significant at $p \leq .10$

Table 3

Estimates for model predicting infant nighttime sleep percentage

	Estimate	***S.E.***	***t* (N =109)**
Fixed Effects			
Intercept	.854	.013	65.07**
Linear Change	.038	.004	9.36**
Quadratic Change	-.008	.002	-3.29**
Mean Co-sleeping	-.040	.031	-1.60†
Mean Maternal EA	.017	.024	.74
Mean Arousing Activities	-.188	.853	-.2.21*
Mean Nursing	.016	.052	.30
Mean Close Contact	-.076	.043	-1.79†
Deviations in Co-sleeping	-.064	.054	-1.17
Deviations in Maternal EA	.052	.017	3.01**
Deviations in Arousing Activities	.035	.341	.10
Deviations in Nursing	.002	.054	.04
Deviations in Close Contact	-.070	.040	-1.76†
Mean Maternal EA × Mean Arousing Activities	-3.07	1.08	-2.85**
Mean Maternal EA × Mean Close Contact	-.099	.052	-1.93*
Mean Maternal EA × Linear Change	.004	.006	.60
Mean Arousing Activities × Linear Change	-.436	.324	-1.34
Mean Nursing × Linear Change	-.056	.018	-3.06**
Mean Maternal EA × Mean Arousing Activities × Linear Change	-.556	.370	-1.50
Mean Maternal EA × Quadratic Change	-.002	.004	-.53
Mean Arousing Activities × Quadratic Change	.231	.159	1.45
Mean Maternal EA × Mean Arousing Activities × Quadratic Change	.389	.200	1.95*
Random Effects			
Intercept	.0019	.0011	1.70*
Residual	.0090	.0012	7.23**

Note.

** Significant at $p \leq .01$

* Significant at $p \leq .05$

† Significant at $p \leq .10$

Table 4

Estimates for model predicting maternal EA

	Estimate	***S.E.***	***t* (N =109)**
Fixed Effects			
Intercept	-.092	.087	-1.05
Mean Infant Sleep	1.93	1.06	1.82 †
Deviations in Infant Sleep	.359	.768	.47
Mean Infant Distress	-14.82	8.82	-1.68 †
Deviations in Infant Distress	-14.89	7.37	-2.02 *
Lagged Infant Distress	-10.89	3.82	-2.85 **
Random Effects			
Intercept	.3275	.0794	4.13 **
Residual	.2082	.4570	4.56 **

Note.

** Significant at $p \leq .01$

* Significant at $p \leq .05$

† Significant at $p \leq .10$