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Abstract

Despite strong theoretical reasons to believe that the quality of parent-infant interactions should influence child sleep, the empirical evidence for links between maternal behavior and children's sleep is equivocal. Notably, it is unclear at which ages such influences might be particularly salient. The current study aimed to examine prospective longitudinal associations between early maternal sensitivity and children's sleep during early childhood. Maternal sensitivity was assessed at 12 months during a home visit. Children's sleep was measured at 12 and 18 months as well as at 2, 3, and 4 years, using a sleep diary completed by mothers. Results revealed significant or marginal positive associations between maternal sensitivity and children's sleep consolidation (percentage of nighttime sleep) at 2, 3 and 4 years, but not at the most proximal assessments of 12 and 18 months. These findings suggest that child age could potentially be a key factor in the associations between maternal behavior and children's sleep.

Keywords: child sleep, maternal sensitivity, early childhood.

Associations between Early Maternal Sensitivity and Children's Sleep throughout Early Childhood

Children's sleep problems are one of the most common reasons for which parents seek medical help (Bayer, Hiscock, Hampton, & Wake, 2007; Wake et al., 2006). Young children spend the majority of their time asleep, which has been taken to suggest that sleep is key for brain and body development (Dahl, 1996). In fact, in addition to being a period of rest, sleep is also characterized by intense brain activity that involves high-level cortical functions (Dahl, 1996). The duration and quality of children's sleep are related to many areas of development and functioning, such as brain maturation (Feinberg & Campbell, 2010; Mirmiran & Van Someren, 1993), learning and memory (Astill, Van der Heijden, Van IJzendoorn, & Van Someren, 2012), physical health (Leproult & Van Cauter, 2010), and socioemotional adjustment (Gregory, Eley, O'Connor, & Plomin, 2004). Conversely, sleep problems may significantly impair optimal child development, as they are associated with sub-optimal cognitive, behavioral, and emotional outcomes (Bélanger, Bernier, Simard, Desrosiers, & Carrier, 2015; Gregory & Sadeh, 2012). Sleep difficulties in early childhood therefore represent an important challenge, especially because they are strong predictors of later sleep problems: it has been found that 50 to 70% of infants who had sleep difficulties at 1 year of age still presented such difficulties at 2 years (Jenkins, Owen, Bax, & Hart, 1984), and that sleep problems tend to persist from infancy to the preschool period (Thome & Skuladottir, 2005). Thus, it is crucial to understand the factors that contribute to well-regulated sleep among young children.

Parent-child interactions and children's sleep

Many studies have emphasized the contribution of family interactions to children's sleep (Dahl & El-Sheikh, 2007). During infancy, parents establish a routine for sleep and awakenings with their children, and while sleep problems such as difficulty falling or staying asleep are common among infants and young children, parents' responses are critical to prevent those difficulties from persisting (Sheldon, 2001). In addition to parental behaviors directly related to sleep, all forms of parent-child interactions may potentially impact children's sleep (El-Sheikh, 2011). This includes, among other factors, mother-child attachment security and its corresponding maternal behavior, namely maternal sensitivity (Bélanger, Bernier, Simard, Bordeleau, & Carrier, 2015; Keller, 2011).

Maternal sensitivity is defined as the capacity to perceive and to respond promptly and appropriately to infant cues (Ainsworth, Blehar, Waters, & Wall, 1978). Sensitive mothers are able to read their child's signals and to respond positively and consistently (Davis & Logson, 2010). The efficacy and the rapidity with which sensitive mothers respond to their child's needs allow for the establishment of a clear contingency between child cues and maternal responses (Leerkes, Blankson, & O'Brien, 2009). This contingency is presumed to favor the development of children's sense of control over their environment (Baumwell, Tamis-LeMonda, & Bornstein, 1997), which, in turn, facilitates adaptation to stress, including stress resulting from the separation and darkness inherent to bedtime (Keller, 2011). In addition, maternal sensitivity leads to the development of children's emotional security (Van IJzendoorn, Vereijken, Bakermans-Kranenburg, & Riksen-Walraven, 2004). When put to bed, children experiencing emotional insecurity may worry about the separation from their caregivers, making it hard to down-regulate and thus fall and remain asleep (Keller & El-Sheikh, 2011). Overall, the hypothesis is that maternal sensitivity supports the development of children's self-regulatory capacity (Bornstein, 1985) and emotional security (Ainsworth et al., 1978; Keller & El-Sheikh, 2011), which are essential to the decrease in vigilance required to initiate and to maintain sleep

(Dahl, 1996). Accordingly, maternal sensitivity should favor child sleep.

Despite this clear and generally endorsed rationale, results of studies investigating the links between maternal sensitivity and children's sleep are inconsistent. A first set of studies suggested positive links between sensitivity and sleep. Philbrook and Teti (2016) found that when mothers were more sensitive at bedtime (i.e., were more emotionally available to their child), their infant slept more throughout the night, as measured with videosomnography during the first 6 months postpartum. Using parental reports to measure children's sleep, Priddis (2009) observed that 7 to 18 month-old infants with better sleep quality had mothers who were more sensitive. Also using parental reports of children's sleep (questionnaires and sleep diaries), Teti, Kim, Mayer, and Countermine (2010) found that greater maternal sensitivity at bedtime (as measured by maternal emotional availability) was inversely related to the frequency of infant night wakings and mothers' perception of their infants' sleep difficulties between 1 and 24 months. Bordeleau, Bernier, and Carrier (2012) observed that maternal sensitivity assessed at 1 year was positively linked to children's sleep consolidation (percentage of nighttime sleep measured by a maternal sleep diary) at 3 and 4 years of age, although sensitivity was unrelated to total 24-hour sleep duration (also derived from a sleep diary). Finally, Adam, Snell, and Pendry (2007) found that parental warmth was associated with greater sleep duration as measured by a time diary among school-aged children, and Bell and Belsky (2008) reported that higher levels of maternal warmth, sensitivity, and involvement with school-aged children were associated with better sleep as measured by parental reports.

This could appear to be a clear and consistent picture. Other studies, however, found non-significant associations or even negative associations between maternal sensitivity and children's sleep. Scher (2001a) found no concurrent relation between maternal sensitivity and sleep measured among 1 year-old infants using actigraphy, an objective measure of sleep based on motor activity. Bates, Viken, Alexander, Beyers, and Stockton (2002) reported similar results using a maternal sleep diary with children aged 4 to 5 years. Tikotzky and Sadeh (2009) observed that higher levels of maternal sensitivity were correlated with *more* nighttime awakenings at 1 year as measured with actigraphy. Futhermore, Dearing, McCartney, Marshall and Warner (2001) observed that higher levels of sensitivity at 6 months were related to less mature sleep patterns (mother-reported) at 19 months, but not at 7 or 31 months. Weinraub et al. (2012) observed that higher levels of maternal sensitivity at 6, 21, and 36 months of age were related to more nighttime awakenings at concurrent ages. In a cross-sectional study, Paret (1983) also found that higher levels of maternal sensitivity (more rapid responses to crying during the day) were associated with more nighttime awakenings among infants aged 9 months. Of note, both latter studies used parental reports to assess awakenings, despite this method's poor reported validity when studying awakenings (Sadeh, 1996). However, Tikotzky and Sadeh (2009) found similar results with an objective sleep measure.

Overall, results of studies examining the relations between maternal sensitivity and children's sleep are quite mixed. The inconsistency in results may be explained partly by the great variability in methodological parameters across studies, notably child age. Child age is likely a key factor to consider, given the documented marked developments in the organization of sleep/wake patterns that take place between infancy and the preschool period (Acebo et al., 2005; Davis, Parker, & Montgomery, 2004). However, given that each study used a sample of different children, often studied at one time point only, existing research does not allow for isolating child age as a potential explanation for the discrepant results. Of note in this regard is the study by Dearing et al. (2001), which found different associations between maternal sensitivity and children's sleep according to child age at the time of the sleep assessment, which suggests that age at which sleep is assessed could be a key factor in the associations between early maternal behavior and children's subsequent sleep.

Also, as described above, studies have used different methods to assess children's sleep. While some studies used subjective measures of sleep such as general retrospective parental reports or prospective sleep diaries, others used objective measures like actigraphy. There is also great variability in the sleep parameters that were considered, such as the frequency or length of night awakenings (Bell & Belsky, 2008; Paret, 1983; Priddis, 2009; Scher, 2001a; Teti et al., 2010; Tikotzky & Sadeh, 2009; Weinraub et al., 2012), sleep duration or consolidation (Adam et al., 2007; Bates et al., 2002; Bordeleau et al., 2012; Philbrook & Teti, 2016; Priddis, 2009; Scher, 2001a; Tikotzky & Sadeh, 2009), sleep onset time and morning awakening time (Priddis, 2009; Scher, 2001a; Tikotzky & Sadeh, 2009), or mothers' perceptions of child sleep difficulties (Bell & Belsky, 2008; Teti et al., 2010).

Indeed, an important issue when studying sleep in young children is the choice of sleep parameters to examine (Hayes, 2002; Jenni & Carskadon, 2007). Because sleep evolves rapidly during early childhood, relevant sleep parameters must be selected based on developmental considerations, notably age-dependent developments in sleep patterns. The development of sleep-wake states is driven by two intrinsic bio-regulatory processes: one is homeostatic, meaning that the need for sleep accumulates during arousal and dissipates during sleep, whereas the other is a circadian process that provides cyclical clock-like signals promoting alertness in opposition to sleep, independently from prior waking and sleep (Jenni & LeBourgeois, 2006). During early childhood, maturation and interaction of these two processes build up to lead to increasingly adult-like sleep-wake cycles characterized notably by clear-cut day-night alternation and a decrease of daytime sleep, resulting in consolidation of sleep into the night period. Large-scale studies confirm that this translates into increasingly greater proportions of the total sleep period taking place at night throughout early childhood (Acebo et al., 2005; Coons & Guilleminault, 1992; Davis et al., 2004). Accordingly, the proportion of total sleep occurring at night can be considered a developmentally appropriate index of sleep regulation in infancy and early childhood. In fact, greater proportions of nighttime sleep have been observed to show positive links to cognitive development among young children (Bernier, Beauchamp, Bouvette-Turcot, Carlson, & Carrier, 2013; Dionne et al., 2011), supporting the validity of this sleep index. Moreover, the ability to consolidate sleep into longer bouts of uninterrupted sleep at night is also a key aspect of biological maturation in infancy and toddlerhood (Coons & Guilleminault, 1984; Sadeh & Anders, 1993). Consequently, both the proportion of nighttime sleep and the longest bout of uninterrupted sleep at night are developmentally-appropriate sleep parameters in infancy and early childhood.

Besides child age and the choice of sleep parameters, discrepancies in prior results may be due to the measurement of maternal sensitivity itself. Indeed, whereas most studies assessed maternal sensitivity in the family's home, whether during daytime (e.g., Adam et al., 2007; Priddis, 2009; Weinraub et al., 2012), bedtime (e.g., Philbrook & Teti, 2016; Teti et al., 2010), or nighttime interactions (e.g., Tikotzky & Sadeh, 2009), Scher (2001a) assessed sensitivity in the laboratory. Contexts of observation also varied, with mothers being observed during mother-child free play (e.g., Scher, 2001a), structured or semi-structured play (e.g., Dearing et al., 2001; Weinraub et al., 2012), or while engaged in an interview with a research assistant (e.g., Adam et al., 2007; Bates et al., 2002). Sensitivity scores could also vary according to the coding system used, based on the occurrence (e.g., Bates et al., 2002), frequency (e.g., Adam et al., 2007) or quality of maternal behaviors (e.g., Dearing et al., 2001).

The current study

The current study, thus, aimed to address the inconsistency in previous results by investigating the prospective links between early maternal sensitivity and young children's sleep with a longitudinal design, assessing the same sleep parameters among the same children and with the same method throughout, thereby allowing us to isolate the age factor. This study builds on a previous study by our team (Bordeleau et al., 2012; described above) that used a subsample (approximately half) of the current study's sample. That prior study aimed to disentangle the contributions of different facets of maternal and paternal parenting in relation to composite sleep scores in preschoolers (averaged across 3 and 4 years) while adjusting for sleep during infancy. The current study aimed, rather, to take advantage of an increased sample size and investigate whether a developmental trend could be identified in the associations between early maternal sensitivity (assessed at age 1) and age-specific assessments of child sleep – which would result in stronger associations at certain ages. To isolate the age factor, we adopted a longitudinal approach: child sleep was assessed five times between ages 1 to 4. We also took a closer look at maternal sensitivity itself, given that sensitivity specifically is expected to play an important role in the development of sleep regulation, as explained above. In line with recent recommendations (Mesman & Emmen, 2013), we used a new multidimensional measure of maternal sensitivity that allowed studying finer potential associations between precise aspects of sensitivity and child sleep, with the aim of exploring the role of maternal sensitivity assessment in the inconsistent results presented above. Hence, we focused on three aspects of maternal sensitivity with close connections to the original Ainsworth maternal care scales (Ainsworth, Bell, & Stayton, 1974):

Cooperation/Attunement, Positivity, and Accessibility/Availability (Bailey et al., 2016; see Methods section).

As explained above, the great diversity of methodological parameters across previous studies makes it difficult to isolate the age factor and formulate specific hypotheses. However, it has frequently been proposed that sleep regulation in infancy could largely be under the influence of central nervous system maturation, whereas environmental factors could play an increasingly important role as children mature (e.g., Dearing et al., 2001; Jenni & LeBourgeois, 2006). Accordingly, it could be expected that associations between early maternal sensitivity and child sleep will become stronger from ages 1 to 4. This is a tentative hypothesis however, given that the current state of the empirical literature does not allow for making firm predictions. Likewise, given that all three aspects of sensitivity under consideration were closely linked to Ainsworth et al.'s (1974) original theorizing about the core aspects of maternal caregiving, no a priori hypotheses were formulated regarding different dimensions of sensitivity.

Method

Participants

At Time 1, the sample was initially comprised of 200 mother-child dyads (101 girls), of which 125 (63 girls) also participated at Time 2, 148 (74 girls) at Time 3, 117 (67 girls) at Time 4, and finally 115 (58 girls) at Time 5. T-tests revealed that families who left the study were not different from others on maternal sensitivity, child sleep parameters, or any demographic variables (all p's > .10). Given this absence of differences, the data were considered missing at random, and missing data were thus handled with multiple imputations (Jelicic, Phelps, & Lener, 2009). Therefore, participants with missing sleep data were included in analyses by estimating their missing values through multiple imputations (10 imputations). However, due to the amount of missing data at certain points, approaching the limit of 50% past which estimation of missing data is not advised (Graham, 2009), we chose a conservative approach so as to diminish uncertainty in the data. Thus, only participants who had sleep data at a minimum of two time points were retained in analyses; this yielded a sample size of 143 families. To maximize the precision of imputed data, missing values were imputed from all other data available, except for maternal sensitivity scores. All subsequent analyses were performed on each of the imputed data sets, and results were then averaged (Schafer, 1997).

Families were recruited from random birth lists, provided by the Ministry of Health and Social Services. The study protocol was approved by the university's institutional review board. Criteria for participation were full-term pregnancy and absence of any known physical or mental disability in the child. Annual family income (in Canadian dollars) varied from less than $20,000 to over $100,000, with a mean situated in the $60,000 –$79,000 bracket. Mothers were between 20 and 45 years old (M = 32.0, SD = 4.5), had 16 years of education on average (SD = 2.1; varying from 11 to 18), and most (91.5%) were Caucasian. Most (86%) were married or living with the child's father throughout data collection.

Procedure

The dyads took part in five visits, when children were 12 (T1; M = 12.6, SD = 1.0) and 18 months (T2; M = 18.3, SD = 1.0), as well as 2 (T3; M = 25.5 months, SD = 1.5), 3 (T4; M = 36.8 months, SD = .74), and 4 years of age (T5; M = 48.8 months, SD = 0.89). The first visit was conducted in the families' homes and aimed at assessing maternal sensitivity in a naturalistic context. The procedure was modeled after the work of Pederson and Moran (1995). The home-visit protocol was specifically designed to create a situation in which the mother's attention was being solicited by both research tasks and infant demands, thus approximating real-life conditions in which parents are often faced with competing demands. This first visit lasted approximately 90 minutes and included child-centered tasks, a brief interview with the mother, a mother-infant interactive sequence (free play), and questionnaires that mothers had to complete while the infant was not looked after by the research assistant. The visit was conducted by graduate observers who had received extensive training based on Pederson and Moran's recommendations (1995). The observers then rated maternal sensitivity based on all their observations during this visit, as described below. In addition, at the end of each visit (T1 to T5), the research assistants left the mother a sleep diary and gave her instructions to complete it to describe her child's sleep pattern as it unfolded on three consecutive days in the week following the visit. Mothers were asked to return the diary by mail with a provided prepaid envelope.

Measures

Maternal Behavior Q-Sort. Maternal sensitivity was assessed during the first visit (T1) using the Maternal Behavior Q-Sort (MBQS; Pederson & Moran, 1995), a 90-item measure of the quality of maternal behavior during mother-infant interactions occurring at home. Pederson and Moran (1995) suggested that assessments based on lengthier in-home mother-child interactions were more reliable than brief lab-based play episodes, often used in previous studies. Thus, research assistants observed maternal behaviors throughout the T1 visit described above and rated the MBQS immediately after, based on the entire observation period. Each item of the MBQS describes a potential maternal behavior. Those potential behaviors are sorted into nine piles, ranging from very similar to very unlike the observed mother's behaviors. The observer's sort is then correlated with a criterion sort, provided by the developers of the instrument and representing the prototypically sensitive mother. Therefore, sensitivity scores can vary from -1 (least sensitive) to +1 (prototypically sensitive).

The MBQS is significantly related to other measures of maternal behavior, such as the HOME Inventory and the Ainsworth scales (see Pederson & Moran, 1995), shows good temporal stability (Behrens, Parker, & Kulkofsky, 2014; Tarabulsy et al., 2008), and excellent prediction of child subsequent socio-emotional and cognitive functioning (Lemelin, Tarabulsy, & Provost, 2006). For almost thirty percent of home visits (29.5%) the MBQS was rated independently by two research assistants, which revealed excellent inter-rater agreement (ICC = .86).

The MBQS has typically been used to obtain one overall score of global maternal sensitivity. Yet, parenting scholars have suggested that a multidimensional approach to the assessment of maternal sensitivity should be preferred, owing to the complexity and inherently multifaceted nature of this concept (e.g., Bailey et al., 2016; Mesman & Emmen, 2013; Seifer, Schiller, Sameroff, Resnick, & Riordan, 1996). The MBQS developers and their colleagues noted that the way in which sensitivity is conceptualized and assessed significantly influences research findings and that greater specificity regarding the developmental role of maternal sensitivity can be expected with the use of a multi-dimensional approach to its measurement (Bailey et al., 2016). They reported that a three-factor structure involving 41 of the original 90 items best represented the latent organization of the MBQS (see Appendix for a list of the items included in each factor – items were drawn from Version 2 of the MBQS). These three factors are *Cooperation/Attunement* (17 items; α =. 93 in the current study), *Positivity* (13 items; α =. 88), and *Accessibility/Availability* (11 items; α =. 91). Cooperation/Attunement describes mothers' ability to accurately perceive and interpret infants' cues, and to adjust the interaction correspondingly, so that infants appeared to find mothers' contributions enjoyable and supportive rather than becoming frustrated or overwhelmed. Positivity refers to mothers' positive mood and comments about their infants, in contrast to mothers who seem overwhelmed or depressed and are critical of their infant. Some items of this factor also concern mothers' apparent comfort and pleasure when interacting with their infant. Finally, Accessibility/Availability describes a mother who prioritizes the interaction with her child over other activities and who remains accessible and aware of her child even when she is engaged in other tasks.

As expected, the three factors were significantly inter-correlated in the current sample: Cooperation/Attunement and Positivity, $r = .31$, $p = .001$, Cooperation/Attunement and Accessibility/Availability, $r = .48$, $p = .001$, Positivity and Accessibility/Availability, $r = .28$, $p = .001$. The moderate magnitude of these associations suggested that it was relevant to keep those three dimensions distinct in analyses. Due to the absence of prior studies investigating different aspect of sensitivity and child sleep, however, no hypotheses were derived about specific links between sleep and particular dimensions of sensitivity.

Sleep diary. The sleep diary is a noninvasive measure widely used in sleep research with infants and children. The sleep diary records, on a timeline of 24 hours, the child's sleep-wake patterns as they unfold. The mother is asked to indicate, for each half hour, whether the child is awake or asleep, and where, if asleep (e.g., child bedroom, car, etc.). The mother is also required to note any event that might have disturbed the child's sleep, such as illness or visitors at home. In the current study, mothers were asked to complete the diary on three consecutive days during which their child had a fairly usual routine. For the reasons mentioned in the introduction, two parameters were derived: percentage of total sleep occurring at night time (between 7 pm and 8 am), and the longest uninterrupted bout of nighttime sleep. While percentage of nighttime sleep was averaged across the three days of recording, the longest uninterrupted bout of nighttime sleep represents the maximum duration observed over the three days.

Several studies have shown the validity of sleep diaries (Acebo et al., 2005; Gaina, Sekine, Chen, Hamanishi, & Kagamimori, 2004; Sadeh, 2004; Tikotzky & Sadeh, 2001). In contrast to general or retrospective questionnaires, sleep diary data show convergent validity with objective sleep measures like actigraphy (Acebo et al., 2005; Sadeh, 2004; Tikotzky & Sadeh, 2001; Werner, Molinari, Guyer, & Jenni, 2008), and discriminant validity to differentiate clinical and nonclinical samples (Sadeh, 2004). In fact, when studying sleep schedule or sleep duration, a sleep diary has been shown to be interchangeable with actigraphy (Bélanger, Simard, Bernier, & Carrier, 2014; Werner et al., 2008). Sadeh (2008) also suggested that when such sleep variables are the primary outcome measures, parental reports, particularly in the form of sleep diaries as used here, are sufficient in most cases. Finally, it has been observed that three days (the duration of the sleep assessment used here) represented the optimal duration to obtain reliable data while accounting for mothers' compliance in filling out diary data (St-James-Roberts & Plewis, 1996).

Results

Preliminary analyses

Table 1 presents descriptive statistics for the three dimensions of maternal sensitivity and children's sleep. All variables showed satisfactory variability and normal or near-normal distributions.

Bivariate correlations were performed between numerous potential confounding variables (i.e., maternal ethnicity, maternal education, family income, maternal age, child exact age at each time point, child gender, and number of siblings) and children's sleep. Very few correlations were significant: at 12 months, the longest bout of uninterrupted sleep was negatively correlated with maternal age ($r = -.19$, $p = .03$) and at 4 years, the percentage of nighttime sleep was positively associated with family income (r = .25, p = .02). In the final regression analyses, we adjusted for the covariates that were significantly associated with the outcome when appropriate. The stability of sleep parameters was also investigated. The percentage of nighttime sleep showed good stability with coefficients ranging from r = .27 to r = .41 (all p's < .005) for consecutive time points, except for stability between T2 and T3, which was low (r = .11, *ns*). For the longest bout of uninterrupted sleep, correlations varied from r = .19 (p = .05) to r = .43 (p < .001) for consecutive time points, except for the link between T4 and T5 which yielded the only non-significant correlation (r = .16, *ns*). Finally, the correlations between the two sleep parameters at each age were non-significant, varying between .06 (at T3) and .16 (at T1).

Main analyses

The zero-order correlations between the three dimensions of maternal sensitivity and the two sleep parameters at each age are displayed in Table 2. A first observation is that the longest bout of uninterrupted sleep was unrelated to any dimensions of sensitivity at any age (all p's > .10). This sleep variable was, therefore, not considered further.

The dimensions of maternal sensitivity were unrelated to the percentage of nighttime sleep at 12 and 18 months (r's between .02 and .11, *ns)*. However, significant correlations were found at later ages. At 2 years, both Cooperation/Attunement (r = .33, p = .001) and Accessibility /Availability (r = .21, p = .01) showed significant associations with the percentage of nighttime sleep. At 3 years, the percentage of nighttime sleep was significantly associated with Cooperation/Attunement and Positivity (r = .27, p = .004; r = .28, p = .003). Finally, at 4 years, only Cooperation/Attunement was associated with the percentage of nighttime sleep (r = .21, p = .05).

We next conducted multiple regression analyses to investigate the unique contribution of each dimension of maternal sensitivity to the prediction of the percentage of nighttime sleep while controlling for the other dimensions (to run conservative analyses accounting for the shared variance among aspects of maternal behavior) and relevant covariates. The covariates (when appropriate) were entered first in Block 1, followed by the three dimensions of maternal sensitivity in Block 2. The results of these analyses are presented in Table 3. In line with the correlational analyses presented above, the results indicated that the three dimensions of maternal sensitivity were unrelated to the percentage of nighttime sleep at 12 (β = .02 to .08, *ns)* and 18 months (β = .05 to .14, *ns*). However, at 2 years, Cooperation/Attunement was significantly associated with this sleep parameter (β = .30, p = .001), which was not the case for Positivity (β = -.02, *ns*) or Accessibility/Availability (β = .07, *ns*). At 3 years, children's percentage of nighttime sleep was marginally predicted by Cooperation/Attunement (β = .20, p = .08) and significantly predicted by Positivity (β = .18, p = .05), although not by Accessibility/Availability (β = .04, *ns*). Finally, at 4 years, only Cooperation/Attunement marginally predicted children's percentage of nighttime sleep (β = .23, p = .06).

Discussion

The aim of this study was to investigate the prospective links between maternal sensitivity and children's sleep across infancy and early childhood. Overall, the results indicated several positive associations between maternal sensitivity and children's percentage of nighttime sleep. However, and as observed by Dearing et al. (2001), associations varied across child ages. Indeed, the relations were negligible at 12 and 18 months, but generally increased in magnitude at 2, 3, and 4 years, with those involving Cooperation/Attunement becoming significant or marginally significant at all three ages. This pattern of generally more compelling results at later ages seems especially stimulating from a developmental and conceptual point of view, given that maternal sensitivity was assessed early, at 12 months only. From a purely methodological point of view, the increasingly longer time lags between the assessments of maternal sensitivity and child sleep should have decreased the likelihood of finding substantial relations with sleep at later ages. On the contrary, results became more compelling from 2 years on despite this lesser methodological proximity, suggesting that developmental processes are likely to be at play.

The results at 2, 3, and 4 years are in line with previous research that found positive associations between maternal behaviors and children's sleep from 3 years to school age (Adam et al., 2007; Bell & Belsky, 2008; Bordeleau et al., 2012; Spilsbury et al., 2005; but see Bates et al., 2002; Weinraub et al., 2012). Furthermore, the absence of associations at 12 and 18 months is also consistent with other studies that found minimal associations between infants' sleep and aspects of mother-child relationships such as maternal sensitivity (Scher, 2001a) and mother child attachment security (Scher, 2001b; Scher & Asher, 2004), although other studies have found associations between maternal behaviors and infants' sleep (Priddis, 2009; Teti et al., 2010). Thus, while exceptions exist, there are indications including in the current study that the links between maternal behaviors and children's sleep might perhaps be more compelling when sleep is assessed after infancy. This would be in line with the proposition that individual differences in infants' sleep are explained mostly by maturational factors, whereas environmental factors such as caregiving would become more important for children's sleep as they get older (Dearing et al., 2001; Jenni & LeBourgeois, 2006). Given also that very pronounced changes in children's sleep occur throughout the second year of life, followed by a period of stabilization thereafter (Acebo et al., 2005; National Sleep Foundation, 2004), it has been suggested that it may be too early, prior to toddlerhood, to effectively measure putative effects of caregiving on children's sleep (Bordeleau et al., 2012).

An important consideration, however, is that maternal sensitivity was the only environmental factor measured here; hence, the current results should not be taken as evidence that environment factors, or even caregiving factors do not play a role in infant sleep. In particular, it may be that environmental factors closer to the sleep domain (sleep arrangements, bedtime routines, bedtime and nighttime parenting) do matter for infant sleep, perhaps more so than daytime maternal sensitivity. This would be congruent with the work of Teti et al. (2010) as well as Philbrook and Teti (2016) who found that maternal sensitivity at bedtime and during the night was associated with infant sleep. It could be potentially explained, as Teti et al. (2015) proposed, by the fact that bedtime and nighttime parenting are more proximal to infant sleep behaviors, thereby possibly exerting a greater influence in comparison to daytime parenting.

Given the design used for the current study, however, a central developmental issue raised by the present results is the process by which maternal sensitivity in infancy may come to impact toddlers' and preschoolers' sleep consolidation while not first impacting their sleep during infancy. Although the current correlational design precludes causal inference, the pattern of longitudinal associations is consistent with such an interpretation. While necessarily speculative, some hypotheses can be proposed to explain this deferred association. First, it is possible that early maternal sensitivity does impact infant concurrent sleep, but the impact is specific to aspects of sleep that were not assessed here (for instance, the proportion of slow-wave sleep or REM sleep). These, in turn, would pave the way to the higher sleep consolidation observed here in the toddlerhood and preschool years. Alternatively, it could be that early maternal sensitivity first supports adaptive regulation at a basic psychophysiological level in infancy, which in turn would favor later sleep consolidation, as suggested by prior research with school-aged children (El-Sheikh & Buckhalt, 2005; El-Sheikh, Erath, & Bagley, 2013). Finally, it may be that early maternal sensitivity, as assessed here, is merely an indicator of later sensitivity, as experienced by the child at the moment of the subsequent sleep assessments, and that it is concurrent rather than early sensitivity that relates to child sleep – a hypothesis that was not possible to test here given the lack of subsequent sensitivity assessments in this study.

In addition to developmental issues, an important methodological factor to consider when studying the caregiving-sleep links is the exact aspect of sleep studied. In the current sample, none of the dimensions of maternal sensitivity were related to the longest bout of uninterrupted nighttime sleep at any age, which is recognized as a useful indicator of sleep among infants and toddlers (Coons & Guilleminault, 1984; Sadeh & Anders, 1993). Maternal sleep diaries are, however, not the optimal assessment tools for this sleep parameter, given that assessment of the longest bout of uninterrupted nighttime sleep requires the accurate detection of night awakenings, which are difficult to assess reliably with parental diaries (Sadeh, 1996). We nonetheless chose to consider this mother-reported sleep variable in the current study, owing to previous studies that did find theoretically sound associations between maternal sensitivity and sleep variables that included maternal reports of child awakenings (Bell & Belsky, 2008; Priddis, 2009). Still, the different results found here across the two sleep parameters might be due to the fact that the percentage of night sleep was assessed more reliably.

Besides child age and sleep parameters, another potential explanation for the inconsistency in previous results regarding the relation between maternal sensitivity and children's sleep relates to the fact that each study assessed maternal sensitivity in a different context and with a different coding system, in addition to examining different maternal behaviors. Because different components of maternal behavior can have distinct contributions to children's development (e.g., Meins, Fernyhough, Fradley, & Tuckey, 2001; Moran, Forbes, Evans, Tarabulsy, & Madigan, 2008), it may be important, when studying links between maternal sensitivity and children's sleep, to consider multiple components of maternal sensitivity. In this context, a new structure of the MBQS was used and allowed us to investigate the hypothesis that, indeed, different dimensions of maternal sensitivity might contribute differently to children's sleep. Overall, only Cooperation/Attunement showed reliable links to child sleep at different ages. This specificity of reliable associations with Cooperation/Attunement is noteworthy, given that this dimension reflects closely the original definition of maternal sensitivity, namely the mother's capacity to accurately perceive the child's cues and to respond promptly and appropriately (Ainsworth et al., 1974). With regards to children's sleep specifically, it could be argued that the behaviors included in the Cooperation/Attunement dimension (see Appendix) are especially likely to contribute to the promotion of children's self-regulation and emotional security, which are believed to favor sleep consolidation among children (Dahl, 1996; Keller, 2011). Indeed, some of those items describe mothers' efficacy and rapidity in responding to their infant's cues, which is believed to allow infants to establish a clear contingency between their cues and their caregiver's responses, thus favoring self-regulation (Leerkes et al., 2009). Another set of items of the Cooperation/ Attunement dimension describes mothers who adjust the interaction adequately based on their infant's pace and current state. This could gradually convey to infants that they can exert a certain level of control over their environment (Baumwell et al., 1997), which could promote adaptation to stress and thus support sleep consolidation (Keller, 2011). Nonetheless, given that this study's analyses of specific dimensions of sensitivity were exploratory, further research is needed to decipher the links between precise aspects of parenting and child sleep.

The current research presents limitations that restrict the conclusions that can be drawn. As mentioned above, the design used precludes causal inference or investigation of bidirectional effects. Another concern is that children's sleep was measured with sleep diaries. As mentioned above, other sleep assessments, particularly objective assessments such as actigraphy or polysomnography, might have produced different patterns of results, for instance regarding the longest bout of uninterrupted sleep. Additionally, concurrent measures of sensitivity were not available, making it impossible to determine whether it is early or concurrent maternal sensitivity that accounts for observed associations with child sleep. Finally, only mothers were included, and it is likely that fathers make unique contributions to their children's sleep.

Despite those limitations, the current results contribute to expanding the literature on parenting and children's sleep, by shedding light on some of the factors that may contribute to explain prior discrepant findings and thus suggesting new research directions. In particular, the repeated sleep assessments provide insight into the possibly critical role of child age in the parenting-sleep links, and suggest that researchers should take developmental considerations into account when investigating parenting and child sleep. Of note, longitudinal designs and related analytic strategies can also allow researchers to tackle qualitatively different developmental questions than those addressed here. For instance, growth curve modeling could be used in future studies to examine the *rate of change* in sleep parameters across time. Although examination of such developmental trajectories was not suited to this study's aim to examine the links between early mothering and sleep at different discrete ages, such analyses can be worthwhile when pursuing different research aims, pertaining to increasing or decreasing developmental trends on certain sleep variables.

Also, considering that different components of maternal behavior can have distinct contributions to children's adaptation (Moran et al., 2008) and provided the current findings, which tentatively point to the Cooperation/Attunement dimension as showing more compelling relations to child sleep, researchers investigating associations between maternal sensitivity and children’s sleep should adopt a multidimensional perspective: various sleep parameters and multiple components of maternal sensitivity should be assessed at different ages. Given the availability of evidence-based intervention modalities to improve maternal sensitivity (see Bakermans-Kranenburg, Van IJzendoorn, & Juffer, 2003), such a multidimensional research orientation could contribute to the development of well-targeted intervention efforts, tailored to the aspects of maternal sensitivity most likely to promote quality sleep in children of different ages. The development of such interventions could contribute to improving young children’s sleep quality and hence support their optimal development.

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Table 1

Means, Standard Deviations and Ranges for the Main Study Variables

Variables	M	SD	Observed range
Maternal sensitivity			
Cooperation/Attunement	7.26	1.27	2.29-8.71
Positivity	7.54	1.12	1.31-8.85
Accessibility/Availability	6.31	1.51	1.09-8.27
Percentage of nighttime sleep (%)			
12 months	71.93	9.41	36.75-90.7
18 months	74.73	9.27	29.41-90.91
2 years	77.76	8.67	50.82-100
3 years	82.44	8.71	57.89-100
4 years	86.62	7.61	67.86-100
Longest uninterrupted bout of sleep (hours)			
12 months	10.62	1.94	1-13.50
18 months	11.15	1.52	3.50-17.50
2 years	10.81	1.35	2.50-14
3 years	10.77	0.80	8-13
4 years	10.72	0.92	6-13

Note. Values for percentage of nighttime sleep are averages of the three days of data.

Table 2

Correlations between Sleep Parameters and Dimensions of Maternal Sensitivity at Each Age

	Maternal sensitivity (12 months)		
	Cooperation/ Attunement	Positivity	Accessibility/ Availability
12 months			
Percentage of nighttime sleep	.10	.03	.08
Longest uninterrupted bout of sleep	-.04	.09	-.06
18 months			
Percentage of nighttime sleep	.11	.02	.02
Longest uninterrupted bout of sleep	.05	.12	-.01
2 years			
Percentage of nighttime sleep	.33**	.11	.21*
Longest uninterrupted bout of sleep	.03	-.01	.05
3 years			
Percentage of nighttime sleep	.27**	.28**	.18
Longest uninterrupted bout of sleep	-.11	-.10	-.10
4 years			
Percentage of nighttime sleep	.21*	.05	.12
Longest uninterrupted bout of sleep	.04	.03	.03

Note. Values for percentage of nighttime sleep are averages of the three days of data.
$^{*}p < .05$. $^{**}p < .01$

Table 3

Hierarchical Regression Models Predicting Percentage of Nighttime Sleep from Dimensions of Maternal Sensitivity

	R^2	ΔR^2	F	β
12 months				
1. Cooperation/Attunement	.01	.01	.53	.08
Positivity				.02
Accessibility/Availability				.04
18 months				
1. Cooperation/Attunement	.03	.03	1.30	.14
Positivity				.05
Accessibility/Availability				.06
2 years				
1. Cooperation/Attunement	.11	.11	5.52^{**}	$.30^{**}$
Positivity				.02
Accessibility/Availability				.07
3 years				
1. Cooperation/Attunement	.13	.13	5.83^{**}	$.20^{t}$
Positivity				$.18^{*}$
Accessibility/Availability				.04
4 years				
1. Family income	.06	.06	8.45^{*}	$.23^{*}$
2. Cooperation/Attunement	.09	.06	2.80	$.23^{t}$
Positivity				.04
Accessibility/Availability				.05

Note. Values for percentage of nighttime sleep are averages of the three days of data.
$^{t}p < .10$. $^{*}p < .05$. $^{**}p < .01$.

Appendix

Items Included in each Dimension of Maternal Sensitivity

Cooperation/Attunement
Interactions revolve around baby's tempo and current state.
Often misses "slow down" or "back off" signals from baby during face-to-face play (R).
Well-resolved interaction with baby – interaction ends when baby is satisfied.
Subjects baby to constant and unphased barrage of stimulation; baby overwhelmed (R).
Interprets cues correctly as evidenced by baby's response.
When baby is distressed, is able to quickly and accurately identify the source.
Slows pace down; waits for baby's response in face-to-face interactions.
Content and pace of interactions with the baby seem to be set by mother rather than according to baby's responses (R).
Unaware of or insensitive to baby's signs of distress (R).
Sometimes is aware of baby's signals of distress, but ignores or does not respond immediately to these signals (R).
Rough or intrusive in interactions with baby (R).
Interactions appropriately vigorous and exciting as judged from baby's responses.
Responds only to frequent, prolonged, or intense signals (R).
Responds immediately to cries/whimpers.
Responds consistently to baby's signals.
Responses to baby's communications are inconsistent and unpredictable (R).
Teases baby beyond point where baby seems to enjoy it (R).
Positivity
Is animated in social interactions with baby.
Flat affect when interacting with baby (R).
Comments are generally positive when speaking about baby
Praise directed toward baby.
Is delighted over baby.
Critical in her descriptions of baby (R).
Predominantly positive mood about baby.
Displays affection by touching.
Seldom speaks to the baby directly (R).
Seems overwhelmed, depressed (R).
When holding, cuddles baby as a typical mode of interaction; molds baby to self.
Seems "long suffering" in her attitude about her maternal duties (R).
Seems awkward and ill at ease when interacting directly with the baby face to face (R).
Accessibility/Availability
Often seems to forget baby is present in the room during interaction with visitor (R).
Not skillful in dividing her attention between baby and competing demands; thus misses baby's cues (R).

Arranges her location so that she can perceive baby's signals.
Preoccupied with interview – seems to ignore baby (R).
Monitors and responds to baby even when engaged in some other activity such as cooking or having a conversation with visitor.
Seems to be aware of baby even when not in the same room.
Leaves the room without any sort of "signal" or "explanation" to the baby (e.g. "I'll be back in just a minute") (R).
Sometimes will break off from the child in mid-interaction to speak to visitor or attend to some other activity that suddenly comes to mind (R).
When in the same room as baby, provides baby with unrestricted access to her.
Fails to interrupt activity by her baby that is likely to be dangerous (R).
Greets baby when reentering room.