What, When and Why Develops in Sleep Development

By

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Abstract

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This dissertation explores in a series of four studies using a developmental perspective the nature of infant sleep and its relation to waking experiences. The first two studies suggest that the sleep disturbance, which is usually observed in the second half of the first year of life, is related to a major transition of the infants becoming effectively mobile through learning to crawl on hands and knees. The sleep disruptions are mainly explained by infants' heightened sensitivity to proximity of a caregiver as a result of the developmental shift initiated by the onset of crawling. Thus, the findings call for consideration of the "sleep disturbance" as a normal developmental phenomenon that should not be treated as a clinical problem but rather accepted with sensitivity from the parents.

Based on the third study of the dissertation, however, parents often apply sleep-training techniques involving prolonged periods of infant crying during the same age period and sometimes as a reaction to the "sleep disturbance". The sleep training is widely recommended together with solitary sleeping arrangement and the study findings demonstrate that the recommendations have a profound effect on parental decisions. However, the fourth study does not support the benefits of the recommendations. Based on the findings, sleep training is not associated with a better sleep. Instead, sleep-trained infants cry more at night and also have a worse mood in the morning. Night feeding, on the other hand, is associated with less crying both at night and during the day. Even though it is also associated with more time awake at night and less self-soothing, it does not seem to affect the overall amount of sleep.

In addition, the nature of "self-soothing" as a self-regulatory ability is questioned by the findings reported in the fourth chapter, since it does not appear to be related to the infant's daytime self-regulatory abilities. Though closer sleeping location and higher parental involvement at night are associated with more interrupted sleep, it is also related to better daytime behavioral outcomes in the infants. Together the findings of this dissertation suggest that the "sleep disturbance" in infancy might be normal for this phase of development, and recommendations given to parents should be carefully examined since those are affecting both infant and parents as one.

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What, When and Why Develops in Sleep Development

Chapter 1: Introduction

Sleep is a basic requirement of human existence. Even though the precise functions of sleep and the mechanisms of sleep effects are not completely clear, studies on animals and adult humans demonstrate that sleep plays an important role in many aspects of life such as health, emotional well-being and learning. Infants spend more time asleep than awake and their proportion of sleep is much higher than that of adults. Moreover, developmental changes in sleep patterns seem to co-occur with other major developmental transitions. However, the importance of sleep and its interrelation with infant development is commonly overlooked both in pediatrics and in developmental psychology. In addition, no consensus exists up today about what is the best sleeping environment for infant sleep and how it affects both infant sleep and development.

The purpose of this dissertation is threefold: (1) to study the relations between some of the major developmental transitions related to self produced locomotion and behavioral patterns of sleep; (2) to learn, using both qualitative and quantitative methods, about different practices related to infant sleeping environment used by parents in United States and the reasoning behind choosing one approach over another; (3) to explore whether the different parental practices might have an important effect both on behavioral patterns of sleep and on other developmental outcomes of the infants.

Sleep is a major physiological and psychological state. Human adults spend one third of their lives in sleep. As noted earlier, children spend in sleep more time than they spend awake: three quarters of time in the newborn period and more than half of the time during the first 3 years of life. Sleep then constitutes an important part of young children's life. Moreover, it is now recognized that sleep is not simply a passive process governed by cyclical changes in the environment but has very important functions. It is essential for life and is characterized by a need to "catch up" following an enforced sleep deprivation with lethal effects if recovery is not allowed, as demonstrated in rats (Rechtschaffen & Bergmann, 1995).

Sleep and the Waking Experiences

Despite the obvious importance of sleep and scientific research dating as far as 80 years ago (Economo, 1930), sleep research was relatively unpopular for a long period of time, except for a brief flurry of psychological research in the 1960s and into the early 1970s. This is surprising given the exciting suggestions that sleep of an organism is very sensitive to different transactions with the environment and can serve as a window into the functioning and organization of the brain, especially the cortical development. Only recently the interest in sleep was revived by new exciting findings on the functions of sleep and its interconnections with waking experiences.

An array of recent studies on animals and human adults illuminated the role of sleep in brain plasticity (Frank, Issa & Stryker, 2001), emotionality (Yoo, Gujar, Hu, Jolesz & Walker, 2007), memory processing and learning (Walker & Stickgold, 2004), problem solving and creativity (Walker, Liston, Hobson & Stickgold, 2002). The studies show that a good sleep is important both before and after a waking experience. While sleep deprivation impairs an ability to encode new memories (Yoo et al, 2007) and even affects moral judgment (Killgore, Killgore, Day, Li, Kamimori & Balkin, 2007), sleep after learning makes the learning more effective

(Walker et al, 2002). Interestingly, the pattern of brain activity related to a specific waking experience seems to be replayed in sleep as shown by multielecrode recording technique in rats (Wilson & McNaughton, 1994).

Thus, on the other side of the coin, waking experiences appear to play a role in sleep structure as well as in sleep regulation. Stress in waking experiences of rodents has been repeatedly found to affect the proportional distribution of sleep stages with decrease in the proportion of Rapid Eye Movement (REM) sleep (Pawlyk, Morrison, Ross & Brennan, 2008). In humans, survivors of traumatic events have more difficulties falling asleep, more awake time, more movement within sleep periods, and shorter REM time (Hefez, Metz & Lavie, 1987). Similarly, sleep regulation in general and REM sleep specifically are disrupted in Post Traumatic Stress Disorder (PTSD), as well as in many other mental disorders (see Nofzinger, Buysse, Reynolds & Kupfer, 1993 for a review). This set of evidence points to a very intimate link between sleep and waking experiences, however the mechanism of the relationship and the origins of the disruptions are still unclear.

Sleep in Infancy

Infancy is the time of the most rapid and most dramatic changes in all areas emphasized in sleep research: emotional regulation, problem solving, learning and memory. In parallel, sleep patterns change immensely during the same period of life. While having a very different structure from adults' sleep at a newborn period, the sleep of a two-year-old child has already an adult-like structure. As in adults the sleep of a newborn consist of a cycle of alternating sleep stages and the cycle repeats itself for a number of times during a night. However, adults's cycle consist of 5 stages of sleep: 4 stages of Non-Rapid Eye Movement (NREM) and 1 stage of Rapid Eye Movement (REM) sleep, while newborns only have 2 stages of sleep: Quiet Sleep (NREM-like) and Active Sleep (REM-like). But the main difference from adults is that newborns have more cycles (7-8 versus 4-5 in adults), and their cycles are shorter than in adults (60 minutes in newborns versus 90 in adults). Sleep cycles become longer and less frequent over development: however, little is known about the precise ages when the changes take place.

Newborns have longer total sleep time duration (16-18 hours a day compared to 8 on average for adults) and their sleep periods distributed evenly across the 24 hours. The relative proportion of Quiet (NREM-like) versus Active (REM-like) sleep is also different in newborns compared to adults. In pre-term infants the predominant sleep state is Active Sleep, which also takes up to 50% of the total sleep at the full term age, then diminishes rapidly over the first few months and continues to gradually fall for 2 to 3 years until it reaches 20 - 25% (approaching adult value). Another important difference is that unlike adults newborns start their sleep from Active Sleep and the two types of sleep are of approximately equivalent duration over a cycle.

Thus there are numerous changes that occur in sleep after the newborn period and mostly during the first year of life. First, spindles (characteristic of Stage 2 of NREM in adults) start to appear on an infant sleep EEG around 1 month of age. The first characteristics of different separate stages of Quiet Sleep (analogous to 1 to 4 stages of adult NREM) start to emerge around 3 month of age and can be seen more clearly at around 6 mo. At around 3 months of age, the Active Sleep starts to become organized into later sleep cycles and Quiet Sleep dominates the earlier parts of sleep. By 6 months of age, sleep is entered through a Quiet Sleep stage and typical (adult like) inhibition of muscle tone occurs in Active Sleep (in contrast to the earlier

activity seen during active sleep).

Periods of continuous sleep also gradually lengthen and become consolidated into a predominantly night time pattern with about 3 daytime naps around 3 to 6 months of age. Total sleep time also decreases and by the age of 12 months, has fallen from 16–18 h/day at term to 14–15 h/day, with most occurring at night and one or two daytime naps. Preschool children still sleep 10-15 hours, while adolescents sleep 10-12, reaching the adult value of 8 hours on average at the age of 16 years (Iglowstein, Jenni, Molinari, & Largo, 2003). Number of night-time awakening also decreases with age; however, the decrease is not linear and regressions are observed around different ages (8 mo, 1 and 2 years).

Studying Sleep in Infancy from Developmental Perspective

Even though the picture of sleep development might seen clear at first, there are many contradictions and very high between subject variability in the developmental timetable of sleep (Peirano, Algarin & Uauy, 2003). There are also controversies about the mechanisms and systems involved in the development. What at first seems to be endogenously driven by biological maturation turns out to be influenced by other factors such as sleeping arrangements (McKenna, 2000), maternal behaviors (Scher, 2001a) and culture (Kawasaki, Nugent, Miyashita, & Miyahara, 1994). Similarly, the changes in sleep onset (night sleep starting from NREM) that are considered to be maturational by many (Peirano et al, 2003), were questioned by Bernstein, Emde and Campos (1973) as the changes could be confounded with the infant' changing reaction to stress of handling.

Moreover, sleep might be serving different functions at different developmental stages. Studying the relations of sleep taken together with other developmental milestones should provide helpful insights into sleep functions in general. First attempts at such an approach was made by Roffwarg, Muzio and Dement (1966), as well as by Feinberg (1974), and later by Dahl (1996). Surprisingly, their developmental approach received very limited attention in the field of sleep and very little is known about sleep functions or the interrelation of sleep with development in infancy and in childhood.

The lack of attention to developmental issues is especially surprising given that the most dramatic changes in sleep (1, 3, 6, 8 months, 1 and 2 years) seem to co-occur with different important developmental transitions in attentiveness, motor development (reaching, sitting, crawling, walking), inter-personal relationship development and more. Thus it is important to analyze these transitional periods from developmental perspective, while considering effects of infant developing capacities (such as locomotion and emotional regulation), sleeping arrangements and family dynamics. Some of the characteristics of A developmental perspective include (a) taking different levels of contexts into account (Bronfenbrenner, 1979); (b) looking at epigenesis as nothing develops in isolation and one change can cause an array of other changes across domains (Bertenthal, Campos, & Kermoian, 1994); (c) considering regressions (not linear improvement) with same skills serving different functions at different stages; (d) emphasizing developing milestones as opposed to chronological age.

Although, many studies were conducted on sleep in infancy as related to different separate characteristics of infants or parents, these are mostly pediatric studies lacking a developmental perspective. At the same time sleep is consistently being ignored in developmental psychology. Thus, it is still not completely clear what is the normal sleep pattern

that is most beneficial for development. However, despite the paucity of understanding of infant sleep functions and how they relate to developmental transitions, there is an abundance of both lay and professional advice offered to parents on how to approach infant sleep.

Most recommendations for infant sleeping environment come from pediatrics, psychiatry and clinical work, and target the problem of sleep “disturbances” in infancy (Godfrey & Kilgore, 1998). The recommendations do not take into account the possible adaptive functions of sleep patterns characteristic of infancy. Instead, the advice is oriented to prevent sleep “disturbances” by teaching infants to sleep through the night independently (in adult-like manner) as early as possible. This approach ignores the possibility that the “disturbance” might be adaptive and normative at least at some developmental stages.

It also overlooks the psychological aspect of sleep regulation. Since awakening during nocturnal sleep between the sleep cycles is a natural phenomenon, sleeping through the night for an infant then means being able to fall back to sleep when awakened by self-soothing without an adult intervention (Anders, Halpern & Hua, 1992). The ability of self-soothing involves both regulation of a physical state and emotional-behavioral regulation. When and how such abilities develop are clearly developmental questions. However, as was stated earlier, most of the research in the sleep domain is not based on a developmental perspective and does not take into account the main developmental processes related to emotional, motor, and cognitive functions.

For example, the development of locomotion around the age of 7-9 months brings an overall excitement which along with the related cognitive advances might also contribute to higher awareness of dangers thus eliciting new emotions, such as stranger and separation anxieties (Campos et al, 2000). These changes might result in difficulties falling and staying asleep, complicate a separation from a caregiver at nighttime (Scher, 2001a) and make a task of self-soothing at night especially difficult. Thus, sleep “disturbance” during this transitional period could be normal and applying the sleep training methods recommended elsewhere exactly during this period might complicate important developmental transitions. The sleep training might undermine exactly the ability it tries to teach – self-soothing, by teaching it at the wrong time and in the wrong context of night (when the sense of security is the most vulnerable).

Moreover, the dominance of recommendations related to teaching infants to self-soothe or sleep train them while letting them cry it out (Ramos & Youngclarke, 2006) might have an effect not only on infants but also on the entire family. It might create disagreements between parents and additional stress in the already difficult task of parenting an infant, especially if the suggested methods are not in line with the parental approach or the general parental attitudes of at least one of the parents in the family.

Unfortunately, sleep rarely is studied or discussed within a family context (Dahl & El-Sheikh, 2007). As beautifully said by Winnicott (1952): “there is no such thing as a baby, there is a baby and someone". However, despite the complete dependence of infants on a caregiver, and the important role of the caregivers in the regulation of most infant activities, parents themselves are largely ignored in the sleep studies. Very little is known about the effect of the literature or other resources available for parents on the decisions they make about their infant sleeping environment and their interrelation with parental general attitudes toward childrearing. Moreover, little is known about the effect of the different strategies recommended to parents depending on its fit with their general parental attitudes.

Overview of the Dissertation

The current dissertation is an attempt to explore some of the questions raised above while taking a developmental perspective. Thus Chapter 2 of this dissertation describes a research on the possible relations between some of the major developmental transitions and sleep "disturbances" in infancy. More specifically the chapter presents two studies on the link between the development of different types of locomotion (an ability to independently move around in the environment) and changes in behavioral sleep patterns in infancy. One study addresses the relation of sleep to acquisition of crawling, and the second study – to the ability to walk in an upright position. In line with the developmental approach this research centers on the interrelation between different developmental domains suggesting that a regression in sleep might be a normal developmental phenomenon. The regression is thought to be related to the major changes in infant development, resulting from an acquisition of locomotion, and not to the age of the infant or a mere physiological maturation.

Further, Chapter 3 focuses on parents as important agents of sleep development in infancy. While using both qualitative and quantitative methodology it provides a window into the processes the parents go through when making decisions about their infants' sleeping environments and factors affecting those decisions. Chapter 4, on the other hand, explores the effects of the choices made by parents from the same families described in Chapter 3, but with an emphasis on infants rather than parents. More specifically the chapter describes some effects of the different sleeping environments and their fit with general parental attitudes on both infant behavioral sleep patterns and other developmental outcomes, such as anxieties, self-soothing abilities and emotional reactivity across situations.

In line with a developmental perspective both Chapter 3 and Chapter 4 defines the sleeping environment functionally, while putting the specific parental practices into different levels of context: general parental attitudes of the main caregiver to childrearing, family dynamics or the agreement between the different members of the family about specific parental practices, and societal influences coming in a way of literature, professional advice and socially acceptably norms encountered by the parents.

Chapter 2: The Link between Locomotor Development and Sleep in Infancy, a New Perspective on "Sleep Disturbances"

The objective of this research is to examine the association between locomotor development and sleep patterns in infancy. Sleep disturbance in the first year of life is one of the most common complaints in pediatric practice. Many research attempts were made to elucidate the possible mechanisms underlying sleep disturbance in infancy and different strategies have been suggested to parents by clinicians and pediatricians to treat the disturbance and "'train the infant to sleep through the night". However, the mechanisms are still not clear and very little evidence exists for the success of the strategies suggested to parents (McKenna & McDade, 2005). Moreover, there is still controversy in the field about what constitutes a normal sleep pattern in infancy and surprisingly little is known about the normal developmental trajectory.

According to some accounts (McKenna, 2000) frequent awakenings are adaptive and might be more the norm for a healthy developing infant than a clinical problem to be treated. Moreover, according to Brazelton (1992), sleep difficulties are normally observed at periods of developmental transitions. Applying sleep-training strategies at times of major developmental changes might exacerbate the sleep difficulties and interfere with the normal developmental transition. Thus it is extremely important to analyze the changes in sleep patterns from a developmental perspective and to distinguish normal developmental regressions in sleep from clinical problems to be treated.

The main changes in sleep patterns taking place in the first year of life are related to the appearance of circadian rhythm (sleeping more during night hours and less during daytime) and change in the number and duration of the sleep cycles. Both in infants and adults the sleep cycle repeats itself a number of times during the night with the possibility of spontaneous awakenings between the cycles. But infants have more cycles, which are also much shorter, thus providing more possibilities for awakenings. The number of cycles decreases from 7-8 in the first months to 4-5 (adult level) in childhood, with the most dramatic changes taking place in the first year of life. All these changes point to a developmental tendency for more consolidated nighttime sleep with fewer chances for spontaneous awakenings.

However, there is also a psychological aspect of sleep that develops in the first year of life. While reduced number of cycles might mean fewer chances to wake up, what happens when an infant wakes up is a very different issue. Sleeping through the night for an infant means when awakened being able to fall back to sleep by self-soothing without an adult intervention (Anders, et al, 1992). The ability of self-soothing involves both regulation of a physical state and emotional-behavioral regulation. When and how such abilities develop are clearly developmental questions. However, most of the research in the sleep domain is not based on a developmental perspective and does not take into account the main developmental processes related to emotional, motor, and cognitive functions.

From a developmental perspective, returning to sleep when awakened as well as falling asleep for the night could be a very difficult task for a young infant. Infants are not born with an ability to independently regulate their physiological or emotional states but rely, instead, upon a caregiver to do this with and for them (Siegel, 2001). Moreover, the ability to regulate states and emotions does not necessarily improve linearly with age, regressions might take place when new

skills and emotions develop. In addition, with cognitive progression and the development of the sense of "self" and separation anxiety, the task of falling asleep can become even more difficult, since falling asleep means "separation" from the caregiver.

Similarly, infants learning so many new skills might be tempted to practice and test those when awake, whether that be a motor skill or the ability to affect others' behavior through a wider range of communicative channels. Thus it is not surprising that the behavioral aspect of sleep or the ability to fall asleep does not improve linearly and an increase in sleep disturbances is reported around 8 months and again around one year of age (Scher, 2005) even in infants who had been already sleeping through the night (without interruptions demanding parental involvement). Interestingly, these are also the times when infants reach some of the most important milestones related to locomotion – crawling and walking.

The onset of locomotion is one of the major life transitions in early development. When infants acquire the ability to move around voluntarily, most if not all aspects of their life and experiences change. The infants undergo an extraordinary psychological reorganization with changes in perception, spatial cognition, and social and emotional development (see Campos et al, 2000 for more detailed review). As independent mobility develops, infants discover many new facts about their environment. They learn to attend to the available information and also use it for their growing needs.

Thus, compared to prelocomotor infants in the sphere of perceptual development infants crawling on hands-and-knees demonstrate better referential gestural communication (Campos, Kermoian, Witherington, Chen, & Dong, 1997), greater wariness of heights (Campos, Hiatt, Ramsay, Henderson,& Svejda, 1978), higher sensitivity to peripheral optic flow and improved postural compensation apparently in response to changes in visual proprioception (Witherington, Campos, & Kermoian, 1995). In addition, crawling infants demonstrate general changes in attentiveness to far space, improved capacity to show position constancy and better landmark-or environmentally based referencing following a displacement compared to prelocomotor infants (Campos at al, 2000).

Even more importantly, the ability to freely move in space contributes to understanding of separateness of the infant from his/her mother, while at the same time creating a sense of autonomy and willfulness in the infant, which may result in active proximity seeking. Mahler and colleagues (1975) underscored the role of locomotion in the "psychological birth" of the human infant and discussed the contribution of walking ability to both independence and anxiety. Not surprisingly, Bowlby (1969) spoke of locomotion marking the onset of the phase of discriminated attachment figures. Indeed, locomotor infants were reported more often than prelocomotor infants to show increased, new, or intense forms of affection to the primary caregiver, a greater sensitivity to maternal departures and whereabouts, and increased checking back in social situations (Campos, Bertenthal & Kermoian, 1992).

The onset of locomotion also changes the nature of parent-infant interactions and ways of communication, which might profoundly affect the infant's social cognition. Crawling, for example, increases the number of opportunities for the caregivers to communicate facially and vocally in an attempt to regulate infant behavior, especially by prohibitions. Some parents of newly locomotive infants indeed report experiencing negative interactions and anger at their infants for the first time in their baby's life (Campos et al, 1992). In the same study parents of

locomotor infants also reported changes in the infants' emotionality in terms of both the frequency and intensity of angry responses to events.

Most importantly, previous studies using an experimental design manipulating use of a Powered Mobility Device (PMD) provided support for the causal relation between locomotion experience and some of the different developmental changes mentioned above (Uchiyama, Anderson, Campos, Witherington, Frankel & Lejeune, 2008). In these studies prelocomotor infants trained to control their movement in the Mobility Device exhibited developmental changes similar to those normally associated with crawling. Similar but weaker effects were found from a simple use of walkers (Campos et al, 2000). Thus locomotion must bring about a wealth of changes all of which should be relevant to sleep.

Adult sleep research had demonstrated that sleep processes play an important role in learning and emotional regulation, with major waking life events and changes being reflected in sleep structure (Walker & Stickgold, 2004). Anxiety causes insomnia in both children and adults and adversely affects sleep (Wagner, 1991). Stress in adults leads to difficulties in falling asleep, more awake time at night and more movement within sleep periods (Hefez, Metz & Lavie, 1987). All the changes initiated by infant locomotor ability thus should be expected to affect infant sleep, especially the psychological aspect of it. Falling asleep should be a much more challenging task for a newly mobile infant who is starting to be more active and autonomous, having a burst of newly developing emotions and anxieties, while also learning and practicing a new life-turning skill of locomotion. Since sleep constitutes a separation from the caregiver (especially if infants sleep separately from their parents), newly mobile infants might have difficulty not only falling and staying asleep but also developing a better ability to protest the separation with their developing communicative skills.

Indeed, a link between crawling and a "sleep disturbance" was documented in an Israeli sample based both on parental reports (Scher & Cohen, 2005) and on measurements of sleep using actigraphy (Scher, 2005). In these samples pre-crawling infants were compared with infants who were able to move forward in any way (moving on abdomen, creeping or by using hands-and-knees). However, the studies were exploratory in nature and, as the authors suggest, more studies are needed to elucidate the effects found. For example, the Israeli samples had a limited and relatively early age range: 107 infants 6 to 8 months of age in the questionnaire study; and 59 infants all 8 months of age in the study that used actigraphy.

The age range included in these previous studies was the age when infants start crawling on average, thus the infants of the sample that already crawled could be considered "early crawlers" versus infant of the same age that did not start crawling yet (who would eventually be "late crawlers"). It is possible then that the difference in night wakening between the groups could be explained by temperamental or other differences such as activity level between early versus late crawlers. The more active babies could reach the crawling milestones earlier and at the same time have more or longer awakenings due to their activity level and not because of their ability to crawl. Thus the association is still unclear and longitudinal study is needed. However, longitudinal design is very problematic in the study of crawling since no good predictors are known so far for the onset of crawling. Thus it is very difficult to define the time point for the assessment of pre-crawling infant without knowing when the infant is going to start crawling. But before such a complicated longitudinal study can be planned, studying a wider range of ages can serve as an intermediate step, since inclusion of older infants allows balance between early

and late crawlers in the sample.

In addition, a larger sample size allows separate assessments of the effects of different ways of crawling. Crawling on hands-and-knees is the most effective way of moving around, it demands less effort, allows more freedom and opportunities to observe the environment simultaneously while moving. Moving on the abdomen or other unconventional ways of moving are much more effortful and do not provide the same perspective on the environment. Thus only hands-and-knees crawling but not moving on abdomen was found to affect the search for hidden objects in the studies of effects of locomotion (Kermoian & Campos, 1988). The different ways of moving around could have differentiated effects on sleep too. In Israeli samples infants using any way of moving were combined into a single group of crawlers, as no differences were found between the groups. However, the groups were also relatively small and perhaps not large enough to detect a difference.

Moreover, a different population of infants from the United States can allow exploration of the nature of the relation between crawling and sleep disturbance through comparison of infants having different sleeping arrangements. For co-sleeping infants separation is not an issue at night and their anxiety or ability to protest might not be relevant to the sleep-related behaviors: since the infants are close to the parents at night there is nothing to fear or protest. Thus, if the sleep disturbance resulting from the onset of crawling is mostly a psychological phenomenon related to the rise of separation anxieties as well as infant self efficacy development – the change in sleep patterns during acquisition of locomotion should be less pronounced in the co-sleeping infants. This question could not be explored in the Israeli sample since infants co-sleeping with their parents were excluded in the study by Scher & Cohen (2005) due to a very small number of families with such a sleeping arrangement. In the US the co-sleeping arrangement has become more prevalent recently (McKenna & McDade, 2005), thus the United States sample can allow more exploration of the possible causes of sleep disturbances reported by parents after the onset of crawling.

Similarly to crawling, only one study examined the association between the onset of walking and night-awakenings on a sample of only 23 Israeli infants (Scher, 1996). In this study infants who started walking were found to have a tendency to wake up more frequently than pre-walking infants. But the author suggests that a comparison of larger numbers of infants is needed to draw conclusions on the link between motor development and sleep-wake organization. Onset of walking is a very important in infancy. Even though the change is of a different type than the onset of crawling (since most infants already move around freely by crawling before they start walking), onset of upright locomotion is still a very powerful experience. The perspective of the infant view of the surrounding world changes with the onset of walking, as does the perception of the self as more similar to others. Unlike a crawling infant who uses the hands to locomote the walking child has his hands free to explore objects and surfaces above the floor level, thus expanding the exposure to different stimuli.

The current study was an attempt to confirm the existence of an association between the two motor milestones of crawling and walking and changes in sleep patterns documented in the Israeli studies on a different population, while also using a bigger sample of infants including a wider age range and different sleeping arrangements. The present study also attempts to explore possible mediators that could explain the link between locomotion and sleep, by assessing some of the social and cognitive changes in the infants related to the heightened sensitivity to

separateness from the mother and better cognitive/communicative skills.

Another novel aspect of this study is an assessment of the use of walkers. The device is somewhat used in the United States and it provides a similar though not completely equivalent experience of mobility for infants as crawling or walking. The link between use of walkers and sleep has never been explored before. In summary, the current study attempted to examine three major hypotheses: first, that a shift in infant locomotor abilities (either by crawling or upright locomotion) would show an association with changes in infant sleep patterns; second, that the association would be mediated or explained, at least in part, by socio-cognitive changes in the infant; and third, that the association would be moderated by infant sleeping location with the association being the strongest if an infant sleeps separately from his/her parents. In addition, the effects of development of other motor skills that take place at the same developmental time phase were assessed in this study, as was the effect of use of walkers.

Study 1: Crawling, Use of Walkers and Sleep

The main aim of this study was to examine, and if possible to explain, the association between the onset of crawling and changes in infants' sleep patterns. The second aim was to assess the association between the use of walkers and sleep patterns in the age range of crawling development.

Methods

Sample

Mothers of 205 healthy infants aged between 6 and 12 months (M=9.1, SD=1.1) completed questionnaires for this study. One case was excluded because of a few scores that were defined as outliers. After careful check of all the questionnaire entries for that case a conclusion was reached that the mother was not answering the questions reliably, giving contradictory answers and unrealistic assessments. The sample thus included 204 infants in total. The mothers (aged M=32.8 years, SD=4.1) primarily had a college education (40.7% of the sample), 32.4% had higher than college education (held graduate degrees), 21.6 % had a high school diploma, and only 2% had only some high school.

The mothers were recruited through the list of volunteer participants in the Bay Area maintained by the Institute of Human Development of the University of California, Berkeley. Participation criteria included healthy infants between the ages of 6 to 12, with no developmental delays. Infants who were able to walk at least 3 steps independently were not included in the sample. The sample consisted of 112 boys and 92 girls primarily from White Caucasian population (48.7%), with 11.8% Asian, 8.6% African-American, 5.9% Hispanic and 25% with a mixed ethnicity.

Assessments

The mothers completed a Sleep Questionnaire, and a Motor Development and Activities Checklist in addition to a basic demographic questionnaire.

Locomotor development. The Motor Development checklist used in this study was an exact version of a questionnaire used by Uchiyama et al (2008). This questionnaire was validated through comparison with a maternal diary assessment of locomotor proficiency of infants'

locomotion. In this checklist parents provided information on different age-appropriate motor achievements and activities of their infants as well as ages when every motor skill has been acquired. The skills were mostly related to mobility of an infant and included moving forward when on abdomen (belly crawling), prototypic crawling on hands-and-knees, speed crawling (free and very fast moving by crawling) and walking. Parents were also asked if their infant used/uses other (unconventional) ways of moving such as rolling, crab crawling (with only one leg active) or scooting (sitting up and dragging self forward).

The Checklist also included questions on two motor milestones not related to mobility and these are pulling up to stand (when using furniture or other objects) and free standing (without holding onto anything/anyone for at least 2 seconds at a time). A number of questions in the Checklist also related to social and cognitive milestones such as proximity seeking or proximity seeking with a parent (trying to go to a parent when in the same room and looking for a parent when in different rooms); communication understanding and following directions (giving/bringing an object to a parent when asked to do so by the parent); and searching/looking for favorite objects that are out of sight (in another room). These questions offered an opportunity to explore possible mediators in the link between locomotion and sleep pattern.

In this study the infants were assigned the status of crawlers if they were able to crawl for a distance of at least twice their own length and had been able to do that at least for one week. The infants were defined as walker-users if they spent anytime in the walkers at least once a day on most days based on the information provided by the parents in the checklist. Three scores were obtained from the motor checklist regarding every milestone and use of walkers: (i) distinction between infants who achieved a given milestone and those who did not; (ii) age when a milestone was achieved; (iii) the amount of experience acquired for a given milestone in days as well as on a scale from 0 to 3, where 0 means no experience, 1 means 31 day of experience (new to the skill), 2 means 31 to 62 days (experienced in the skill), and 3 means more than 62 days (proficient).

The division into groups based on experience follows results of a pilot study as well as a previously observed process of infant adaptation to a new motor skill in a study of locomotor development effects on visual proprioception (Uchiyama et al, 2008). Similar scores were obtained for walkers use based on a starting point of using the device. A fourth score was obtained related to the duration of use of walkers per day (from 1, 15 minutes or less to 5, more than 2 hours). In addition, A mobility index was assessed pertaining to ways of locomotion from 0 to 5, where 1 means rolling and 5 means speed crawling. The use of walkers was not included in the mobility index since it is not a self-produced type of mobility, which depends on the exogenous condition of availability of walkers, and is not reflective of a developmental level.

Sleep assessment. The Sleep Questionnaire used to assess infant sleep was an adaptation of Sadeh's (2004) Brief Infant Sleep Questionnaire (BISQ). In this questionnaire parents are asked to report their infants' average sleep patterns: time it takes to fall asleep for the night, usual time of night sleep onset, time of waking up in the morning, number of awakenings, and time it takes to fall back to sleep when awakened in the middle of the night. The parents are also asked about their strategies of settling the infant to sleep for the night and the location of infant sleep.

The questionnaire was originally validated using 2 methods: (1) finding high and significant correlations between BISQ measures and sleep diary and objective actigraphy

measures for clinical and control groups of infants (including high test-retest correlation for a sub-sample of infants); (2) comparing results of a large Internet survey using the BISQ with existing literature on developmental sleep patterns. Though thoroughly validated parental report does not provide an exact objective sleep pattern assessment since parents might not be aware of all infant awakenings, especially when sleeping in separate rooms. However, since the main interest of this study is the difficulty of infants to fall asleep without assistance, parental reports are useful in assessing the extent to which the infant needed the assistance.

The following scores were obtained from the questionnaire to assess the sleep patterns – (1) duration of the entire night sleep period from the sleep onset to the morning wakening (in minutes); (2) duration of settling for night-sleep - time it takes to fall asleep for the night (in minutes); (3) number of awakenings per night; (4) average duration of night awakenings (in minutes); (5) time awake at night - number of awakenings multiplied by the average time of falling back to sleep; (6) pure sleep per night in minutes – time spent asleep out of the entire night sleep period, defined as duration of the entire sleep period minus the time awake at night. For the purposes of this study, additional items were added pertaining to prevalence of sleeping through the night as well as parental subjective perspective of sleep being problematic (ranging from 0, not a problem at all, to 3 – a serious problem). Parents were also asked about their strategies of settling the infant back to sleep when awakened in the middle of the night and number of feedings at night. The strategies were assessed based on parental presence and involvement in the process of infant falling asleep: 1 - no involvement or presence at all, 2 - mere presence of a parent, 3 - active involvement (holding, rocking, or feeding/nursing).

An additional question was added pertaining to parental reluctance to respond right away to an infant awakening or after a specific period of time (the period being reported by parents in minutes). This item was validated in a pilot study, based on a sub-sample of infants from the present study. The item scores significantly correlated with other parental sleep strategies scores (r=0.52, N=152, p<0.01) and in addition predicted sleep outcomes above and beyond what other measures of parental strategies predicted (ΔR^2=0.06, $\Delta F(1,152)$=7.15, p<0.01), suggesting a specific predictive validity in addition to parental strategy types. The finding was not surprising given that strategy types usually assess reports of parental behaviors that could be based not only on parental decisions but also on the result of poor sleep in the infants in the first place. Parents' involvement might be needed more for infants who have more sleep disturbances. The question related to reluctance to respond, however, targets a parental decision that seems to be independent at least to some degree of the infant sleep pattern.

Approach to Analyses

Statistical analyses examining the relations between crawling and sleep patterns were based on comparisons of the sleep patterns between groups of infants who could crawl with those who couldn't. First, the hypotheses were tested using simple group comparisons through *t* tests. Then, to address specifically the link between the onset of crawling (versus the status of being able to crawl) and sleep, groups with different crawling experience were also compared through analysis of variance (ANOVA). A similar approach was taken to examine the link between sleep and other motor milestones, as well as the use of walkers and motor milestones.

Mediation and moderation analyses were conducted according to the methods of Baron and Kenny (1986). The moderation hypothesis was tested using interaction term in two-way

analysis of variance (Two-Way ANOVA) between the independent variable and the potential moderator, while first making sure the moderating variable has no relation to the dependant variable itself. The mediating hypothesis was tested using regression analysis while entering the mediating variable simultaneously with the independent variable as predictors of the dependent variable, while making sure the mediating variable was significantly related to both independent and dependent variables. All nominal variables entered into regression equations were first transformed into dummy variables where the group with largest number of subjects was chosen as a reference group and received a score of 0. Cases with missing data for some of the variables (when parents omitted a question) were excluded analyses by analysis.

Results

Preliminary Analyses: Gender and Age Effects

Gender relation to the variables of interest. Comparison between the Motor Development and Activities Checklist scores of boys and girls indicated only one significant difference: more boys (58%) than girls (42%) were categorized by their parents as "speed crawlers", $\chi^2(1)=4.92$, $p<0.05$. None of the other motor or socio-cognitive scores was associated with gender, though there was some tendency for higher use of walkers among boys (37%) than among girls (26%; $\chi^2(1)=2.99$, $p=0.08$). Sleep scores did not differ between boys and girls, except for a slight tendency for boys to have more awakenings per night ($M=1.71$, $SD=1.14$) than for girls ($M=1.41$, $SD=1.03$; $t(190)=1.87$, $p=0.06$). Some significant differences were found however in the prevalence of some of the parental night strategies but not in sleeping locations among boys and girls: proportionally more boys than girls (77% versus 57%) had night feedings ($\chi^2(1)=8.51$, $p<0.001$; $t(170.38)=3.11$, $p<0.01$), and parents of boys were more involved in the middle of the night awakenings, $t(180.79)=3.24$, $p<0.01$. Data from boys and girls were combined for subsequent analyses but the differences were taken into account when relevant.

Effects of age at the assessment. As expected, age at the assessment was positively correlated with the mobility index ($r=0.24$, $N=204$, $p<0.01$) and with the attainment of most motor and socio-cognitive skills as reported by parents at the time of the assessment. On the assessment date older infants were more often speed crawlers ($r=0.20$, $N=204$, $p<0.01$), and more often were able to crawl on hands and knees ($r=0.18$, $N=204$, $p<0.05$), as well as pull up to stand ($r=0.21$, $N=204$, $p<0.01$). Age also correlated with parental observations of infants searching for objects out of sight ($r=0.19$, $N=204$, $p<0.01$), and bringing objects when asked ($r=0.28$, $N=204$, $p<0.01$), but not with the behaviors related to seeking proximity with a parent.

Age at the assessment also showed significant associations with ongoing sleeping arrangements, night feedings and parental responses to infants' awakenings at nights. Older infants' sleep locations were more distant from the parents ($r=-0.20$, $N=203$, $p<0.01$) with fewer occasional co-sleeping episodes ($r=-0.18$, $N=204$, $p<0.05$), had fewer feedings at nights ($r=-0.15$, $N=196$, $p<0.05$), and their parents reported waiting longer before reacting to the infants' awakening/giving more time to the infants to go back to sleep by themselves ($r=0.22$, $N=201$, $p<0.01$).

However, a different pattern of results was observed when testing the relations between age and the sleep patterns. Though the infant's age was positively correlated with parental perception of infant sleep being problematic ($r=0.17$, $N=203$, $p<0.05$), it had not a single

significant correlation with the direct night-sleep measures as reported by the parents (all *ps* >0.46). In the day-time sleep older infants had fewer naps (r=-0.21, N=204, p<0.01), but no difference in their total hours of daytime sleep (r=-0.09, N=204, p=0.17). An identical pattern of results was observed when using age from conception (based on the infant's expected birth dates reported by parents), except for the correlation between age and sleep perceived as problematic being more pronounced in this analysis (r=0.24, N=190, p<0.01). Curve testing analysis did not show any non-linear relationships of age with sleep measures.

To summarize, age was related to the achievement of most developmental milestones, except for belly crawling and proximity seeking with a parent. Age was also related to more independent sleeping environment (farther location and less parental involvement at nighttime awakenings). However, age did not seem to be related to any of the direct *nighttime sleep* measures. Only parental perception of sleep problem in their infants tended to increase with age. *Daytime sleep* also seemed to become more consolidated with age by having fewer naps with no difference in total daytime sleep amount.

The pattern of association of the age at the assessment with the locomotor and socio-cognitive milestones and with parental strategies was taken into account in all the subsequent analyses in three ways. First, all sleep outcome measures were corrected for age using the regression corrected residual scores and the residual scores were used instead of the original sleep scores in all the analyses comparing groups using *t*-test and/or ANOVA. We also conducted all the analyses using the original scores and the result of these can be found in Appendix 1 for comparison. Second, when correlational analysis was appropriate - partial correlation test was used with age entered as a control variable. Third, age was entered in the first step in all regression analyses before entering other predicting variables.

Effect of the age of onset of developmental achievements. The age of onset of different motor skills, detailed in Table 1, had a very wide range in this sample and ensured that infants with both early and late motor development were included. Partial correlational analysis, controlling for the age at the assessment and the amount of experience in a given skill, did not show a single significant relation of any of the sleep measures with the age of onset of pulling up to stand, free standing, belly crawling and speed crawling. The age of onset of crawling on hands-and-knees, however, did show a strong relation with some of the sleep measures. Hands-and-knees crawling age of onset correlated negatively with problematic sleep according to parents, r_{pc} (40)=- .47, p<0.01; with average duration of night awakening, r_{pc} (40)=- .36, p<0.05 and with the duration of settling for the night sleep, r_{pc} (40)=- .36, p<0.05.

Table 1

Age ranges and mean ages of motor skills onsets in months

Motor skill	N	Range	Minimum	Maximum	Mean	SD
Belly crawling	152	6.95	3.44	10.39	6.95	1.39
Hands-and-knees crawling	150	6.03	4.95	10.98	7.77	1.29
Speed crawling	111	5.38	5.67	11.05	8.27	1.17
Pull up to stand	153	7.61	3.44	11.05	7.93	1.28
Free standing	65	4.52	6.69	11.21	8.63	.99

In other words, the earlier in development infants started crawling the longer it took them to settle for the night sleep as well as after awakening in the middle of the night, and the more t heir sleep was perceived as problematic by their parents. None of the parental strategies or closeness of sleeping arrangement correlated with the onset age of any of the crawling types (all *ps* >0.61). These results were taken into consideration in later analyses (details to follow).

Crawling and Sleep

Partial correlation (controlling for age) between the mobility index and sleep measures indicated only one significant relation: the more mobile the infants were, the longer it took them to settle/fall asleep for the night (r_{pc}=0.14, N=191, p=0.05). Before further examination of the relations between mobility and sleep we compared the sleep scores of infants who used different ways to move around by themselves. As expected, only a small number of babies used exclusively the rare types of moving around by means of either rolling (N=8) or scooting/crab-walking (N=7). Since these non-crawling types of locomotion are even less efficient in mobility than belly crawling and much less efficient than hands-and-knees crawling, and none of their sleep scores differed significantly from the non-crawlers (all *ps* >0.31), these infants' data was combined with that of the non-crawlers.

Next, belly crawlers were compared with hands-and-knees crawlers on age and all sleep scores. Even though no significant relation with age was found between the groups, regression corrected residual scores were nevertheless used for consistency. These analyses revealed significant differences between hands-and-knees crawlers and belly crawlers in the time spent awake at night, $t(63.95)=-2.44$, $p<0.05$; and in prevalence of sleeping through the night, $t(48.97)=-2.34$, $p<0.05$, with hands-and-knees crawlers having poorer sleep scores. Due to the differences, the groups were treated separately and the relations of these milestones to sleep patterns were explored independently.

The speed hands-and-knees crawlers (those who were able/preferred to move fast) did not differ significantly from the regular hands-and-knees crawlers (all *ps* >0.31) and were combined into one group of hands-and-knees crawlers, especially since all of the speed crawlers crawled on hands and knees with the only difference being in speed. The means and standard deviations of sleep scores by types of crawling versus no crawling are presented in Table 2.

Important to note, the belly crawling category only included infants who moved on belly exclusively. Many of the hands-and-knees crawlers also experienced belly crawling earlier in development, however they were included in the hands-and-knees category as they were predominantly moving on hands-and-knees at the time of the assessment. In summary, hands-and-knees crawlers did not differ from the speed-crawling infants, but did differ from belly-crawlers at least in some sleep measures. Infants using non-traditional ways of moving around such as rolling, scooting or crab-walking did not differ from the non-crawling infants. As a result, three separate categories of infants based on the type of locomotion were chosen for further analyses: (1) non-crawling infants, including those who move by other means, such as rolling, scooting or crab-walking; (2) infants crawling exclusively on their belly; (3) hands-and-knees crawlers, including speed hands-and-knees crawlers.

Table 2

Age and sleep scores means and standard deviations by types of mobility

	No crawling N=27	**Belly crawl N=31**	**Hand&Knees N=42**	**Speed crawl N=104**	**Total N=204**
Age in months	8.68 (.70)	8.93 (.95)	9.00 (.92)	9.28 (1.02)	9.09 (.97)
Sleeping through the night	1.52 (1.08)	1.96 (1.02)	1.44 (1.14)	1.45 (1.09)	1.52 (1.10)
Time spent awake at night	10.92(10.12)	9.00 (7.98)	17.11 (18.15)	11.78 (12.12)	12.60(13.37)
Number of awakenings	1.33 (.96)	1.50 (.88)	1.78 (1.18)	1.56 (1.14)	1.58 (1.10)
Average awakening duration	8.63 (7.12)	7.26 (5.24)	9.10 (7.09)	8.87 (7.61)	8.71 (7.16)
Duration of night sleep	642.7(60.5)	639.1 (52.8)	634.5 (65.6)	624.6 (72.4)	630.5 (67.6)
Pure sleep per night	631.2 (60.4)	632.7 (53.8)	618.2 (69.7)	613.6 (73.20)	618.9(69.17)
Duration of settling for night	11.61 (6.77)	11.60 (7.14)	14.28 (12.09)	16.07 (11.20)	14.62 (9.69)
Parental perception of problem	.20 (.41)	.30 (.56)	.48 (.66)	.48 (.76)	.42 (.58)
Number of daytime naps	2.40 (.52)	2.35 (.57)	2.20 (.59)	2.14 (.62)	2.21 (.60)
Total daytime sleep duration	135.7(43.29)	161.0 (67.81)	142.1 (64.04)	140.7 (58.88)	142.7(59.44)

Note: values in parentheses indicate Standard Deviations – (SD), values in bold - significant difference.

Belly crawling and sleep. First, we compared the mean ages of the infants who did not crawl at all with the ages of those who moved exclusively on belly and found no significant difference, $t(56)=-1.13$, ns. None of the sleep corrected for age measures differed significantly between the groups either, when compared using t tests except for one: belly crawlers had longer naps during the day time, $t(56)=-2.19$, $p<0.05$. None of the parental strategies/sleeping arrangement or demographic measures differed between the groups. Almost identical results were observed when rolling/scooting/crab walking infants were excluded from the analyses and belly crawlers were compared only to completely immobile infants.

To explore the effect of the initiation of belly crawling rather than the effect of the ability in general, new belly crawlers (less than one month of experience) were separated from the experienced. When the groups of new belly crawlers ($N=15$) and experienced belly crawlers ($N=16$) where compared with the 27 non-crawlers independently, no difference was found in age, use of walkers, parental strategies/sleeping arrangement or demographic characteristics. In sleep, however, two significant differences were found. The new belly crawlers differed from the non-crawlers in the overall daytime sleep $t(37)=-2.25$, $p<0.05$ and in the nap durations, with the new belly crawlers having the longest naps ($M=73.65$, $SD=21.95$) and the non-crawlers the shortest ($M=58.08$, $SD=19.41$; $t(37)=-2.31$, $p<0.05$). Thus new belly crawlers seemed to be responsible for the overall tendency found in previous analysis of all belly crawlers to have longer naps.

Hands-and-knees crawling and sleep. To test the effects of hands-and-knees crawling as the most efficient way of moving around specifically, we compared hands-and-knees crawlers with infants not yet able to locomote on hands and knees, including both non-crawling and belly-crawling infants. Thus in these analyses, an infant was categorized as a non-crawler if the infant

was not able to crawl on hands-and-knees, even if the infant was able to move on abdomen (was a belly crawler). When sleep scores of hands-and-knees crawlers (N=146) were compared with the scores of the infants who did not crawl on hands-and-knees (N=58) using t tests, a few differences were found to be statistically significant. The results are presented in Table 3.

As can be seen from the table, the parents of hands-and-knees crawlers perceived their children's sleep as more problematic, the crawlers slept through the night less often, had less pure sleep and also took longer to settle to sleep for the night. Though none of the other differences reached significance, all sleep scores of crawlers indicated poorer sleep. It is worth noting that the poor sleep did not seem to be compensated by daytime naps, on the contrary, the crawlers seemed to have less daytime sleep too (p=0.07) compared to the non-crawlers.

To rule out the possibility that other related factors may explain the differences, the groups were compared on parental strategies, sleeping arrangements, age and other demographics. The comparisons revealed that crawlers were significantly older, $t(202)=-2.53$, $p<0.05$, had higher parental involvement at bedtime, $t(202)=-2.81$, $p<0.01$, and more often than non-crawlers had a nighttime feeding, $t(105.17)=-2.42$, $p<0.05$. Moreover, when entered into regression after age and feeding, crawling still added significantly to the explained variability in settling for the night duration $\Delta F(1,200)=3.45$, $p<0.05$, even though feeding explained 2% of the variability before crawling was entered, $\Delta F(1,200)=3.41$, $p<0.05$.

Table 3

Sleep comparison of infants who crawled on hands-and-knees with those who did not

	Non-crawlers		**Crawlers**		
	Mean	**SD**	**Mean**	**SD**	**Test values**
Parental perception of sleep problem (0 to 3)	.26	.51	.50	.59	t(201)=-2.42*
Sleeping through the night (0 to 3)	1.73	1.07	1.42	1.10	t(201)=2.07*
Settling for night duration (minutes)	12.22	8.75	15.64	11.30	t(201)=-2.02*
Pure sleep per night period (minutes)	630.48	54.41	613.85	74.28	t(201)=1.88*
Duration of night sleep period (minutes)	639.95	53.67	626.38	72.65	t(201)=1.60, ns
Number of awakenings per night	1.43	.98	1.64	1.15	t(201)=-1.45, ns
Awakening average duration (minutes)	7.88	6.64	9.09	7.39	t(201)=-0.81, ns
Time spent awake at night (minutes)	10.66	11.00	13.43	14.22	t(201)=-1.36, ns
Number of naps	2.29	.539	2.17	.62	t(201)=0.88, ns
Nap average duration (minutes)	67.54	24.00	65.12	25.46	t(201)=0.67,ns
Total time of nap sleep per day (minutes)	153.79	62.54	137.81	57.59	t(201)=1.54,ns

+$p<0.08$. *$p<0.05$, **$p<0.01$

Feeding, however, seemed to be the best predictor of other measures – of the parental perception of sleep problem and of the prevalence of sleeping through the night. Crawling on hands-and-knees did not add significantly to the explained variability of these variables when entered after feeding. Rather, feeding (entered after both age and parental involvement at bedtime) explained 11% of parental perception variability, $\Delta F(1,188)=5.58$, $p<0.05$; and 27% of sleeping through the night, $\Delta F(1,193)=71.65$, $p<0.001$. Since higher involvement of parents of

crawlers did not conflict with their longer bedtime duration, rather supporting the notion of settling to sleep difficulty it was not entered into the regression.

To summarize, hand-and-knees crawlers had poorer sleep than infants not yet crawling on hands and knees based on four different sleep measures. However more frequent nighttime feedings of the hand-and-knees crawlers seemed to be responsible for at least two of the differences: for lower sleeping through the night prevalence and higher parental perception of a sleep problem of the hand-and-knees crawlers. At the same time, shorter pure sleep per night and longer settling for sleep duration of the hand-and-knees crawlers was not explained by feeding or any other variables except the crawling status itself.

*The onset of hand-and-knees crawling and sleep***.** To investigate the effect of hands-and-knees crawling onset rather than effects of crawling itself we divided the crawlers into groups based on the amount of experience in hands-and-knees crawling, thus separating newly crawling infants (less than 1 month of crawling experience, N=60) from experienced (more than 1 month of crawling experience, N=45) and "proficient" (more than 2 months of crawling experience, N=40) crawlers. We then compared all the groups between each other and with the infants not crawling on hands and knees (N=58), using analysis of variance (ANOVA) with contrasts. We did not use Multivariate analysis since many of the sleep variables had missing data as parents omitted answering some of the questions. Average duration of awakenings, for example, was not relevant for infants that do not wake up at night. Using ANOVA allowed excluding cases with missing variables analysis by analysis rather than a complete exclusion of a case with a single missing data point from all analyses.

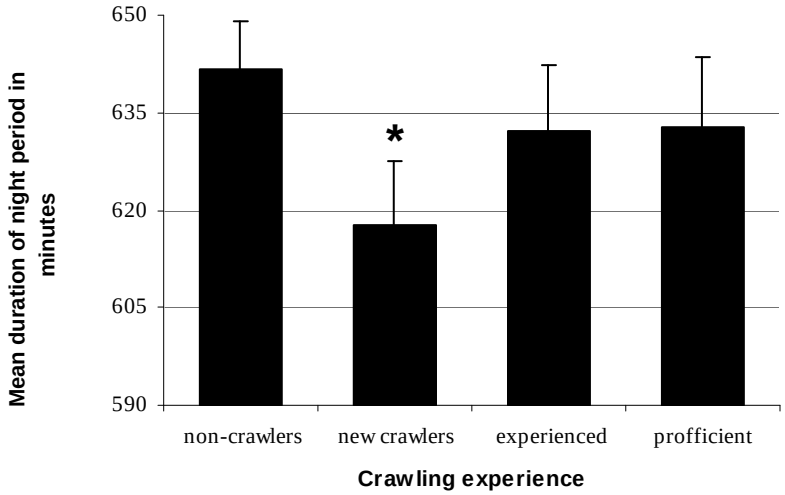
In the pair-wise comparisons only one age difference was found: proficient crawlers were significantly older (M=9.49, SD=0.91) than all the other groups, $t(202)=2.17$, $p<0.05$, but the new crawlers' mean age did not differ from the non-crawlers' or experienced crawlers' age (8.90, 8.85 and 9.11 months respectively). Age also did not correlate with any of the sleep measures within each group independently. Most of the sleep measures of the new crawlers, however, differed significantly from the scores of all other groups, and especially of the non-crawlers. Compared to all other groups the new crawlers had the highest number of awakenings, $t(187)=-1.92$, $p<0.05$; spent the most time awake within the night sleep period, $t(185)=-2.73$, $p<0.01$; and had the least pure sleep per night, $t(187)=1.87$, $p<0.05$. Pair-wise comparisons revealed that all three of the differences were even more pronounced between the new crawlers and non-crawlers. In addition, compared to the non-crawlers only the new crawlers turned out to have also shorter night sleep period, $t(197)=1.94$, $p<0.05$; slept through the night less often, $t(199)=2.14$, $p<0.05$; and their parents perceived their sleep as more problematic, $t(198)=-1.99$, $p<0.05$.

The means plots of the original sleep measures can be observed in Figure 1 (a, b, c, d, e). It can be seen on the figure that the new crawlers not only had a shorter night sleep period duration (went to sleep later and woke up earlier), but within this shorter period they also had more awakenings. The awakenings seemed to be the longest on average in this group (see Figure 1). Though not statistically significant, taken together with higher number of awakenings this difference contributed to the highest score for time spent awake at night and lowest score for the pure sleep per night period in this group. The new crawlers also did not seem to compensate for poor night sleep in day-time naps: though not statistically significant their total daytime sleep duration was actually less than in non-crawlers on average (M=136.11 versus 148.88).

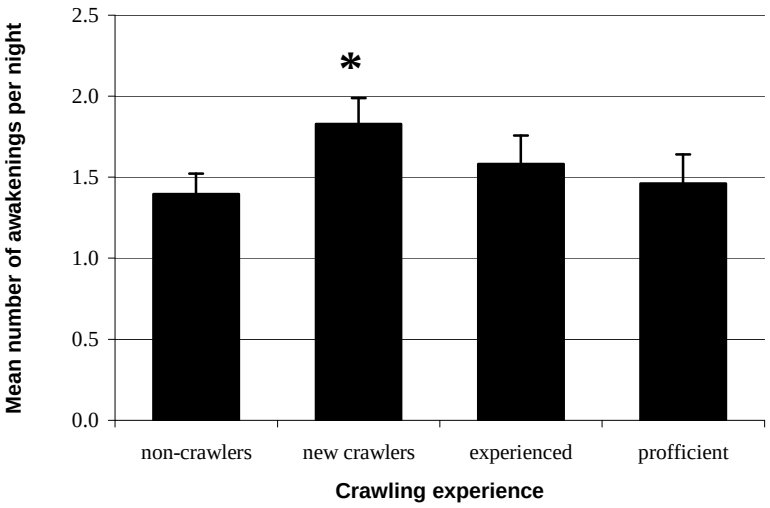
Figure 1

Means and Standard Errors of sleep measures by level of crawling experience

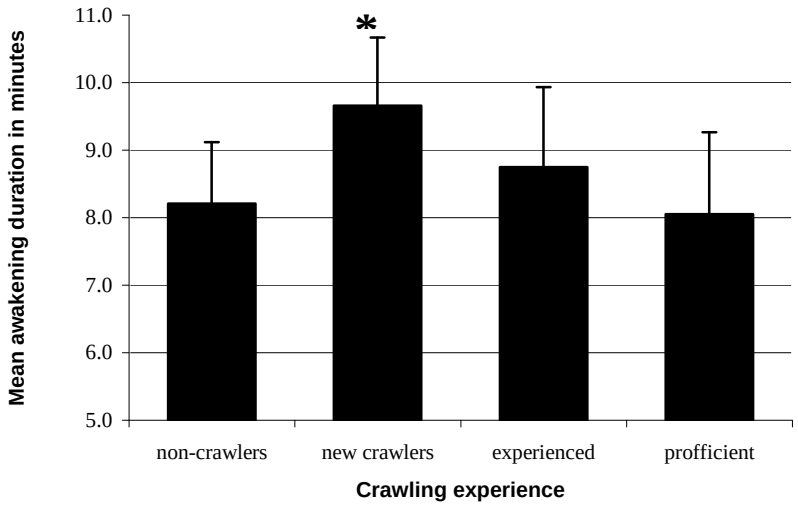
a) duration of night-sleep period



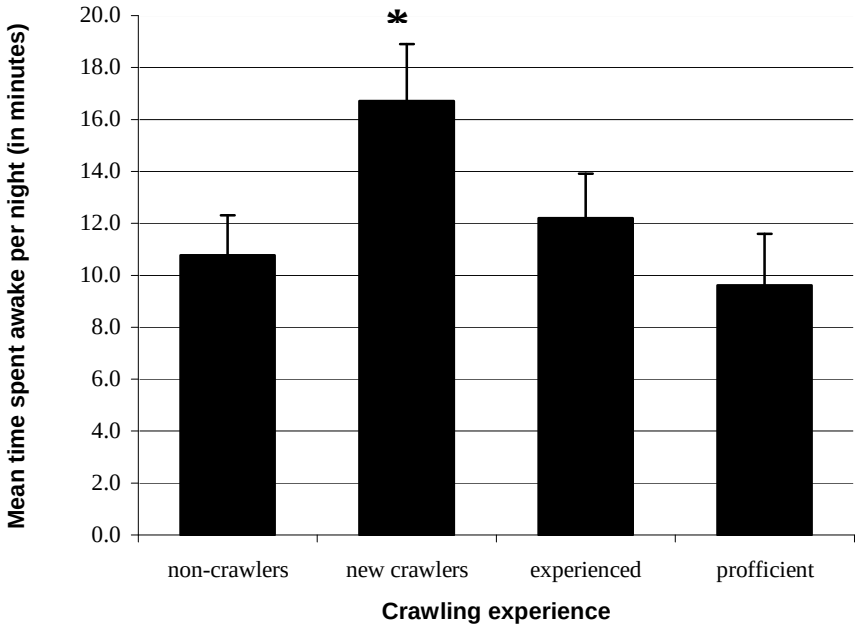
b) number of awakenings per night



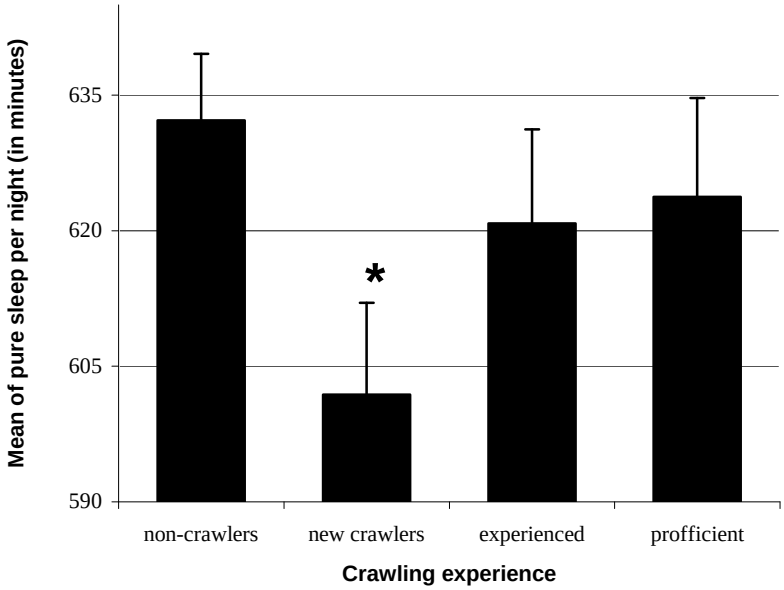
c) awakening duration



d) time spent awake per night



e) pure sleep per night



The new crawlers did not differ from other groups in any of the demographics or use of walkers. However, when we compared all the groups on the parental strategies and sleeping arrangements we found that the new crawlers' parents were involved the most in the settling for the night sleep $t(297)=-3.07$, $p<0.01$, had highest proportion of infants fed at night χ^2 (3, 20)=11.78, $p<0.01$, $t(199)=-2.99$, $p<0.01$, and had more occasional bed-sharing $t(199)=-2.08$, $p<0.05$. Feeding and bed-sharing indeed correlated with the ability to crawl on hands-and-knees (controlling for age), $r_{partial}(191)=0.23$, $p<0.01$ and $r_{partial}(191)=0.17$, $p<0.05$ respectively; but not with the amount of experience in crawling. In other words, more infants among those who could crawl (disregarding proficiency of crawling) had night feedings and bed-sharing episodes compared to those who couldn't crawl. However, the feeding and /or bed-sharing did not increase or decrease as the crawling progressed from no crawling to proficient crawling (more than 2 months of experience).

To rule out the possibility that the differences between the new crawlers and the non-crawlers could be explained by bed-sharing or simply more nighttime feedings we conducted a regression analysis for these two groups, while entering the crawling status after bed-sharing and feeding. We also included age and gender in the first step of the regression, even though there was no difference in age between these two groups. Feeding but not occasional bed-sharing explained a significant amount of variance in the sleep scores (details to follow in mediation analyses), reducing the prediction of crawling onset to non-significant for most of the night sleep scores. More specifically, crawling did not add to the variability explained by feeding in prevalence of sleeping through the night, in parental perception of the sleep problem, in number of awakenings and in time spent awake at night, but it did add to explained variability in the duration of night sleep period, $\Delta R^2=0.03$, $\Delta F(1,111)=4.02$, $p<0.05$; and of pure sleep per night, $\Delta R^2=0.04$, $\Delta F(1,103)=4.96$, $p<0.05$.

Since earlier age of onset of hands-and-knees/speed crawling correlated with some of the sleep measures in preliminary analyses (bedtime and awakening duration as well as sleep perceived as more problematic by the parents), we tested whether the new crawlers had relatively early age of crawling onset which could potentially explain their poor sleep compared to other groups. Using contrasts in the analysis of variance when controlling for age we found that the new crawlers' mean age of onset was actually later (M=8.37, SD=1.02) than of either experienced, M=7.82, SD=0.98, $t(146)$=2.71, $p<0.01$, or proficient crawlers, M=6.46, SD=1.02, $t(146)$=9.12, $p<0.01$. This result was not unexpected since given a similar age infants having more experience of crawling should have started to crawl earlier.

To summarize, infants who just started to crawl (within one month of onset) had the poorest sleep compared to all other groups based on most of sleep measures. These infants also had higher frequency of occasional bed sharing and of nighttime feeding and the feeding (but not bed-sharing) did explain some but not all of the differences. While feeding explained differences in prevalence of sleeping through the night, in parental perception of the sleep problem, in number of awakenings and in time spent awake at night, onset of crawling still was responsible for differences in the duration of night sleep period, and of pure sleep per night. No other variables, including early versus late onset of crawling, seemed to be contributing to the differences.

Mediating Effects in the Relation of Crawling to Sleep

Since most significant differences were found between the non-crawlers and new hands-and-knees crawlers (less than 1 months of experience), and since the shift to locomotion rather than locomotion per se was the primary interest of this research we excluded the experienced and proficient crawlers from the mediation analyses. Thus all mediating analyses were based on a sample of 58 non-crawling and 60 newly crawling infants. Though not predicted in the research hypotheses feeding seemed to play a mediating role in the relation between crawling onset and sleep based on the previous analyses. Indeed, feeding at night could be considered as a mediator of the relation between newly started crawling and sleep based on criteria suggested by Baron and Kenny (1986). New crawler status predicted feeding (B=0.26, SE=0.08, β=0.28, t=3.10, $p<0.01$), feeding explained a significant portion of variance in all of the night sleep measures predicted by new crawling except from duration of night period, (see Table 4 for significant predictions), and reduced the effect of crawling to non significant when entered together into a regression equation predicting all sleep measures except from duration of night sleep period and pure sleep per night (as reported earlier).

Table 4

Regression analyses examining the prediction of night sleep scores from night feeding

Variables predicted by feeding	**B**	**SE**	**β**	**t**	**R^2**
Parental perception of sleep problem	.40	.12	.32	3.46**	.09**
Sleeping through the night	1.33	.19	.57	7.06**	.29**
Number of awakenings per night	.911	.22	.39	4.08**	.13**
Time spent awake at night	11.21	3.10	.36	3.61**	.11**
Pure sleep per night period	-22.60	15.34	-0.16	- 1.78+	.03+

+$p<0.08$. *$p<0.05$, **$p<0.01$

Even though feeding seemed to mediate the effect of the onset of crawling on the night sleep a significant portion of the variance in some of the sleep measures was unexplained by feeding while predicted by the crawling onset (new crawling status). Thus other mediators such as socio-cognitive changes could play a role too. Based on the approach of Baron aND Kenny (1986), we first tested the relations between the new crawling and socio-cognitive abilities. New crawling did not predict infant search for parent when the parent is out of the room and giving an object when asked, but it did predict proximity seeking with parent when in the same room (B=0.51, SE=0.08, β=0.53, t=6.62, p<0.01) and searching for objects out of sight, as reported by parents (B=0.43, SE=0.08, β=0.44, t=5.37, p<0.01).

Moreover, in the entire sample (including experienced and proficient crawlers) the age of crawling onset (M=7.77, SD=1.29) correlated with age of onset of proximity seeking behaviors (M=7.83, SD=1.22, r=0.67, N=141, p<0.01) and the onset of searching for objects (M=8.42, SD=1.09, r=0.71, N=102, p<0.01). None of the sleep scores were predicted by search for object out of sight, however proximity seeking with a parent significantly predicted all the same sleep scores as the new crawling did, and when entered into the regression equation reduced all the effects of crawling to non-significant (see Table 5 for details). In summary, feeding and proximity seeking were found to be mediators of the *relation* between onset of crawling and sleep based on all the criteria suggested by Baron and Kenny (1986).

Table 5

Regression mediation analyses examining the prediction of night sleep scores by new crawling and proximity seeking with a parent separately and together

	New crawling alone		**Proximity seeking alone**		**New crawling when entered with proximity seeking**	
	β	T	β	t	β	t
Parental perception of sleep problem	.19	2.04*	.15	1.67+	.15	1.36, ns
Sleeping through the night	-0.20	-2.27*	-0.15	-1.66+	-0.17	-1.63, ns
Duration of night sleep period	-0.18	-1.93+	-0.15	-1.65+	-13.	-1.22, ns
Number of awakenings	.19	2.08*	.21	2.26*	.11	1.03, ns
Time spent awake at night	.20	2.14*	.16	1.72+	.16	1.43, ns
Pure sleep per night period	-0.20	2.05*	-0.19	-1.95*	-0.13	-1.16, ns

+p<0.08. *p<0.05, **p<0.01

Sleeping Location as a Moderator of the Relation Between Crawling Onset and Sleep

For the assessment of the moderating effect we limited the sample to non-crawling and newly crawling infants only again and in addition excluded infants with mixed sleeping arrangements (most of the parents in these category reported solitary sleeping arrangement for their infants with part of the night spent by the infants in the parental bed). Based on the nature of the moderating hypothesis it was important to include only stable sleeping arrangement not related to occasional bed-sharing. Infants sleeping in the same rooms as their parents were combined with infants sharing the bed with their parents into a co-sleeping category as opposed to infants sleeping solitary in separate rooms. The distribution of the groups based on the sleeping location can be found in Table 6.

Table 6

Numbers of non-crawling and newly-crawling infants sleeping close to parents versus separately

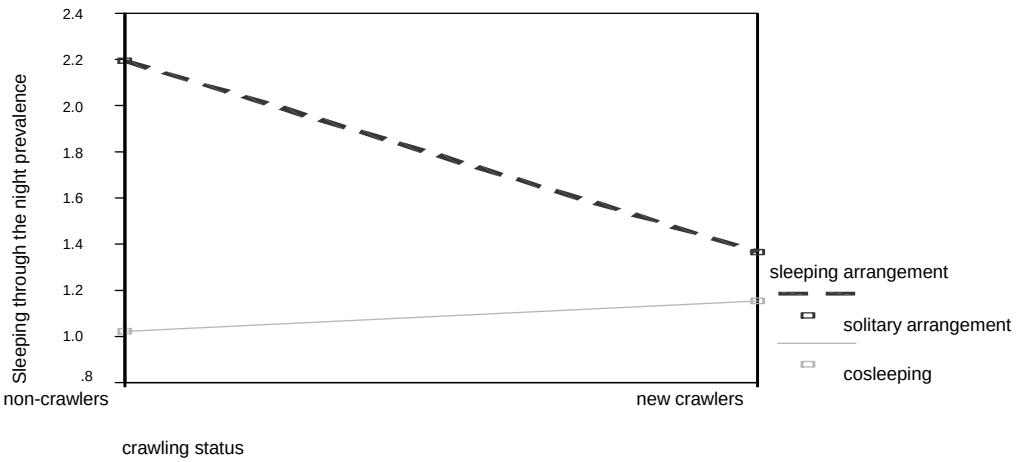
		Sleeping location		Total
		Solitary room	**Co-sleeping**	
Crawling status	Non-crawlers	38	19	57
	New crawlers	29	28	57
Total		67	47	114

First we looked at the relation between crawling and sleeping location and found that new crawlers were sleeping with their parents more often (M=1.49, SD=0.50) than non-crawlers (M=1.33, SD=0.48), though the difference was only close to significance, $t(112)$=-1.72, p=0.09). Given the relation with the independent variable sleeping location could not be considered as a classical moderator but we still looked at the interactions between the crawling onset and sleeping location in the effect on night sleep using ANOVA, while controlling for age and gender. Three significant interactions were found in this analysis. The interaction plots are presented in Figure 2 (a,b,c). Only for solitary sleeping infants and not for co-sleeping ones the onset of crawling was associated with lower prevalence of sleeping through the night ($F(1,94)$=5.81, p<0.05), longer awakening duration ($F(1,94)$=3.88, p<0.05), and longer time awake at night ($F(1,94)$=5.03, p<0.05).

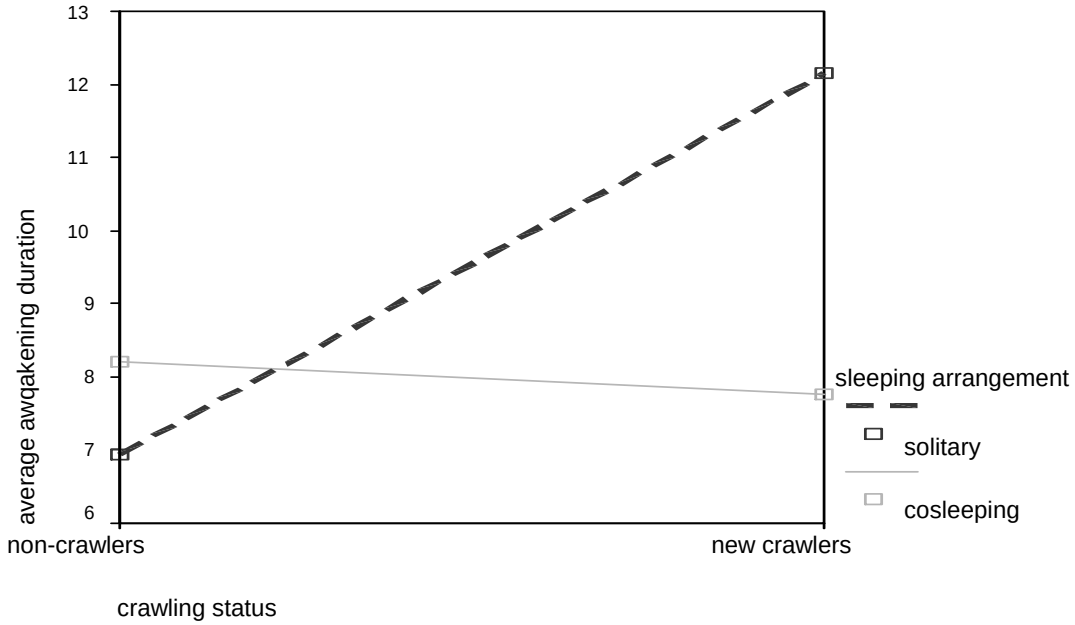
Though for most other sleep measures the effects looked very similar they did not reach an acceptable level of significance. We also looked whether effect of crawling on proximity seeking of the infant depended on the sleeping location, but this effect was the same for the two groups as can be clearly seen on Figure 2(d). To summarize, though both co-sleeping and solitary sleeping infants similarly exhibited increased proximity seeking with achievement of hands-and-knees crawling, only solitary sleeping infants showed poorer sleep based on some of the sleep measures. Co-sleeping infants, on the other hand, did not show different sleeping patterns based on the status of crawling.

Figure 2

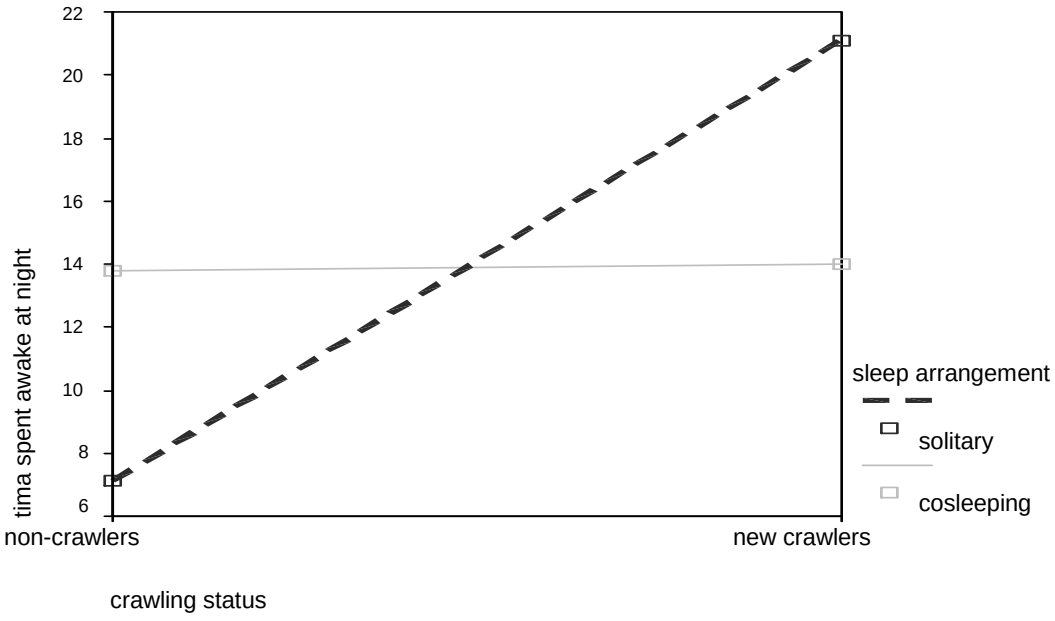
a) Sleeping through night by crawling status in co-sleeping and solitary sleeping infants



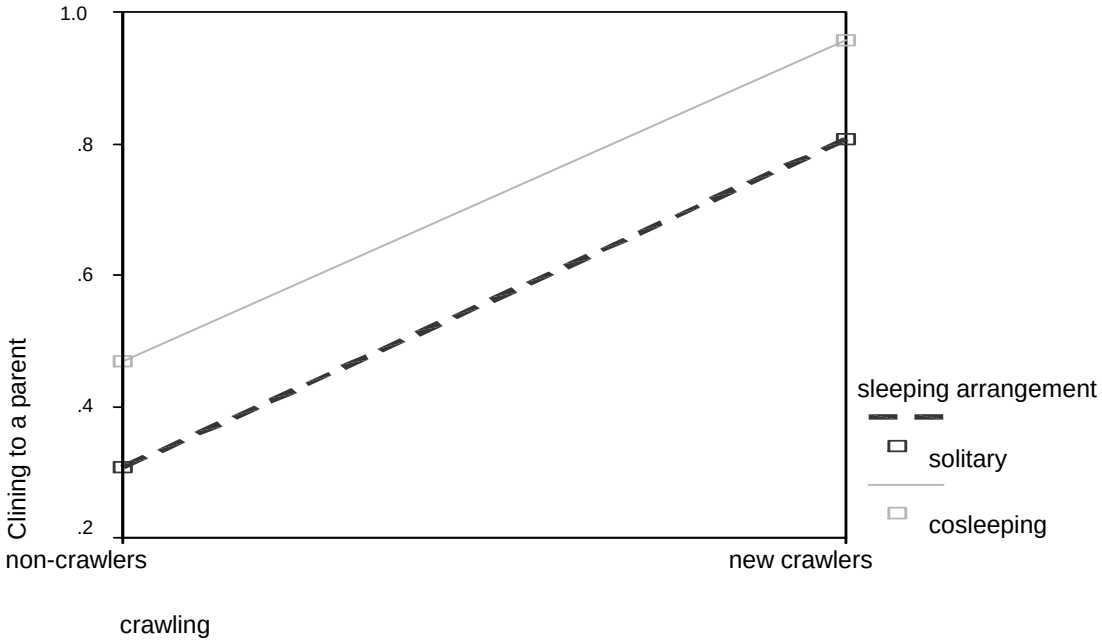
b) Average awakening duration by crawling status in co-sleeping and solitary sleeping infants



c) Time awake at night by crawling status in co-sleeping and solitary sleeping infants



d) Proximity seeking by crawling status for co-sleeping and solitary sleeping infants



Mobility Non-related Motor Milestones and Sleep

Pulling up and sleep. Since infants who were able to pull up to stand at the time of assessment (N=153) were on average older than those who couldn't (N=51) as reported earlier, regression corrected for age scores were used instead of original sleep scores. However original scores were also compared and the results can be found in Appendix1. The comparison results based on regression corrected scores for the two groups of infants are presented in Table 7. The table also includes original sleep scores means and standard deviations for the groups. The results seemed to mirror the effects of crawling with a lesser significance except from the effect on the number of awakenings per night.

Indeed, the transition to being able to pull up seemed to co-occur with crawling onset: only 13.70% of infants who were able to pull up did not crawl yet, while only 19.6% of crawling infants were not able to pull up, χ^2 (1,204)=80.36, p<0.01). Moreover, the age of crawling onset (M=7.77, SD=1.29) correlated with age of onset of pulling up (M=7.94, SD=1.28, r=0.69, N=139, p<0.01). Thus, when entered into regression analysis after age and crawling status, pulling up added significantly only to number of awakenings, ΔR^2=0.03, ΔF(1,188)=5.39, p<0.05. This result was even more significant among non-crawlers and new crawlers only, ΔR^2=0.06, ΔF(1,106)=7.15, p<0.01.

Table 7

Sleep measures: means, standard deviations and t-values from comparison of infants who could pull up to with those who did not

	Unable to pull up		Able to pull up		
	Mean	**SD**	**Mean**	**SD**	**Test values**
Number of awakenings per night	1.27	.86	1.68	1.16	t(211.65)=-3.17**
Pure sleep per night period (in minutes)	633.24	58.37	612.95	72.20	t(201)=1.88*
Duration of night sleep period (in minutes)	644.55	57.35	625.86	70.26	t(200)=1.83+
Sleeping through the night (0 to 3)	1.73	1.04	1.44	1.11	t(202)=1.88+
Settling for night duration (in minutes)	11.93	8.59	15.48	11.17	t(192)=-1.73+
Parental perception of sleep problem (0 - 3)	.27	.53	.47	.59	t(90.98)=-1.70+
Awakening average duration (in minutes)	8.22	6.18	8.88	7.50	t(182)=-0.24, ns
Time spent awake at night (in minutes)	10.42	10.20	13.52	14.25	t(186)=-1.34, ns
Number of naps	2.38	.51	2.15	.62	t(201)=0.88, ns
Nap average duration (in minutes)	67.99	25.84	65.15	24.75	t(201)=0.67, ns
Total time of nap sleep per day (in minutes)	158.95	63.62	137.24	57.17	t(201)=1.54, ns

+p<0.08. *p<0.05, **p<0.01

Thus the effect of pulling up to stand on number of awakenings could be considered specific to pulling up independently of crawling status and was examined further. To see whether the effect of pulling up on number of awakenings was more pronounced in infants who were sleeping in cribs (which allows the activity of pulling up to stand at night) we tested the interaction between pulling up and sleeping location on the number of awakenings. For the comparison of infants sleeping in crib versus parental bed we excluded infants having a mixed (crib/parental bed) sleeping location. We also combined data from infants sleeping in the same room as their parents with solitary sleeping infants into one “sleeping in a crib” category versus infants sleeping in a parental bed. The effect was similar in both groups and the interaction was not significant, F (1,173)=0.05, p=0.83.

To see whether the socio-cognitive changes could explain the effect of pulling up to stand on the number of awakenings we conducted mediation analyses, controlling for age and gender. Though pulling up predicted proximity seeking with a parent when in the same room (t=7.25, p<0.01), searching for a parent who is out of the room (t=3.42, p<0.01) and searching for an object that is out of sight (t=5.53, p<0.01), none of the variables reduced the significance of the pulling up as a predictor of number of awakenings when entered into a regression equation together (after age and gender). In summary, above and beyond crawling status pulling up to stand seemed to be associated with more frequent night-waking, but this association was neither mediated by socio-cognitive changes nor moderated by a sleeping location.

Free standing and sleep. When infants who were able to stand free without support (N=155) were compared with infants not able to do so (N=49) on sleep measures no significant differences were found. The results were the same when using either original sleep scores or the regression corrected residual scores. A similar pattern was observed when controlling for

crawling status.

Use of Walkers and Sleep

First we looked at the differences between sleep scores of the walker users versus non-users in the whole sample (regardless of crawling experience). Out of the 205 infants 66 used walkers: 18 of them did not crawl on hands-and-knees yet while 48 did. Infants who used walkers did not differ on age, ethnicity, crawling status or sleeping arrangement from infants who did not use walkers. But in families where walkers were used mothers had a lower education, $t(195)=3.23$, $p<0.01$; as did fathers, $t(193)=4.07$, $p<0.01$; and their family income was lower compared to families that did not use walkers, $t(200)=2.66$, $p<0.01$. Parents of walker-users also reported less involvement in night-time awakenings of their infants, $t(197)=1.98$, $p<0.05$.

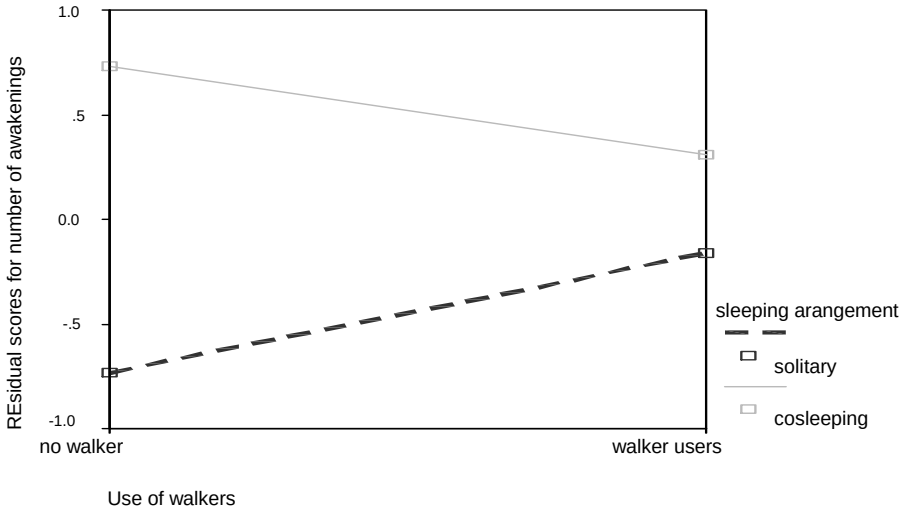
When we compared sleep scores of the walker users versus non-users in the whole sample using ANOVA, while controlling for parental involvement in awakenings and parental SES (socio-economical status comprised from parental education and family income), no significant differences were found. The groups did not differ on the socio-cognitive scores either and no significant interaction was found between walker use and sleeping arrangement. Neither the length of experience in walkers nor the amount of use per day correlated with any of the sleep measures when tested using partial correlation controlling for SES among walker users only. Neither use of walker nor age of start of walkers correlated with age of onset of the different motor skills or age of sleeping through the night.

To assess the effect of walkers relative to no mobility at all we compared infants who did not crawl but used walkers ($N=18$) with those who neither crawled nor used walkers ($N=44$). Among the non-crawlers walker users were significantly older ($M=9.28$, $SD=1.12$) than non-users ($M=8.65$, $SD=0.79$; $t(24.17)=-2.14$, $p<0.05$) and their family income was lower ($t(60)=2.91$, $p<0.01$). When compared on the sleep regression corrected for age residual scores while also controlling for family income in ANOVA only one significant difference was found between the groups on the sleep measures: the walker users had shorter night duration ($M=621.67$, $SE=49.40$ based on original scores in minutes) relative to non-users ($M=647.62$, $SE=54.08$; $F(1, 61)=4.32$, $p<0.05$). The difference in pure sleep between the groups was close to significant, $F(1, 56)=3.73$, $p=0.06$.

None of the socio-cognitive scores differed between the groups (all p's >0.12). However, when we tested the interaction between use of walkers and sleeping arrangement (solitary versus co-sleeping infants excluding mixed arrangements) one interaction was found significant. Parents of solitary sleeping infants reported more awakenings if their infant used a walker, while parents co-sleeping with their infants reported fewer awakenings if they used a walker relative to non-users, $F(1, 55)=4.17$, $p<0.05$ (see Figure 3). Almost identical results were observed when belly crawlers were excluded from the sample and 20 completely immobile infants were compared with 11 infants who could move around by walkers exclusively. Only 4 of the non-crawling walker users had less than 1 month of experience in walkers at the time of assessment so that analysis of the effect of onset of walkers relative to no mobility was not possible. Among the non-crawlers only, similarly to the whole sample, neither amount of experience in walkers nor the amount of time using it per day correlated with any of the sleep measures (when tested using partial correlation controlling for age and family income).

Figure 3

Interaction between use of walkers and sleeping location on sleep



To summarize, use of walkers did not seem to have any effects on sleep in general. However, compared to immobility or inefficient ways of crawling, use of walkers had effects somewhat similar to the effects of crawling on the duration of sleep. Moreover, walker users seemed to have more awakenings than non-users if they slept separately from their parents. Co-sleeping walker users, on the other hand, seemed to have even fewer awakenings than non-users based on parental reports.

Discussion

The main hypothesis of the study that a shift in infant locomotor abilities would show an association with changes in infant sleep patterns was generally supported by the findings. Importantly, age of infants at the assessment of sleep in this sample did not explain any of the direct nighttime sleep measures, even though parents of older infants perceived their infants' sleep as more problematic. The lack of actual change of sleep as a function of age from measures reported by the same parents points to rather growing parental expectations with age, possibly leading to higher perception of a problem in older infants even if their sleep is not really different from that of younger infants. In contrast, developmental stage related to locomotion seemed to explain differences in sleep better than age. More specifically, as with previous findings (Scher, 2005; Scher & Cohen, 2005) crawling was associated with poorer sleep.

However, it is important to note though that among the different types of crawling only crawling on hands-and-knees seemed to be related to poorer sleep. In contrast to findings reported by Scher & Cohen (2005) that there was no difference between belly crawlers and hands-and-knees crawlers in sleep, we did find that the belly crawlers had a different pattern of sleep with less time spent awake at night and higher prevalence of sleeping through the night than did hands-and-knees crawlers. Moreover, belly crawling actually seemed to have an opposite effect on sleep, since compared to the non-crawling infants the belly-crawlers, and especially new belly-crawlers, had longer daytime naps. This finding is not surprising and

supports our hypothesis that belly crawling, like other unconventional ways of moving, is very effortful and not very effective, thus probably leading to more tiredness than exploration in the infants.

Hand-and-knees crawling, on the other hand is the most effective way of crawling. However, as the results of the current study suggest it is not the crawling per se that causes the sleep disturbances but the transition from being ineffectively mobile to effectively mobile (by means of hands-and-knees crawling). Thus, the new crawlers who started to crawl within a month of the sleep assessment time were found to have the poorest sleep in the current sample based on most sleep measures: prevalence of sleeping through the night, parental perception of the sleep problem, number of awakenings, time spent awake at night, duration of night sleep period, and duration of pure sleep per night.

Moreover, the association of crawling onset with sleep disturbances was not related to an earlier age of crawling onset. Even though early crawling onset did show an association with more disrupted sleep, suggesting that infants who start crawling earlier differ from late crawlers on some additional parameter that might also be responsible for more disturbed sleep, the new crawlers did not seem to have exceptionally young age of crawling onset. As a matter of fact the new crawlers had a later age of onset than either experienced or proficient crawlers. Thus the crawling status at the time of sleep assessment seemed to have a stronger effect on infant sleep than the characteristics related to being early versus late crawler, since even while having relatively late crawling onset, the new crawlers still had the least sleep.

However, the new crawlers also had the most night feeding and this factor explained most of the sleep differences of the new crawlers from other groups, except for duration of night period. The effect of feeding was unexpected. Though it is not possible to determine the causal relation it is not likely that feeding stimulates crawling, since it does not explain why the most fed infants would start crawling before the study took place independently of their age, especially given the fact that the new crawlers included a wide age range of crawling onset. The opposite direction is more likely with at least three possible explanations: (1) that onset of crawling requires more feeding since there should be a spurt of physical activity with the start of crawling; (2) the parents interpret the sleep disruptions of their infants as need for food because the infants just started to crawl; (3) the parents use feeding as the easiest solution for the frequent and disruptive night awakenings. These explanations also fit well with another finding that newly crawling infants have more occasional bed sharing. Either way feeding seemed to mediate most of the effects of crawling onset on sleep.

Moreover, feeding was not the only mediator of the relation between onset of crawling and sleep. Though socio-cognitive changes related to awareness of object properties or ability to follow directions were not shown to mediate the relation in this study, the proximity seeking behaviors of infants as reported by parents did meet the criteria of a mediator. The group of newly hands-and-knees crawlers had significantly higher proportion of infants exhibiting proximity seeking behaviors compared to infants who did not crawl on hands and knees, and this difference explained most of the variation in sleep between the non-crawlers and hand-and-knees crawlers. This finding supports our hypothesis suggesting that onset of crawling might affect sleep through heightened sensitivity to or awareness of separateness from parents as a result of continuous experience of changing the distance from parents while crawling.

Further support for the same explanation comes from the interaction found between sleeping arrangement and hands-and-knees crawling onset. As predicted, only for solitary sleeping infants and not for co-sleeping ones the onset of crawling was associated with lower prevalence of sleeping through the night, longer awakening duration, and longer time awake at night. Thus new crawlers who were co-sleeping with their parents, either in the same room or in the same bed, did not differ from co-sleeping non-crawlers, suggesting that the onset of crawling did not have an effect on their sleep, as they did not need to seek proximity to their parents or protest separation given their closeness to parents at night. The sleeping arrangement, though, did not meet all the criteria for a moderator since it was also related to the independent variable: parents were co-sleeping more often with new crawlers than with non-crawlers. However, even if onset of crawling led parents to closer sleeping arrangements, the explanation that co-sleeping infants do not show the effect of crawling because of the close proximity with the parents still remains possible.

The link between crawling and sleep, of course, could have alternative explanations such as maturational physiological changes that drive both onset of crawling and changes in sleep patterns. However, such an explanation is unlikely due to the lack of relation of sleep to age and also the fact that crawling onset is a phenomenon that depends on many different factors, such as infant weight or parental preferences for infant environment (playpen versus floor). The best evidence comes from cross-cultural studies: Chinese infants show a 3.3 months delay in the onset of locomotion for cultural and ecological reasons, mainly related to little space and sanitary problems (Campos et al, 2000). Similarly, sleep is influenced by a variety of exogenous factors and not solely defined by infant physiological maturation (Anders et al, 1992).

An achievement of another developmental milestone - pulling up to stand, but not free standing – was closely related to the onset of hands-and-knees crawling and thus had very similar effects on sleep. Although the age of onset of pulling up follows the onset of hands-and-knees crawling, it is still not completely clear whether crawling and not pulling up is responsible for all of the differences in sleep. Pulling up seemed to be also associated with more frequent night waking independent of crawling status, and this effect was not explained similarly to crawling, since it was neither mediated by socio-cognitive changes nor moderated by sleeping location. As parental report and not objective sleep measure were used in this study, it is possible that the effect of pulling up stems from parents' better awareness of the awakenings, since the infant can pull up, become more awake and then call/signal to the parents. Further studies are needed to clarify the effect as well as differentiate the effects of pulling up and of crawling.

Use of walkers did not seem to have any effects on sleep in general. However, compared to immobility or inefficient ways of crawling, use of walkers seemed to have a similar effect on sleep as did crawling, though to a much lesser degree. The walker users only had shorter duration of sleep compared to the non-crawling infants, and did not differ on any other sleep measures. Interestingly though, walker users also seemed to have more awakenings than non-users if they slept separately from their parents. Co-sleeping walker users, on the other hand, seemed to have even fewer awakenings than non-users based on parental reports. Less sleep and more awakenings of the walker users are consistent with our hypothesis that any efficient way of moving should affect sleep. This pattern of results is also consistent with the findings of Campos et al (2000) who reported that walker users exhibited weaker but similar developmental changes to those normally associated with crawling.

In conclusion, the non-experimental design restricts directional interpretation but the present findings point to the possibility that the regression in sleep that is observed in the second half of the first year of life might be related to a normative and major developmental transition. The phenomenon of elevated sleep disturbances during this age has been documented both in cross sectional (Armstrong, Quinn, & Dadds, 1994; Goodlin-Jones, Burnham, Gaylor, & Anders, 2001) and longitudinal studies (Anders & Keener, 1985; Scher, 1991). However, based on the findings of the current study this widely documented phenomenon should not be considered simply as an age-related effect. Further, not chronological age, but developmental stage should be used in analysis of sleep development since infants acquire different skills at different ages. More specifically the findings suggest that crawling onset is an important milestone and should be taken into account while studying sleep in infancy.

Another important implication of the finding it that if sleep disturbances related to locomotor development are considered a normal developmental phenomenon these should be carefully differentiated from real clinical sleep problems and should not treated as such. Since many parents start applying sleep training techniques when infant' sleep becomes more disrupted in the second half of the first year (see chapter 3), it is important that the parents, as well as sleep professionals advising parents, be informed about the possibility of disruption in sleep being a temporary and normal developmental phase. If the disruption is indeed related to the child heightened sensitivity to separation and proximity seeking, sleep training techniques might actually worsen the situation and be even potentially harmful for the child's development.

Study 2: Walking, Use of Walkers and Sleep

The main aim of this study was to compare sleep patterns of infants who started upright locomotion versus infants still moving around in prone position or not able to move effectively at all. The second aim of this study was to see if any effects of upright locomotion are mediated by socio-cognitive changes and/or moderated by sleeping arrangements. An additional goal was to explore a possible association between use of walkers and sleep patterns in a different age range than of Study 1.

Methods

Sample

Mothers of 162 infants aged between 9 and 13 months (M=11.00, SD=1.38) completed questionnaires for this study. This sample of families was not completely independent from the crawling sample of Study 1. Reports of 79 mothers of non-walking infants from Study 1 were included in this sample as the infants fit the criteria of Study 2 as well. The participation criteria of Study 2 included healthy infants with no developmental delays between the ages of 9 to 13 months (as opposite of 6 to 12 criteria of Study 1). The overlap of subjects, however, should not constitute a problem since the objective of this study is different and centered on the onset of walking while non-walking infants only provide a base for comparison. There shouldn't be any sampling bias as well as families were recruited for both studies simultaneously based on a wide age range of infants and were separated into samples based on the specific criteria of the samples after the recruitment was finished.

All the families were recruited through the list of volunteer participants in the Bay Area maintained by the Institute of Human Development of the University of California, Berkeley.

The mothers (aged *M*=29.6 years, *SD*=4.2) primarily had a college education (46.3% of the sample), 33.6% had higher than college education (held graduate degrees), 17.4 % had a high school diploma, and only 2.7% had only some high school. There were 82 boys and 79 girls in this sample of infants, primarily from White Caucasian population (51.3%), 12.2% were Asian, 5.2% - African-American, 7% - Hispanic and 24.3% had a mixed ethnicity.

Assessments

The mothers completed the same set of questionnaires as in Study 1: a Sleep Questionnaire, and a Motor Development and Activities Checklist, in addition to a basic demographic questionnaire. Based on the Motor Development and Activities Checklist the infants were assigned a status of walking if they could walk for at least 3 steps at a time without holding onto anything or anyone, according to maternal report. Another milestone included in the Checklist and relevant to the age range of walking was “cruising”, or moving upright on two feet along furniture and walls while holding onto them. An infant was assigned a status of cruising if she or he could move around using furniture or walls for at least 3 steps at a time. The infants were defined as walker-users if they spent any time in the walkers at least once a day on most days based on the information provided by the parents in the checklist.

Three scores were obtained from the Motor Checklist regarding the two milestones of walking and cruising (i) distinction between infants who achieved the milestone and those who did not; (ii) age when the milestone was achieved; (iii) the amount of experience acquired for the milestone up to the testing date in days as well as on a scale from 0 to 3, where 0 means no experience, 1 means 31 day of experience (new to the skill), 2 means 31 to 62 days (experienced in the skill), and 3 means more than 62 days (proficient). Same scores were obtained regarding the socio-cognitive skills. Crawling experience was assessed in this study too (in a similar manner as in study 1) with the purpose to control for the possible interfering effect of crawling onset versus crawling per se when comparing the walking infants to crawling.

The use of walkers was assessed based on a starting point of using the device instead of an achievement of a skill. A fourth score was obtained for the use of walkers that was related to the duration/amount of time of use per day (from 1, 15 minutes or less to 5, more than 2 hours). In addition, A mobility index was calculated pertaining to the progress in effective locomotion from 0 to 5, where 0 means no effective moving (neither hands-and-knees crawling nor walking), 1 means hands-and-knees crawling, 2 means cruising, and 3 means independent walking. The use of walkers was not included in the mobility index since it is not a fully controlled self-movement.

The Sleep Questionnaire was the same questionnaire used in Study 1 and it provided the following scores: (1) duration of the entire night sleep period from sleep onset to morning wakening (in minutes); (2) duration of settling for night-sleep - time it takes to fall asleep for the night; (3) number of awakenings per night; (4) average duration of night awakenings; (5) time awake at night - number of awakenings multiplied by the average time of falling back to sleep; (6) pure sleep per night – time spent asleep out of the entire night sleep period, defined as duration of the entire sleep period minus the time awake at night.

Two more scores pertained to prevalence of sleeping through the night as well as to parental subjective perspective of sleep being problematic (ranging from 0, not a problem at all,

to 3 – a serious problem). Night feedings and parental strategies of settling the infant back to sleep when awakened in the middle of the night were also assessed based on parental presence and involvement in the process of infant falling asleep (1 - no involvement or presence at all, 2 - mere presence of a parent, 3 being actively involved) as well as on parental reluctance to respond to a night time awakening (the wait time before responding).

Approach to Analyses

Statistical analyses examining the relation between walking/cruising and sleep patterns were based on comparisons of the sleep patterns between groups of infants who could walk/cruise with those who couldn't, while taking into account the different locomotive/crawling experience of the non-walking infants. First, the hypotheses were tested using simple group comparisons through *t* tests. Then, to address specifically the link between the onset of walking/cruising (versus the status of being able to walk) and sleep, groups with different walking experience were compared too through ANOVA. A similar approach was taken to examine the link between sleep and the use of walkers. Mediation and moderation analyses were conducted according to the methods of Baron and Kenny (1986), similar to Study 1. Cases with missing data for some of the variables (when parents omitted a question) were excluded from analysis.

Results

Preliminary Analyses: Gender and Age Effects

Gender effects. Comparison between the Motor Development and Activities Checklist scores of boys and girls indicated only one significant difference: girls were more often reported by their parents to be able to give/bring a specific object when asked, $t(151.47)=-2.28$, $p<0.05$. When compared on sleep scores girls were found to have a longer duration of night ($M=649.75$, $SD=61.31$ versus $M=625.75$, $SD=71.27$ in boys; $t(157)=-2.28$, $p<0.05$) and accordingly more pure sleep per night ($M=638.22$, $SD=65.49$ versus $M=615.40$, $SD=72.04$ in boys; $t(157)=-2.09$, $p<0.05$). Boys also had their parents more involved in the middle of the night awakenings, $t(156)=2.04$, $p<0.05$, but did not differ from girls on the sleeping arrangements or other parental strategies. Data from boys and girls were combined for all analyses but were also analyzed separately. The results of the separate analyses by gender are reported only if found different.

Effects of age at the assessment. As expected, age at the assessment was positively correlated with the mobility index ($r=0.51$, $N=161$, $p<0.01$) and with the attainment of all motor skills separately. On the assessment date older infants were more often crawling on hands-and-knees ($r=0.26$, $N=161$, $p<0.01$), cruising ($r=0.43$, $N=161$, $p<0.01$) and walking ($r=0.43$, $N=161$, $p<0.01$). Age also correlated with parental observations of infants searching for objects out of sight ($r=0.26$, $N=161$, $p<0.01$), and bringing/giving objects when asked ($r=0.26$, $N=161$, $p<0.01$), but not with the behaviors related to seeking proximity with a parent. The use of walkers was also not related to age of the infants. Age showed significant negative associations with night-time feedings ($r=-0.19$, $N=156$, $p<0.05$) and involvement at bedtime ($r=-0.16$, $N=159$, $p<0.05$), but not with involvement in the middle of the night awakenings, wait time to respond to awakenings, sleeping arrangements and occasional bed-sharing.

Unlike the crawling sample of Study 1, in this sample some of the night sleep characteristics did show a significant association with age. Infant's age negatively correlated

with the parental perception of infant sleep being problematic (r=-0.19, N=160, p<0.05), number of awakenings per night (r=-0.24, N=158, p<0.01) and time awake at night (r=-0.19, N=151, p<0.05); and positively correlated with the prevalence of sleeping through the night (r=0.17, N=161, p<0.05). Though the total amount of day-time sleep did not change with age, it seemed to become more consolidated as older infants had fewer naps (r=-0.18, N=161, p<0.05) of a longer average duration (r=0.27, N=161, p<0.01). An identical pattern of results was observed when using age from conception (based on the infant's expected birth dates reported by parents), except for the negative correlation between age and time awake at night being even more pronounced in this analysis (r=-0.24, N=142, p<0.01).

As in study 1, the pattern of association of the age at the assessment with other research variables was taken into account in all the subsequent analyses in three ways. First, all sleep outcome measures were corrected for age using regression-corrected residual scores, with the residual scores used instead of the raw sleep scores in all the analyses comparing groups using t-test and/or ANOVA. Second, when correlational analysis was appropriate - partial correlation test was used with age entered as a control variable. Third, age was entered in the first step in all regression analyses before entering other predictor variables.

Effects of the age of onset of the motor skills. The age of onset of the motor skills under study, detailed in Table 8, showed a wide range in this sample and ensured that infants with both early and late motor development were included. Partial correlational analysis, controlling for the age at the assessment and the amount of experience in a given skill, did not show significant relations between any of the sleep measures with the age of onset of cruising and of crawling on hands-and-knees. Onset of walking, however, correlated negatively with parental perception of sleep being problematic, r_{pc} (15)=- .54, p<0.05; and almost significantly correlated with longer day-time sleep, r_{pc} (15)=0.46, p=0.06. In other words, the later in development infants started walking the longer was their day-time sleep and their sleep was perceived as less problematic by their parents. None of the parental strategies or closeness of sleeping arrangement correlated with the onset age of any of the motor milestones.

Table 8

Ranges and mean ages of onsets of motor skills in months

Motor skill	N	Range	Minimum	Maximum	Mean	SD
Hands-and-knees crawling	149	7.59	4.25	11.84	8.19	1.62
Cruising	122	8.59	5.64	12.52	9.21	1.38
Walking	44	4.16	8.36	12.52	10.51	1.21

Upright Independent Locomotion and Sleep

First, we looked at the partial correlation (controlling for age) between the mobility index and sleep measures and found no significant linear relations. We then compared groups with different styles of locomotion. At the date of assessment in this sample 39 infants were able to walk, 72 were cruising, 32 were crawling on hands-and-knees and 18 could do neither of the above. All of the cruising and walking babies were able to crawl on hands-and-knees, meaning none of them skipped crawling as a stage. Similarly, only one of the walking infants skipped cruising and started to walk right after crawling.

Before addressing the question of the effect of upright locomotion we looked at the differences in sleep patterns between cruising and walking infants while using t test and found no significant differences. Sleep scores of infants using any type of upright locomotion (either cruising or walking, N=111) did not differ from the scores of non-crawling or crawling on hands-and-knees infants. When compared separately, neither walking nor cruising infants differed from the other groups. Moreover, the results were similar when we excluded all the newly crawling infants (less than 1 months of crawling, 16 infants out of 32 crawling) to control for the effect of the crawling onset found in Study 1. Same results were also observed when all the walker users (N=47) were excluded from the sample and when analyzed separately for boys and girls. We then explored whether the onset of the walking or cruising rather than the ability of upright locomotion by itself had an effect on sleep.

Onset of walking and sleep. To investigate the effect of walking onset we divided the walking infants into groups based on the amount of experience in walking, thus separating newly walking infants (N=19) from experienced (N=10) and proficient (N=10). We then compared the newly walking infants with the crawling and the cruising infants as well as between each other. The groups did not differ on demographics, parental strategies, sleeping arrangements and use of walkers. The groups did differ in age with infants more advanced in walking development being older, $F(4,106)=8.46$, $p<0.01$. In addition, the proficient walkers (walking for more than 2 months) had a significantly younger age of walking onset (M=9.45, SD=0.56) compared to both new (M=10.86, SD=1.27) and experienced walkers (M=10.83, SD=0.97), $F(2,38)=3.09$, $p< 05$. The age difference was expected and was controlled for in all the analyses as explained earlier. The difference in the age of walking onset, however, was taken into consideration when analyzing differences between infants with different level of walking experience (details to follow).

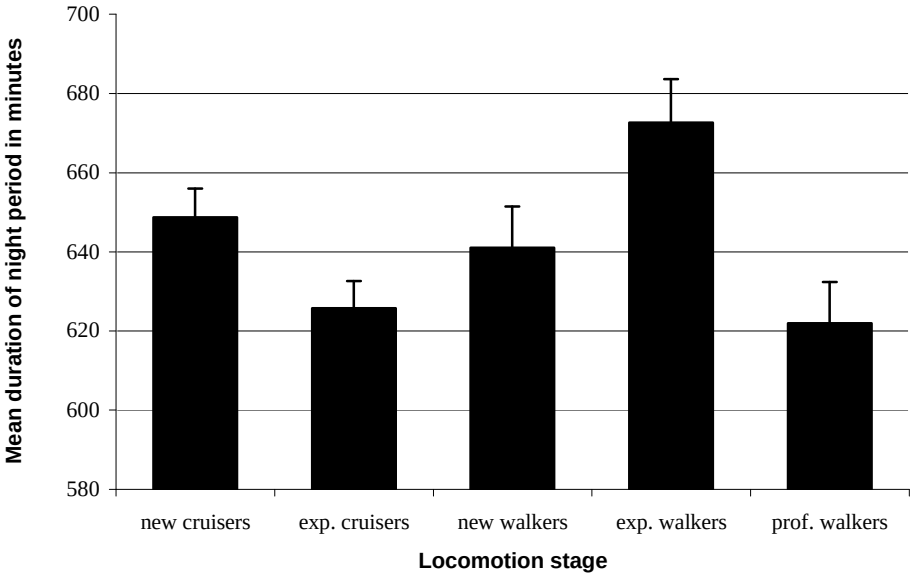
The newly walking infants did not differ on any of the sleep measures from non-walking infants, either crawling or cruising. The same results were observed when new crawlers were excluded from the analyses, to control for the possible effect of onset of crawling found in Study 1. Since onset of cruising could also have an effect and thus constitute a confound in the test of the effect of onset of walking we divided the cruisers into groups based on the amount of experience in cruising too, thus separating newly cruising infants (N=31) from experienced cruisers (N=41). As there were only 5 infants having more than 2 months of cruising while not yet walking, and since they did not differ from the infants having more than 1 month of experience on any of the sleep measures, we combined the infants into one group of experienced cruisers.

We then compared the newly walking infants with both of the cruising groups, using analysis of variance (ANOVA) with contrasts. The onset of walking did not seem to have a negative effect on sleep based on comparison with the experienced cruisers only. The newly walking infants actually had a tendency for somewhat better sleep, though the differences only reached significance in settling for the night sleep duration $t(45.60)=2.30$, $p<0.05$. One more difference was close to significance: newly walking infants had slightly fewer awakenings than the experienced cruisers, $t(53.91)=1.71$, $p=0.09$. Interestingly, the experienced walkers (with more than one month of walking) had even better sleep with significantly longer duration of night sleep period, $t(16.93)=-2.14$, $p<0.05$, and more pure sleep per night, $t(16.18)=-2.29$, $p<0.05$, compared to the experienced cruisers. Moreover, the motor progression from

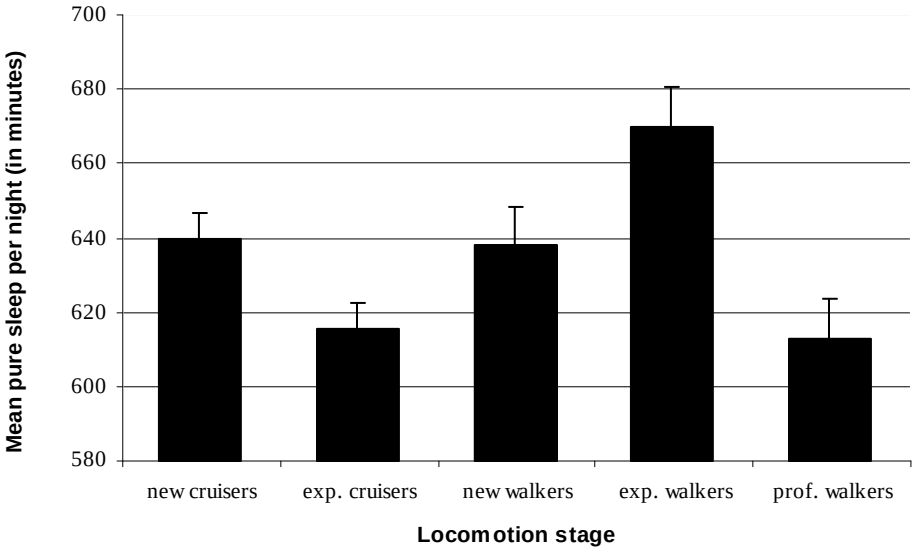
experienced cruising to new walking and to experienced walking correlated positively with duration of night, r_{pc}=0.25, N=70, p<0.05, and pure sleep per night, r_{pc}=0.27, N=70, p<0.05. The proficient walkers had, by contrast, less sleep compared to the experienced walkers both based on night-sleep period duration, t(18.01)=2.07, p<0.05, and pure sleep per night, t(17.99)=2.13, p<0.05. The original averages of night-sleep period duration and pure sleep for all the groups are presented in Figure 4.

Figure 4

a) Means and Standard Errors of night-sleep period duration by level of cruising and walking



b) Means and Standard Errors of pure sleep per night by level of cruising and walking



However, the early walking onset of the proficient walkers (as reported earlier) could explain their difference from the other walkers, especially since age of walking onset correlated with some of the sleep measures, as reported earlier. We tested this hypothesis using linear regression equation for the 2 groups of infants while entering walking status after the infants' age at the assessment and the age of onset of walking. Walking status (proficient versus experienced) neither added to the explained variability in night-sleep duration nor in pure sleep, in both cases mostly explained by the age of the walking onset (ΔR^2=0.16, ΔF=3.37, p=0.08 for night-sleep duration, and ΔR^2=0.15, ΔF=3.33, p=0.09 for pure sleep per night). The pattern of results was similar in both boys and girls.

Moderation and mediation of the effect of walking development on sleep. The sleeping location (solitary/mixed versus same room) did not seem **to moderate** the effects as no interactions between the sleep location and the motor status were found significant in their effect on sleep. To see whether socio-cognitive changes can explain the association found between the motor progressions and sleep duration (not including the proficient walkers) we conducted a **mediation analysis.** The progression from experienced cruising to new walking and then to experienced walking correlated positively with the attainment of the milestones of bringing the objects when asked, r_{pc}=0.42, N=67, p<0.01 and searching for an object out of sight, r_{pc}=0.26, N=67, p<0.05. Infants with more progress in motor development were also further away from the day they first showed proximity seeking TO a parent, r_{pc}=0.33, N=70, p<0.05.

When analyzed separately for boys and girls it turned out only boys were responsible for the correlation with the ability to bring objects (r=0.53, N=33, p<0.01 among boys only). Thus when entered into a regression equation after age together with the motor progression, the ability to bring object only reduced the significance of motor progression as a predictor in boys, while in girls the motor progression still predicted almost significantly both the duration of night , B=27.16, SE=11.56, β=0.31, t=1.81, p=0.08, and pure sleep per night, B=28.56, SE=12.52, β=0.33, t=1.96, p=0.07.

On the other hand, girls were mostly responsible for the correlation of the motor progression with searching for objects out of sight (r=0.31, N=31, p=0.08 among girls only). However, entering search for objects into the regression equation did not reduce the significance of the motor progression as a predictor both in girls and in boys. The experience in proximity seeking did not have a different relation with motor progression in boys and girls and when entered into a regression equation after age and gender it did not significantly change the motor progression prediction of sleep period duration, B=21.18, SE=12.31, β=0.23, t=1.76, p=0.08, and of pure sleep per night, B=22.89, SE=12.38, β=0.24, t=1.85, p=0.07. Thus the relation between waking development and sleep was not mediated by any of the socio-cognitive variables that were assessed in this study.

Onset of cruising and sleep. To investigate the effect of cruising onset we compared the new cruisers with the experienced between each other and with all the pre-cruising groups: the non-crawling infants (N=18), newly crawling (N=16) and experienced crawlers (N=16). We used analysis of variance (ANOVA) with contrasts for the comparison, excluding cases with missing variables analysis by analysis. The groups did not differ on demographics, parental strategies or use of walkers, however interesting pattern was observed in the distribution of the sleeping arrangements. First, there were surprisingly few infants (5 out of 122) with stable

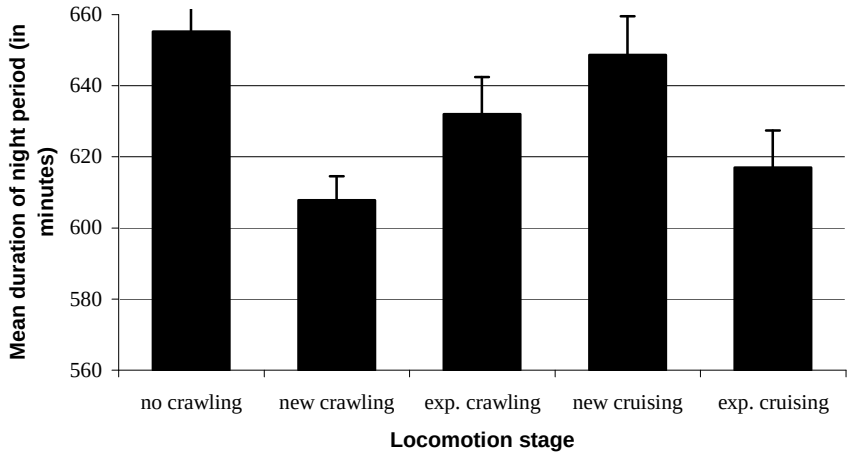
solitary (separate room) sleeping arrangement among these groups. Second, the sleeping arrangement of all the mobile groups was similar, while the non-crawling infants differed significantly from all other groups by sleeping farthest away from their parents, $t(117)=2.07$, $p<0.05$. Though the groups differed in age, $F(4,117)=8.85$, $p<0.01$, this should not be a problem since we controlled for the age effect using regression corrected residual scores when comparing the sleep measures of the groups. More importantly, experienced cruisers had a younger onset of age of cruising ($M=9.21$, $SD=1.44$) compared to the new cruisers ($M=9.86$, $SD=1.14$), $t(70)=2.07$, $p<0.05$.

The experienced cruisers did not differ significantly from the new cruisers, except for one difference being close to significance with experienced cruisers having less pure sleep per night compared to the new cruisers, $t(115)=-1.74$, $p=0.08$. However, when age of onset was entered as a covariate in the ANOVA, the difference between these two groups in pure sleep was no longer close to significance. The new cruisers, by contrast, seemed to have longer sleep compared to all other groups with the exception of the non-crawlers (having the longest sleep), while having the biggest contrast with the new crawlers (having the least sleep). The contrast between the new cruisers and new crawlers reached significance in both the duration of the night sleep period, $t(115)=-1.93$, $p<0.05$; and the pure sleep per night, $t(115)=-2.16$, $p<0.05$.

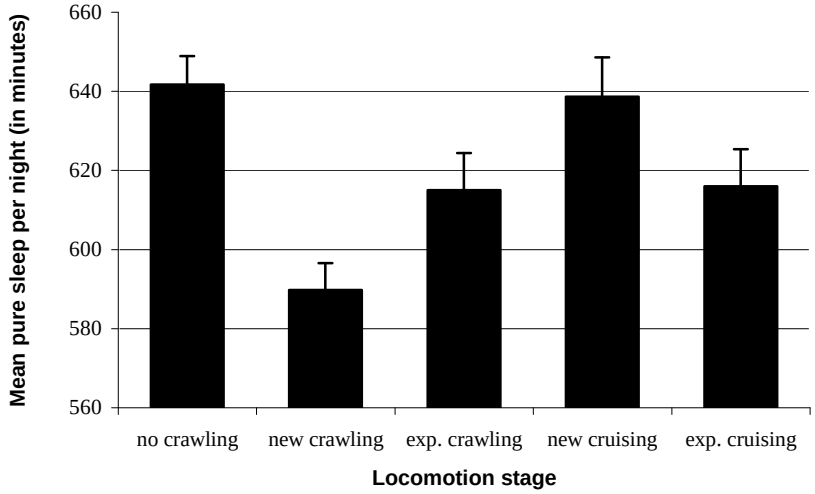
The means of the original sleep scores of night-sleep duration and pure sleep for all the groups can be seen in Figure 5. Since the figures looked similar when using either residuals or original scores, we chose the original scores to be presented in Figure 5 as more assimilable for purposes of data interpretation. According to Figure 5 it seems that the amount of night sleep grows gradually with the development of locomotion after the onset of crawling, given that the shorter sleep of experienced cruisers is explained by other factors than motor development, factors that could be responsible for earlier age of cruising in these infants. Indeed, the progression from new crawling to experienced and then to new cruising correlated positively with the duration of night ($r_{pc}=0.25$, $N=59$, $p<0.05$) and the pure sleep per night ($r_{pc}=0.27$, $N=59$, $p<0.05$).

Figure 5

a) Means and Standard Errors of duration of night sleep period by level of crawling and cruising



b) Means and Standard Errors of pure sleep per night by level of crawling and cruising



*Moderation and mediation of the effects of the cruising development on sleep***.** To see whether the socio-cognitive changes might be responsible for the phenomenon we conducted **mediation analyses**. First, we tested partial correlations between the locomotor progression from new crawling to new cruising and the socio-cognitive scores. Since most of the infants already started to show some of the behaviors under question when they started to crawl (such as proximity seeking) we looked not only at the categorical ability scores (whether the infant started to show the behavior) but also at the amount of experience (how many days passed since the infant started to show the behavior).

The infants who were more advanced in motor development did not have a higher proportion of proximity seeking infants, but the motor progress did correlate with the amount of experience in proximity seeking with a parent, or more specifically with the number of days since the behavior was first observed up until the assessment date (r_{pc}=0.27, N=59, p<0.05). It is important to note that it is possible the infants were not continuing to show the behavior, since parents only reported when the behavior was first observed and were not asked whether and when the behavior stopped. We also found a positive correlation of motor progression from new crawling to new cruising with the ability to give/bring objects when asked (r_{pc}=0.29, N=59, p<0.05). However, when entered into a regression equation after age and gender together with motor progression from new crawling to new cruising neither the ability to bring objects when asked nor days since the start of proximity seeking reduced the significance of the motor progression as a predictor of night period duration and pure sleep per night (B=21.81, SE=11.30, β=0.26, t=1.98, p<0.05 with ability bringing objects; B=26.40, SE=10.94, β=0.32, t=2.41, p<0.05 with proximity seeking experience).

To see whether sleeping locations **moderate** the effects found we tested the interaction of a sleeping location with the motor progression. Since there were only a few infants sleeping solitary they were combined with infants having the mixed arrangement (those who start the night off in a separate room but end up in the parental bed) into one category of sleeping location for a total of 60 infants to be compared with another category of 44 stably co-sleeping infants

(either room- or bed-sharing). No significant interactions were found and the pattern of results was very similar for infants having the two different categories of the sleeping location. Thus the relation between the motor progression and sleep was not mediated by any of the socio-cognitive variables that were assessed in this study.

Use of Walkers and Sleep

Out of the 161 infants of this sample 62 used walkers: and the users were distributed evenly across groups of infants with different types of independent locomotion, including no locomotion at all. Infants who used walkers did not differ from infants who did not use walkers on age, gender, ethnicity, family income, type of locomotion or sleeping arrangement/parental strategies. But in families that used walkers mothers had a lower education, $t(147)=1.99$, $p<0.05$; and the infants spent less time in day-cares, $t(158)=2.01$, $p<0.05$. Thus we looked at the differences between sleep scores of the walker users versus non-users while controlling for maternal education and time in day-care using ANOVA. We found that walker users spent less time awake at night than the non-users, $F(1,139)=3.83$, $p<0.05$. The walker users also had slightly fewer awakenings per night but this difference only approached, $F(1,147)=2.85$, $p=0.09$. The groups did not differ on the socio-cognitive scores.

Among the walker-users it did not matter how long the infants had been using walkers but the more hours they used it per day the longer was their night-sleep period duration ($r=0.27$, $N=59$, $p<.05$) and they had more pure sleep per night ($r=0.27$, $N=59$, $p<.05$). Even though the amount of use of walkers per day also positively correlated with maternal age, same results were observed in partial correlation while controlling for the age of the mothers ($r_{pc=}0.26$, $N=59$, $p<.05$ for duration of night; $r_{pc=}0.25$, $N=59$, $p<.05$ for pure sleep per night). The age of start of using walkers did not correlate with age of onset of the different types of locomotion, socio-cognitive changes or age of starting to sleep through the night. No interaction was found between sleeping locations and the use of walkers. To assess the effect of use of walker relative to no mobility at all we compared 7 non-crawling walker users with 11 non-crawling infants who did not use walkers and found no differences in sleep.

Discussion

The main hypothesis of the study predicting that infant sleep would become more disrupted with the onset of walking was not supported by the data. Infants using upright locomotion either by walking or cruising (moving along furniture and walls while holding onto them) did not differ in sleep from infants still moving in a prone position. Moreover, the progression from new crawling to experienced, then to cruising, to new walking and to experienced walking was associated with progressively longer night-sleep period and accordingly also longer pure sleep per night. In addition, newly walking infants had a trend (close to significance) for fewer awakenings compared to cruisers.

Though infants with a long history/experience of either cruising or walking did not fit the general linear trend and had somewhat less sleep, their difference from other infants could be also explained by their relatively early onset of the upright locomotion. Earlier onset of upright locomotion was previously found to be related to temperamental characteristics of an infant (Biringen, Emde, & Campos, 1995); and was also found to be related to less day-time sleep and more problematic night-sleep (according to parental perception) in the current study. It is very

important to emphasize that the age of onset of different motor skills could be also confounding other results of the study and more studies are necessary to assess the true effect of the upright locomotion with a larger sample size and a better control for the age of the onset of upright locomotion. Since the direction of the relation between upright locomotion and sleep was not predicted by this study's main hypothesis it is not surprising that the relation between locomotion and sleep was neither moderated by the sleeping arrangement nor mediated by the socio-cognitive changes that were assessed in this study following the main hypothesis.

The lack of a disruptive effect of the onset of walking on sleep in the results of this study also contradicts the findings of Scher (1996), who found that walking infants had a tendency to wake up more frequently than pre-walking infants. Even though the sample size in the current study is larger compared to the study of Scher (1996), there are other problems such as confounding effect of the age of walking onset that complicates the conclusions. On the other hand, longer sleep of those infants more progressed in motor development as found in the current study could be seen differently in the light of the expected normal sleep development. The amount of sleep should normally go down with development; however, since upright locomotion follows the development of crawling, the period of late crawling and start of upright locomotion could be considered as a recovery period after a regression related to the start of mobility/crawling. Walking might not constitute such a dramatic change for an infant who is already mobile by other ways.

It is also possible that other factors become more influential for sleep during this period. Indeed, unlike the period of crawling development, age seemed to play an important role during the walking development period (between the nine to thirteen months). Interestingly age seemed to be responsible for different aspects of sleep than locomotor experience. While motor progression was associated with longer sleep, age was related to fewer disruptions. Independent of motor development, older infants in this study slept through the night more often, had fewer awakenings per night, spent less time awake at night, and were perceived by their parents as less problematic in sleep.

The effect of walkers was also unexpected in this study. Walker users spent less time awake at night than the non-users and also had a trend for fewer awakenings per night. Moreover, the more hours they used it per day the longer was their night-sleep period duration and they had more pure sleep per night. It is possible that during this developmental period, when mobility is not an issue, walkers might just play a role of an enhancer of a physical exercise, thus leading to longer, less interrupted sleep. There are other possible explanations related to the type of parents who use walkers. We did find that parents who used walkers in this study had lower education and used a day care less than other parents. Even though we tried to control for these differences statistically in the analyses, it is still possible that the use of walkers stands for some other hidden parental characteristic. For example, parents who use walkers, which are not recommended by the American Association of Pediatrics, might also be less sensitive to their children's awakenings and underestimate their frequency and length. Thus, objective sleep measures are needed to further explore the effect of walkers.

General Discussion

The two studies of locomotor development showed that an onset of crawling and an onset of walking have different associations with sleep. While onset of hands-and-knees crawling was robustly associated with less sleep due both to shorter duration of sleep as well as more frequent

and longer awakenings, walking did not seem to play an important role in the sleep development of the children. The motor progression after the acquisition of crawling actually seemed to be associated with longer sleep, though this finding is not as robust as the one related to crawling onset and needs further investigation. Moreover, in the first study, during the phase of the development of crawling between the ages of six and twelve months, the motor progress was found to be the best predictor of sleep, while even the age of the infants did not explain any of the sleep variation. In contrast, during the period of walking development in the second study, between the ages of nine and thirteen months, age and not the motor progress was shown to be the best predictor of sleep variation, despite the smaller age range in this study (4 months compared to the 6 months in the first study).

The findings point to the fact that it is not just the locomotor progress that influences sleep but the mere transition from being immobile or almost immobile to an effectively mobile human being. As outlined in the introduction of this chapter, when infants acquire the ability to move around voluntarily most of the aspects of their life change and the infants undergo an extraordinary psychological reorganization with changes in perception, spatial cognition, and social and emotional development, especially affecting a sense of autonomy and willfulness in the infant, which in turn allows an active proximity seeking. Walking, on the other hand, brings much less dramatic change into the infant life, when only their posture changes from prone to upright while moving around.

In line with this explanation is also the finding that despite the effect of walking on some of the cognitive abilities such as object understanding and direction following, the social aspects related to the relationship with the parents were no more relevant for this period of development. The proximity seeking behaviors almost reached a ceiling effect in the study of walking with most of the infants leaving the phase of heightened sensitivity to the distance with parents far behind at this point of development. The combined findings support the psychological explanation of the sleep disruption around the crawling period since the cognitive progress did not seem to explain any of the changes in sleep during both transitional periods. Proximity seeking, on the other hand, did explain the sleep disturbance during the transition into crawling, when it was probably most relevant since it was shown to have a major shift during the same time.

However, it is also important to emphasize that very limited cognitive abilities were explored in both of these studies, and furthermore, both were also assessed from parental reports. More objective assessments of multiple cognitive abilities are needed to examine the role of the cognitive changes on sleep during both of the developmental periods. For example, the different posture of walking might be contributing to other new types of learning that were not assessed in the current studies but could explain a somewhat longer night time sleep, without reduction in the daytime sleep.

It is also possible that there are changes occurring in sleep structure as a function of walking development that could not be observed in simple quantitative measures of sleep, especially when using non-objective measures. While having the same quantitative properties, those infants more progressed in locomotion might have a very different physiology or structure of sleep, related to such parameters as proportion of active versus quiet sleep, frequency of sleep spindles occurrence, etc. Metabolic changes should be also assessed in future studies since sleep and metabolism are very strongly linked and locomotion might have an impact on metabolic

processes, which might in turn drive changes in sleep, especially related to nighttime feeding.

Worth noting is the point made by both of the studies on how important it is to take into account the variability of ages of acquisition of the different motor skills among infants when studying the effects of locomotor development. The age of onset of both crawling and walking seemed to be related to some other characteristics of the infants that could in turn be responsible for the differences in infants' sleep patterns. Infants who started to crawl or to walk at relatively earlier ages had more disrupted sleep. One of the most relevant characteristics playing a role in this relation could be the level of activity of the infants relative to others, that could lead to earlier motor development and at the same time also to more difficulties of settling to sleep. However, this question was out of scope of the present studies and should be explored in future.

As with endogenous locomotion, the use of walkers also had different effects during the two transitional periods based on the two studies. While having a negative effect during the phase of crawling development, use of walkers contributed to longer and less interrupted sleep later in age, during the period of walking development. The most likely explanation is that compared to complete immobility use of walkers contributes to the same processes of change from immobility to mobility explained by crawling on hands-and-knees. Later in development, however, when mobility is not an issue anymore, walkers could serve a different function. However, more studies are needed to make such conclusions.

It is important to note though that both studies have many limitations steaming from cross-sectional non-experimental design and the use of non-objective measures, such as parental report, for both sleep and other measures. It is desirable to employ a longitudinal or an experimental design to study the effects of mobility on sleep in future investigation. However, the findings provide basis for a more thorough examination of the link between locomotor development and the structure and physiology of sleep using more objective measures. The studies also suggest new direction for studying the effect of mobility or locomotor development in general not only on quantitative but also qualitative changes in sleep.

Chapter 3: Parental decision making regarding sleeping environment: consistency with general parental attitudes and factors affecting the consistency

This research proposes to explore different types of sleeping environments experienced by parents in the United States using both qualitative and quantitative methodology. Most studies on infant sleep are centered on infants and despite the consensus about the importance of parenting parents are often left out of the research scope. However, nighttime parenting is an important source of stress for many parents. Moreover, decision-making regarding the sleeping environment might be much more complex compared to decisions made in daytime parenting due to lack of consensus about the best sleeping arrangement and/or nighttime strategies. Yet, very little is known about how parents make the decisions regarding the nighttime strategies, whether the decisions are consistent with their general parental attitudes toward childrearing, and what are the other factors that are affecting the decisions. The proposed research attempts to add to the understanding of the processes of parental decision-making in nighttime parenting by comparing it to daytime parenting, exploring the relations of the decisions to the general parental attitudes as well as the role of other factors that could affect both the decisions and the consistency of these decisions with general parental attitudes to childrearing.

Sleep problems represents one of the most common complaints of parents in pediatric practice (Anders at al, 1992). However, despite increasing recognition of the importance of sleep in relation to physical, emotional, and behavioral health for both infants and adults, the dimension of the family context of sleep is largely absent in the sleep literature (Dahl & El-Sheikh, 2007). Only recently have parents started to receive attention with growing recognition that sleep problems of one individual often impact other family members. Thus infant sleep disturbances were found to affect maternal stress, sleep deprivation and mood (Meltzer & Mindell, 2007), as well as marital satisfaction and parental self-efficacy in both fathers and mothers (Meijer & Van Den Wittenboer, 2007).

Dealing with sleep disturbances might be especially difficult given the wealth of conflicting information about the best sleeping environment for the infant the parents are exposed to. There are at least three major decisions the parents are generally faced with when construing the sleeping environment for their children: (1) deciding about the physical sleeping arrangement or location of the baby relative to the parents; (2) choosing a proper bedtime routine that would actually get the baby to sleep; (3) deciding on how to respond to middle of the night awakenings of the baby. However, parents lack proper and consistent resources to make those decisions in a way that would fit best the families' needs.

The most conflicting advice the parents are exposed to is about the best sleeping arrangement. Since 1999, when the U.S. Consumer Product Safety Commission stated that cribs were the safest place for an infant to sleep, a debate has raged among scientific, medical, and parenting groups about where infants should sleep (Morgan, Groer & Smith, 2006). Thus, though a continuum of practices and suggestions exists regarding the sleeping arrangement, there are two main directions that are in the center of the controversy. Some professionals support the historically-based and biologically-evolved environment for infant sleep, namely bed-sharing, arguing that babies have a need to sleep in a close proximity to their caregivers, as evolutionarily this constitutes the safest context for falling asleep (McKenna, Thoman, Anders, Sadeh, Schechtman, & Glotzbach, 1993).

According to other groups of advocates, coming mostly from medical background, the crib is much safer because the infant cannot be smothered by adult blankets and pillows or the mother's or father's body. Moreover, when put to sleep separately the infant is more likely to learn independent sleep habits, be less aroused by his parents and have longer and deeper periods of sleep, thus providing longer uninterrupted sleep periods for parents (Vemulapalli, Grady & Kemp, 2004). Even though newer evidence suggests that bed-sharing with breastfeeding is actually associated with a lower risk for Sudden Infant Death Syndrome and that arousal at night might be actually good for infants, many parents are still compelled to choose the separate arrangement promising independence development for their babies and uninterrupted sleep for themselves (McKenna & McDade, 2005).

Similarly, there is substantial disagreement about how a parent should respond to infant nighttime awakenings both in the public and scientific literature (Porter, 2007). Since most infants wake up during the night the awakenings only constitute a problem when the infants are not able to fall back to sleep on their own or "self-soothe", and instead "signal" to their parents (Goodlin-Jones et al, 2001; Anders et al, 1992). According to advocates of attachment parenting (Porter, 2007) or evolutionary psychology (McKenna & McDade, 2005), the "signaling" is a normal developmental phenomenon and responding to infant "signaling" is biologically necessary for infant well-being and health, especially at night, when infants should rely on their caregiver the most for protection and survival. However, according to other professionals (mostly from a medical background), responding to a "signaling" infant reinforces infant dependency and gets in a way of the infant's progress toward independence and developing "self-soothing" capacities (Ferber, 1986, Hall, 2006). Thus, use of different techniques to train the babies to "self-soothe" is recommended by these professionals. These techniques employ strategies in which a baby is left alone to cry for increasingly longer intervals until s/he learns to fall asleep alone.

Though some consensus exists about the more effective bedtime routine with most professionals favoring the least parental involvement at bedtime (Cohen, 1999), it is still unclear what is the best way to achieve this goal. The minimum involvement at the process of falling asleep is believed to increase the chances that the infants will learn to fall asleep alone. Thus, it is recommended to avoid nursing the child to sleep or creating a movement such as rocking or swinging because such strategies create conditioning of the baby to specific routines and make it more difficult for the baby to learn to fall asleep on his own when awakened in the middle of the night. However, for some infants it is more difficult to fall asleep than for others, and many parents may be forced to get involved, thus the parents are faced with the same dilemma whether they should leave the baby to cry himself/herself to sleep or get involved in the process.

Ramos and Youngclarke (2006) conducted an outstanding review of the literature available for parents on infant sleep. The authors identified the book sources of parenting advice about child sleep in the United States and then characterized those sources with respect to their authorship and the content of advice about co-sleeping and cry-it-out sleep training. Forty parenting advice books about sleep were identified. Most books were accessible regarding price and reading grade level. Most authors either had a medical background or no professional credentials at all. With regard to co-sleeping, 28% of books endorsed it, 32% took no position, and 40% opposed it. Those that endorsed co-sleeping generally recommended long-term bed sharing, but a few suggested room sharing only during the first few months after birth. With

regard to crying it out, 61% of books endorsed it, 8% took no position, and 31% opposed it. Most of those that endorsed crying it out recommended scheduled checking, but a few suggested a method called “cold-turkey” when the parent is recommended to completely ignore infant cries at bedtime and during nighttime awakenings. More than half of the books presented advice that explicitly supported either co-sleeping or crying it out and rejected the other.

Given the sleep deprivation of the new parents and the inconsistent information available it is likely that many parents would act inconsistently and even in conflict with their general parental attitudes to childrearing. Indeed, many mothers report conflicting feelings about solitary sleeping arrangements, still choosing it since it is perceived as a culturally “normal” arrangement that is also recommended by professionals (McKenna, 2000). In addition, infant characteristics might also play an important role in parental decision-making. Parents might have no choice but to be involved and have the infant sleeping close by if the infant has troubles sleeping for different reasons (temperamental, health, emotional problems).

Moreover, another factor that might complicate the decision-making process is the disagreement between the spouses about what is the best sleeping environment for the infant. For example, some women in the study of Morelli, Rogoff, Oppenheim and Goldsmith (1992) reported that they chose solitary sleeping arrangement for their children only because their husbands did not feel comfortable with the idea of having the infant in their bedroom. Interestingly, very little is known about the role fathers play in the decision-making related to the sleeping environment, even though night is the time when the fathers are most present and can be involved the most as opposed to such domains as feeding or daily activities schedule. Only a few studies have examined the role that fathers play in choosing the sleeping arrangement and demonstrated that this domain of parenting is not solely a maternal prerogative (Ball, Hooker, & Kelly, 2000; Germo, Chang, Keller & Goldberg, 2007). Thus further exploring the role of fathers not only in decisions on sleeping arrangements but also on other nighttime parenting aspects is yet another purpose of this research.

Based on the assumptions above, it is possible that the sleeping environment chosen by parents might not be consistent with their general parental attitudes due to infant individual differences or to at least two other factors or contextual pressures: (1) some parents may favor responsive co-sleeping but be advised differently by pediatricians or related literature, and (2) some parents may differ with each other on what type of sleep strategy is best (with presumably fathers favoring solitary self-soothing sleeping environment more than do mothers). Interestingly, the literature linking parental behaviors to infant sleep is quite extensive, particularly the behaviors related to bedtime involvement. Thus most clinical interventions for sleep-disturbed infants with night-waking problems are based on training the parents in behavioral interventions aimed at extinction of parental involvement during the night and limit-setting approaches (Sadeh, 2005). However, most of these behavioral approaches appear to ignore (at least in the literature) the cognitive component. Very few studies have attempted to explore the underlying factors leading certain parents to become more involved than others, including general parental attitudes to childrearing.

The role of parental attitudes in child development has recently received increasing attention. Various studies have shown significant links between parental cognition and child development in several domains. Parental cognitions are believed to affect child development by

guiding parents in their behaviors and the ways they interact with their children (Bugental & Johnston, 2000). However, very few studies have looked at the effect of parental cognition on infant sleep (Sadeh, Tikotzky & Scher, 2010). Even less attention was paid to the link between the general attitudes and specific parental behaviors in the sleep domain, especially for fathers. In light of different contextual pressures such as confusing advice on infant sleep it is important to understand whether parental decisions in sleep are guided by their general attitudes similarly to other domains of childrearing. It is essential to look more closely at the parental reasoning behind choosing different strategies in the sleep domain as parental decisions might be much more complex for nighttime parenting compared to the daytime parenting decisions and might potentially create inconsistency of different aspects of parenting.

In addition to affecting parental consistency of the sleep related decisions with their general attitudes or daytime parenting the contextual pressures might also affect parental subjective experiences such as stress, satisfaction from the sleep situation and parental self-efficacy. Self-efficacy is usually defined as a person's estimation of his/her ability to perform on a specific task. Bandura (1997) defined self-efficacy as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments". Parental self-efficacy then refers to a parent's estimation of his/her ability to manage parental tasks and responsibilities. According to empirical research individuals with high parenting self-efficacy are more optimistic, authoritative, and consistent in their interactions with their children than are those with less confidence (Bandura, Barbaranelli, Caprara, & Pastorelli 1996; Teti & Gelfand, 1991). Sense of self-efficacy has also been shown to be a major predictor of parent-infant attachment (Mercer & Ferketich, 1990).

To summarize, this research had two main purposes. First, different contextual pressures affecting parental decisions regarding infant sleeping environment were identified using qualitative analysis. Second, four main hypotheses were examined in this study quantitatively. The first hypothesis was that general parental attitudes toward childrearing, would predict daytime and nighttime parenting differently with weaker prediction for nighttime than for daytime. Second, factors other than attitudes such as infant characteristics or different contextual pressures, would be associated with nighttime parenting including both sleeping environment and parental subjective experiences. Third, the relation between parental general attitudes and the nighttime parenting would be moderated by the existence of the different contextual pressures. In other words, caregivers are expected to choose a strategy that is consistent with their general attitudes when there is no interference of such factors as excessive professional/other advice or disagreement with a spouse. On the other side, caregivers are not expected to act entirely consistently with their general attitudes if exposed to high levels of information or have disagreements with their partners.

Methods

Sample

This study was a part of a bigger research project. 54 families with healthy firstborn infants between 6.5 and 9 months of age (M=7.99, SD=0.74) were initially recruited for the project. However only 49 mothers and 44 fathers completed the study fully. Five mothers and eight fathers completed only part of the study due to time conflicts/lack of availability. Data

collected from two other fathers was not used due to technical problems. The limited reports of parents who did not complete the study fully, however, were still included since the completed part of their assessments could serve for analyses of some of the research questions. Thus the cases with missing data were excluded analysis by analysis. One family had twin infants. Since those infants had very different characteristics, including different sleeping environments, their parents' reports were used twice (once for every twin) in the analyses that included variables related to the infants and their differences. The reports were used only once in analyses limited to only parental variables.

The families were recruited through the list of volunteer participants in the Bay Area maintained by the Institute of Human Development of the University of California, Berkeley. Participation criteria included parents of healthy firstborn infants between the ages of 6 and 9, with no developmental delays from 2 parents family from Caucasian population. Only parents of a firstborn child were included since new parents are the most susceptible to the effect of contextual pressures such as media and professional advice and are less likely to base their decisions on previous experiences with older children. The sample was limited to a primarily Caucasian-American population to minimize confounding factors related to cultural differences in the perception of normative sleeping arrangement, parental attitudes and the use of resources for parental decision-making. The research was presented to parents as a study of parenting and infant development with an emphasis on parental difficulties, feelings, resources used and family services provided. The parents thus were not aware of the study interest in sleep to allow an unbiased assessment of both general attitudes and sleeping strategies.

The mothers (aged M=34. 31years, SD=5.44) had primarily higher than college education and held graduate degrees, (63.6% of the sample), 23.6% had college education and 12.7 % had only a high school diploma. The fathers (aged M=35.21 years, SD=5.51) had primarily college education (38.9% of the sample), 37% had higher than college education and 11.1% had only a high school diploma. 88% of mothers and 95% of fathers were from White Caucasian population. 10% of mothers and 5 % of fathers were from Asian origin, and 2% of mothers from Hispanic origin. The ethnic minority parents were at least from a second generation of immigrants. The sample of infants consisted of 28 boys and 27 girls.

Assessments

This research employed assessments based on 3 types of parental report: (1) a set of questionnaires for both parents, (2) a 7 days Baby's Diary, (3) phone interviews with both parents separately. The Questionnaires were used to assess demographic information, general parental attitudes and infant characteristics. The questionnaire for assessing general parental attitudes was completed by both parents, however the primary caregiver only completed the questionnaire on infant characteristics. The Diary was completed by any caregivers who were in charge of the baby during the 7 days period of assessment and included information about infant sleeping locations and different daytime activities.

The Interviews explored parental attitudes and choices/strategies related to childrearing in general and in 4 specific domains: childcare choice, feeding, daily activities and sleep. The main purpose of the interviews was to understand the decision-making processes at the different domains of care and factors affecting the decisions. The interview methodology also allowed a better look at parental strategies and to construct a fuller picture of the environment experienced

by an infant during daytime as well as night. Even though parental behaviors are difficult to assess from self-report some of the interview questions had the potential to elicit useful information about parenting styles. Thus all general statements in the interviews were followed by a request to provide a specific example or memory in support of the general statement, so that the types of examples provided by parents could constitute a window into a better picture of the infants' experiences.

The interviews were conducted by 2 trained undergraduate research assistants and by the primary investigator. The interviews were audio-taped and transcribed into text. The primary investigator first conducted a qualitative analyses looking for different types of families or factors affecting parental decisions. Part of the variables coded for analysis were related to the *a priori* hypotheses, others were the result of qualitative analysis. Two trained undergraduate assistants conducted the final coding of the interviews independently of each other for a between-judges reliability check. Between-coders reliability ranged from 89 to 95% and any disagreements were resolved through discussions.

Three parts of every interview were coded separately: (1) general attitudes toward childrearing or the parental philosophy of childrearing, (2) parental approach in specific domains of daytime care (feeding, day care, daily activities), (3) approach to sleep/nighttime parenting. The parts were separated before coding so that while coding one part (sleep for example) the coders were blind to the parent's answers to similar questions in other domains (general or daytime domains of care). All the cues of the gender of the parents were eliminated in the process of transcribing so that the coders were blind to the gender as well as to the study questions. Different sets of variables/measures coded in the analyses of the research questions were based on multiple types of reports and are described next.

General parental attitudes. The attitudes were assessed through a Parental Attitudes Questionnaire but the measures were validated using interview-based assessments. The questionnaire was based on an integration of the Questionnaire on Parental Attitudes from Easterbrooks and Goldberg (1990) and Raphael-Leff's Facilitators and Regulators Questionnaire (1983) and includes 24 items. The items express explicit general beliefs and approaches to parenting and are rated by parents on a scale from 1 ("strongly disagree") to 6 ("strongly agree"). The questionnaire yielded measures for 4 scales based on 4 theoretical constructs: (1) value of dependency/affection, (2) independence fostering, (3) facilitating style of parenting, and (4) regulating style of parenting. Two items were excluded to increase reliability of the scales for the total of 22 items. Same four factors were generated when a factor analysis was carried out on all the items using the maximum likelihood method for the whole sample of mothers and fathers (N=107). Reliabilities and examples of items for the scales, as well as the means and standard deviations for the entire sample can be found in Table 9.

The scales were somewhat interrelated. Facilitation and Dependency Scales positively correlated with each other (r=0.43, N=106, p<0.01) and negatively with the Regulation Scale (r=-0.30, p<0.05 and r=-0.37, p<0.01 respectively). Independency was not related to any other scales. The Questionnaire was validated through assessment of the same constructs based on parental answers to general open-ended questions on parenting in the first (general) part of the phone interviews for a sub-sample of 30 parents. The interview answers were coded by the trained coders based on salience of the themes in parental answers on a scale from 1 ("no mention of the theme") to 6 ("mentioned numerous times and importance is stressed"). The

between-coders reliability ranged from 81% to 89%. All disagreements were reconciled through discussions. The rating of the parents by the coders based on interviews significantly correlated with the self-reported parental measures derived from the Questionnaire on all of the 4 scales. The correlations ranged between r=0.39 and r=0.43, all ps<.05.

Table 9

Parental Attitudes Scales: Reliabilities, Means, Standard Deviations and examples

Scale	# of items	α Cronbach	M(SD)	Examples
Dependency	7	.62	5.55(.41)	"It is important to express affection by hugging, kissing, and holding a child"
Independence	5	.66	4.14(.93)	"It's important to encourage a child to be independent of his/her parents"
Facilitation	5	.71	4.70(.78)	"Parents have to trust their baby's signals because a baby knows what he/she needs better than the parents do most of the time"
Regulation	5	.77	2.58(.91)	"It is important to teach a child to keep control of his/her feelings early in life"

Nighttime parenting: sleeping environment and parental subjective experience. The sleeping environment was assessed both based on the 7 days Baby's Diary and on the part of the interview related to sleep domain. Three sets of measures were used to define the sleeping environment: (1) measures assessing the sleeping arrangement, operationalized as sleeping locations and their flexibilities, (2) separate parental behaviors/strategies in sleep domain, and (3) measures of the general responsiveness of the sleeping environment. Sleeping arrangement measures included current sleeping location (relative to parents), location right after birth, current flexibility/exceptions allowance in the locations, and number of changes in locations over time. These were *a priori* variables, determined before data collection based on the study hypotheses.

The current sleeping location measure was validated between interview and diary. Two families (both fathers and mothers) had reports conflicting with the diary, however the conflicts were due to a change in location during the time period between filling the diary and completing the interview. For the current purposes of the study we used the sleeping location as was reported in the interview as the most current and most related to other interview based variables. Mothers' and fathers' agreement on the sleeping arrangement measures ranged from 95 to 100%. The only disagreements existed in the assessment of the flexibility/exceptions from current location. In most cases mothers' and fathers' original reports were used when analyzed separately in the two populations for parent-oriented questions, however, one family measure was calculated per child for infant-oriented analyses. In the family measures the maximum score from the two parents was used (presuming one parent was just less aware of the exceptions). Thus, if the father reported the exceptions from the current sleeping location were made once a month, and the mother said it happened once a week, a higher rate of exceptions (once a week) was chosen for

the infant sleeping arrangement assessment.

Separate parental strategies were assessed based on interviews with both parents and included involvement in the falling asleep for the night/bedtime strategy, nighttime awakenings involvement/middle of the night strategy, wait time before responding to nighttime awakenings in minutes, and implementation if "cry it out" sleep training (teaching the infant to self-soothe to sleep by letting him/her cry for prolonged periods of time). Parental involvement was assessed based on parental presence and behaviors from 1 - no involvement or presence at all, 2 - mere presence of a parent, 3 active involvement (holding, rocking, or feeding/nursing). Agreement between parents ranged from 91 to 100% on these measures. Most disagreements between parental reports were related to the difference between high versus medium involvement (only presence versus talking and patting). As with sleeping arrangement parental strategies were used as originally reported by parents separately for mothers and fathers; however, one measure was calculated for every family per child for analyses related to infant characteristics. All family measures were based on the maximum score out of the two parental reports

The general responsiveness of the sleeping environment was defined in two ways: (1) overall stability/instability in the sleeping environment - the number of changes parents made over time both in parental strategies and arrangements; (2) cumulative score of the general responsiveness over time based on 4 categories: first sleeping location, current sleeping location, parental involvement in nighttime strategies, and implementation of sleep training involving "cry it out". All of the categories were converted into 1 (no) or 2 (yes) scales and the sum was calculated. Thus the minimum score of 4 meant least responsiveness (separate room sleeping location – both first and current, minimum parental involvement in nighttime strategies, and at least one implementation of sleep training); while the maximum score of 8 meant more responsiveness (close first and current location, high involvement at night and no implementations of sleep training using "cry it out" methodology).

Parental subjective experiences were related to parental self-efficacy in the sleep domain, parental satisfaction from the sleeping environment, parental stress, conflicting feelings and feelings of being angry or helpless at nights. The self-efficacy and satisfaction were assessed through direct questions in the interview that required a responder to give a numerical rating from 1 to 7. The sleep self-efficacy was calculated based on average of parental responses to a number of specific questions targeting self-confidence in specific areas/behaviors. For example, the parents were asked: "how confident do you feel about putting your child to sleep", or "how confident do you feel about choosing the right sleeping arrangement for your baby". Parents were also directly asked whether they felt angry or helpless at night on a scale from 1 to 3, where 1 meant never, 2 – sometimes, and 3 – often.

Stress and conflicting feelings were assessed by the coders based on parental spontaneous expressions of stress and conflicting feelings when discussing nighttime parenting and were coded on a scale from 1 –no conflicting feelings/stress at all, to 3 – a lot of conflicting feelings/stress. Parents were also asked about their expectations about the normative ages when infants should be able to fall asleep alone for the night and in the middle of the night when awakened. The coding system for stress and conflicting feelings was developed as a result of qualitative analysis, while other variables related to parental experience were *a priori* variables (predetermined before data collection).

Daytime parenting: daytime strategies and parental subjective experience. The daytime strategies were assessed both through diary and interview. All the variables related to daytime parental strategies were *a priori* variables (predetermined before data collection). Based on the diary, the proportion of time spent by babies in different activities/location was calculated for the 7 days. More specifically, parents were asked to report how many hours their infant spent in each of the following activities: (1) in the caregiver's arms; (2) in direct interaction with a caregiver but not on arms; (3) playing on the floor by himself/herself with the caregiver being around; and (4) in crib alone while awake with nobody around, (5) other. Then the proportion of every activity's duration was calculated relative to the duration of all other activities (proportion out of the sum duration of all activities).

Based on interview, four types of assessments were used. First, the care arrangement was measured on a scale from 1 to 5, where 1 meant full time day care, 2 – part time day care, 3 – full time nanny, 4 – part time nanny, and 5 – parents only. Second, parental responsiveness to cry during daytime was assessed through direct question followed by demand for specific examples regarding how the parent usually responds to infant cry and coded by coders on a scale from 1 - mostly leaving the infant to self-soothe, to 5 – responding to every cry with little or no exceptions. Third, feeding and daytime routines schedules were coded on flexibility based on parental explicit statements from 1 – having a very strict schedule with no exceptions to 3 – having a flexible schedule/on demand feeding. Fourth, following the Raphael-Leff's approach (1991) parents were also asked whether they try to adapt to the baby more, have the baby adapt to them/house routines when planning daytime activities. The answers were coded by coders on a scale from 1 – child oriented, to 3 – parent oriented, while taking into account not only parental statements but also specific examples the parents mentioned when prompted.

Parental subjective experiences during the daytime were assessed through parental daytime self-efficacy, parental stress and conflicting feelings. Stress and conflicting feelings were assessed by the coders based on parental spontaneous expressions of stress and conflicting feelings when discussing daytime parenting and were coded on a scale from 1 –no conflicting feelings/stress at all, to 3 – a lot of conflicting feelings/stress. Coding of both stress and conflicting feelings in daytime parenting discussions was developed after the qualitative analyses, similarly to the sleep related discussion to make the two domains comparable.

The daytime self-efficacy was calculated as an average of the self-confidence of parents in the different specific domains of care (day care choice, feeding, daytime activities). The self-confidence in specific domains was assessed through direct questions in the interview that required a responder to give a numerical rating from 1 to 7. For example, the parents were asked to give a number on a scale from 1 to 7 of how confident they felt about gauging the right amount of food for their baby, or how confident they are about choosing the best routines/schedules for daytime activities with their baby. In addition, the parents were also asked a very general question on self-efficacy in the very beginning of the interviews on how confident they felt about being a good parent. This measure was used as a general feeling of parental self-efficacy above and beyond the more specific self-efficacy assessments in both nighttime and daytime.

Infant characteristics. Infant characteristics were assessed in four ways. First assessment included infant demographics such as age and gender, as well as health situation - how many times the baby was sick/had cold since birth. Second assessment was based on the diary

information and pertained to the mean amount of crying during daytime and the proportion of difficult days as recorded in the diary by parents (when the baby was "cranky" based on the parent). The mean amount of crying was computed from number of incidents the infant cried for longer than 3 minutes during the day over the 7 days period, as recorded by the caregivers. Third, parents were asked to rate their infant on the sleep tendencies in the early months of life – from 1 being a good sleeper to 3 - being a very bad sleeper.

Fourth, infant daytime behaviors were assessed using a number of scales from the Infant Behavior Questionnaire – Revised (Gartstein & Rothbarth, 2003). In this Questionnaire primary caregivers were asked to rate on a scale from 1 to 7 how often they observed a specific behavior during the past week. Part of the questionnaire also included questions centering on a 2 weeks span of time. This questionnaire is a well-established assessment of a range of infant behaviors that are clustered into meaningful dimensions. The following scales were included in the assessment: (1) fearfulness in general; (2) distress to limitation; (3) general sadness; (4) positive affect expression (both low and high intensity); (5) vocal reactivity; and (6) soothability by a caregiver across contexts.

Contextual pressures affecting parental decisions. Even though most of the contextual pressures variables resulted from the qualitative analyses, the interview included questions targeting some of the possible factors based on the hypotheses of the study. Two major contextual factors having a major influence on parental decisions were identified in the qualitative analyses: parental use of resources and spousal disagreement. To target the different influences in interview all parents were directly asked on what they were basing their decisions and what was the main source they relied on for every decision discussed. While the question was posed by an *a priori* hypothesis, the coding of parental answers to this question was developed in the process of qualitative analysis based on the distribution of different types of answers.

Thus, four types of answers were identified and coded for parental **reliance on different sources**: (1) personal beliefs, intuitions, experience; (2) literature, including books, magazines, online resources; (3) personal advice of a professional such as pediatrician, sleep consultant, nurse or doula; (4) advice of other parents. In addition, it was noted in the qualitative analyses that some parents refer to different resources much more often and mention more sources than others. Thus another measure was developed for coding the extent of referring to two major sources that were identified: literature and professional advice. The coders simply counted how many times a source was mentioned by a parent. Thus for literature referencing the coders counted every time a book, or any other type of literature, was mentioned by a parent. Mentioning the same book for similar/same argument repeatedly was not counted in. However, when the same book, for example, was mentioned for two different arguments/decisions made, the book was counted twice. If two books were mentioned for the same argument, both books were counted too, as representing two different sources.

Similar coding was done for the number of references to professional personnel. The developed variables were coded for sleep and daytime sections separately for comparison. So as described earlier, while coding one section the coders were blind to the other section content from the same interview/same parent. In sleep section only, an additional measure pertaining to the timing of resources use was developed as a result of qualitative analysis. This variable was coded on a binary scale based on the coders' judgment of whether the resources were mainly

used proactively versus reactively (as a reaction to sleep problem or disagreement between spouses).

For **spousal disagreement** the parents were simply asked whether they had any disagreements with their partners for every decision made. Two major types of disagreements were identified in the sleep section: (1) disagreement on the sleeping arrangement; (2) disagreement on general strictness in the sleeping environment. The disagreements were coded on a scale from 1 to 3, where 1 meant parents never disagreed, 2 meant parents somewhat/slightly disagreed, and 3 – there was definite disagreement between the parents. When there was disagreement in the family the coders also coded the nature of disagreement, namely whether self or the other was on the more responsive side.

After the coding was completed, the measures were transformed into one scale: mother versus father rather than self versus other. The reports were matching in 100% between the mothers and the fathers on the nature of disagreement. However, there were 3 families with conflicting reports about having the disagreement in the first place. In two cases the mothers overestimated the disagreements while the fathers underestimated (said there was slight disagreement), in the third case the pattern was opposite. The maximum score was thus used per family since at least for one parent the disagreement was substantial.

Two major types of disagreements were identified in the daytime parenting section too: (1) disagreements on day care options; (2) disagreements on schedule strictness. The reports were 100% matching between the spouses. For the general daytime parenting disagreement measure disagreements of any kind were combined, so that a family was coded for disagreement in daytime parenting if there was at least one disagreement in any of the daytime topics. An additional measure was developed for both daytime and sleep sections separately based on how much the topics were discussed between the parents from 1 - no discussions at all, to 3 – having many discussion. This measure was coded based on the coders' judgment and there was 95% of agreement between the coding of mothers' and fathers' interviews. The maximum score was chosen per family.

Approach to Analyses

First, a qualitative analysis was carried out to identify different types of decision-making in the domain of sleep environment, at different types of families or sleep problems. Also different contextual pressures were grouped in the process to outline the possible moderating factors for the relations between parental attitudes and sleeping environment. Second, quantitative analyses were performed to test the hypotheses of the study – both *a priori* hypotheses and hypotheses generated in the process of qualitative analysis. To test whether general parental attitudes predict actual parental choices the relations between parental attitudes and daytime as well as nighttime parenting variables were examined separately for mothers and fathers based mainly on correlations. For all correlation analyses being conducted the scatterplots were examined to make sure the relationships were linear and curve-fitting tests were applied when appropriate.

To test the effects of contextual pressures as well as infant characteristics on the nighttime parenting we used a series of correlational analyses mainly, however t-test was used instead for comparisons of groups of parents if the factors affecting parental decisions were represented by a nominal scale with 2 categories. The moderating effects were tested using the significance of

interaction terms between the attitudes and the moderating variables according to the methods of Baron and Kenny (1986). Since attitudes had continuous scales we applied regression tests were the original variables were entered simultaneously with the interaction terms (the product of the original variables). As recommended by Cohen, Cohen, West & Aiken (2003) we centered the continuous attitude scales by subtracting the mean from every score. All nominal variables entered into regression equations were first transformed into dummy variables while the group with the largest number of subjects was chosen as a reference group and received a score of 0. Cases with missing data for some of the variables when parents omitted a question, when the interviewer did not ask a question, or when interview was not available for coding, were excluded analysis by analysis.

Results

Preliminary Analysis

Sleep in the family context. When parents were asked using an open-ended question about the most difficult aspect of their parenting experience 37.5% of mothers and 34.1% of fathers named sleep related issues. Similarly, when asked for examples of times when they did not feel confident about being a good parent (examples of general self-efficacy) 28.9% of mothers and 26.3% of fathers brought up sleep related situations. 6.1% of mothers and 14.8% of fathers also gave an example of sleep situations when asked about feeling guilty as a parent. It is important to note that these questions on general parental experience were asked in the beginning of interviews with parents without the parents being either aware of the study interest in sleep or anticipating discussing sleep issues in the following parts of the interviews. When discussing sleep issues in the last part of the interviews, 51.4% of mothers and 27.3% of fathers admitted sometimes feeling angry at nights, while 47.1% of mothers and 34.4% of fathers admitted feeling helpless.

Contribution of sleep domain to the general parental feeling of self-efficacy. For mothers, self-efficacy in sleep domain was not related either to self-confidence in separate daytime domains or to the averaged daytime self-efficacy. However, both sleep self-efficacy and daytime self-efficacy predicted the general feeling of parental self-efficacy of the mothers (r=0.44, N=48, p<0.05 and r=0.47, N=48, p<0.01). Moreover, based on a regression analysis both daytime and sleep efficacy were significant predictors of the general maternal self-efficacy in the final model (B=0.51, SE=0.19, β=0.35; t=2.66, p<0.05 and B=0.47, SE=0.17, β=0.36; t=2.74, p<0.01). Interestingly, an opposite pattern of results was observed for fathers. While fathers' self-efficacy in the sleep domain and self-efficacy in daytime tasks were significantly correlated with each other (r=0.46, N=43, p<0.01), neither of them predicted the fathers' general feeling of parental self-efficacy. The mean self-efficacy scores and Standard Deviations for both mothers and fathers are presented in Table 10.

Table 10

Means and Standard Deviations for self-efficacy scores separately for mothers and fathers

	N	**Day efficacy M (SD)**	**Night efficacy M (SD)**	**General efficacy M (SD)**
Mothers	48	6.01 (.66)	6.43 (.73)	5.88 (.95)
Fathers	44	5.74 (.57)	6.02 (.90)	6.05 (.65)

*Differences between mothers and fathers in the general attitudes toward childrearing***.** Before addressing the main questions of the study, we looked at the differences between mothers and fathers in their general attitudes toward childrearing, using paired t-test. Compared to mothers', fathers' attitudes were higher on regulation and lower on facilitation and dependency. There was no significant difference on independence fostering between the parents. The means, standard deviation, t-test values and correlations between the attitudes of mothers and fathers are presented in Table 11.

Table 11

Comparison of mothers' and fathers' attitudes: Means, SDs, t-tests values and correlations

Scale	Mothers M(SD)	Fathers M(SD)	*t*(53)	*r*
Facilitation	4.95 (.60)	4.46 (.86)	3.86**	.23+
Regulation	2.34 (.75)	2.82 (.99)	-3.76**	.44**
Dependency	5.66 (.29)	5.46 (.46)	3.23**	.28*
Independency	4.19 (.83)	4.07 (1.03)	.90	.39**

General Parental Attitudes: Relations with Daytime and Nighttime Parental Strategies

To address one of the main questions of the study, whether maternal and/or paternal attitudes predict the strategies of daytime and nighttime parenting differently we conducted a series of analyses, testing the relations of parental attitudes first with the daytime parenting, then separately with the nighttime parenting.

*Parental attitudes and daytime parental strategies***.** The relation of parental attitudes to specific daytime strategies was tested separately for mothers and fathers. **Among mothers**, independence fostering attitude was negatively correlated with the proportion of time baby spent in parental arms based on diary (r=0.30, N=55, p<0.05). Mothers' dependency valuing correlated with more baby- rather than parent-oriented approach for choosing and scheduling daytime activities, based on examples provided by parents in the interview (r=0.31, N=47, p<0.05), and more flexible ("on demand") feeding schedule (r=0.34, N=48, p<0.05). Regulatory attitudes, on the other hand, correlated negatively with baby-oriented approach (r=-0.33, N=47, p<0.05), and flexibility of the feeding schedule (r=-0.32, N=48, p<0.05), as well as with responsiveness to cry during daytime (r=-0.37, N=48, p<0.05), while positively with the time of baby spending in a crib when awake (r=0.34, N=55, p<0.05). Mothers' facilitative attitude did not predict any strategies of the daytime parenting.

Among fathers, attitudes-daytime activities relations had a similar pattern to that of mothers. Like mothers', fathers' independence fostering attitude negatively correlated with the time of baby spending in parental arms (r=-0.31, N=54, p<0.05) and regulatory attitudes – positively with the time of baby spending in a crib when awake (r=0.33, N=54, p<0.05), while dependency attitudes positively correlated with flexibility of the feeding schedule (r=0.37, N=44, p<0.05). Unlike mothers', fathers' attitudes had no significant relation to responsiveness

to baby cries during the daytime or the type of schedule (baby- versus parent-oriented); however, father's regulatory attitudes negatively correlated with the flexibility/exceptions of regular routines/schedules (r=-0.38, N=44, p<0.05).

*Parental attitudes and nighttime parental strategies***.** Unlike daytime parenting, the night time parenting seemed to have very different patterns of relation with mothers' and fathers' attitudes. **Among mothers**, regulatory attitudes were found significantly related only to the closeness of sleeping arrangement right after birth (r=-0.43, N=50, p<0.01), but not of the current sleeping arrangement (p=0.69). Though, mothers' independence fostering attitudes were negatively associated with flexibility of making exceptions in sleeping location (r=-0.39, N=44, p<0.01) and parental involvement in bedtime/falling asleep (r=-0.28, N=50, p<0.05), none of the attitudes were associated with nighttime strategies/responsiveness, implementation of "cry it out" sleep trainings, night feedings or the cumulative measure of the responsiveness of the sleeping environment.

Among fathers, the general attitudes, on the other hand, were related to most of the sleeping environment characteristics. Both dependency and independency attitudes were significantly related to the closeness of the current sleeping arrangement (r=0.37, N=50, p<0.01 and r=-0.36, N=50, p<0.01 respectively), as well as to the cumulative measure of the responsiveness of the sleeping environment (r=0.29, N=50, p<0.05 and r=-0.28, N=50, p<0.05 respectively). Both dependency and regulation in father's attitudes were related to the wait time before responding to infant cry at night (r=-0.40, N=49, p<0.01 and r=0.28, N=49, p<0.05 respectively). In addition, dependency attitudes positively correlated with nighttime parental involvement (r=0.45, N=49, p<0.01), while independence fostering – negatively with involvement at bedtime (r=-0.33, N=50, p<0.05).

Summary: general attitudes, daytime and nighttime parenting. The daytime and nighttime parenting strategies showed different patterns of relation to general parental attitudes. General attitudes predicted most of the daytime strategies among mothers and fathers alike. The nighttime parenting, however, was better predicted by fathers' general attitudes, than those of mothers. Mothers' and fathers' attitudes also seemed to be responsible for different aspects of the sleeping environment. While fathers' attitudes predicted current sleeping arrangement and nighttime responsiveness as well as involvement in nighttime awakenings, maternal attitudes only seemed to be responsible for sleeping arrangement right after birth and making exceptions in the current sleeping arrangement. Both mother's and fathers' attitude of independence fostering were similarly associated with the bedtime involvement, but none of the parental attitudes was related to the implementation of sleep trainings using "cry it out" methodology or to feedings at night.

Infant Characteristics as Important Factor for Nighttime Parenting

Results based on qualitative analysis. Based on the qualitative analysis parents made and changed their decisions based on infant characteristic. One of the best examples comes from the family with twins where the twins were so different that the parents adopted completely different strategies for the two infants: while one child slept solitary in a separate room and was sleep-trained, the other was bed-sharing and had high involvement of the parents in the falling asleep process both at bedtime and at nighttime awakenings. Even after hiring a sleep consultant who spent numerous nights in the family's house the parents still couldn't change the sleep habits of

the second child. Here is how the mother explained the difference:

> When they were younger, 2 months we thought about sleep training them, and the methodology of sleep training, no matter how you slice it, comes down to let them cry it out. Um [pause] and, with Baby1 that was possible but with Baby2 it went [pause] Like I said, he gets mad and he would [pause] he would [pause] I [pause] He popped [pause] he one time he was [pause] when he was really young he screamed and cried so hard he popped blood vessels in his eyes. At which point we were like "alright we can not let him do this", this is not healthy and it's really a function of him and his personality but we just can not, you know we can not subject him to this. Um, so we decided not to sleep train him.

Results based on quantitative analysis. Unlike the results of the qualitative analysis, based on the quantitative analyses, infant characteristics did not seem to affect parental choices very much. **Infants' age** was not related to any of the parental choices regarding current sleeping environment. The results were not surprising due to a small age range of the sample and the nature of the sleep related measures reflecting more of an overall history of sleeping environment rather than assessment of one point in time. **Infants' gender** was only associated with one aspect of the sleeping environment. Boys were more likely to have exceptions in sleeping locations than girls, M=1.95, SD=0.48 versus 1.34, SD=0.86 , $t(48)$=-2.89, p<0.01. **The health condition of infants** did seem to affect parental choices the most. Infants who had more colds over time seemed to have more involved bedtime strategies ($r_{partial}$=0.34, N=39, p=0.05) and were more likely to have a change of sleeping location ($r_{partial}$=0.31, N=39, p<0.05), based on partial correlations when controlling for age, as older babies could have more chances to have more colds or changes in locations over time.

Based on diary measures, parents who reported more difficult days (baby being cranky more often) did not have different sleeping environments; however, both mothers and fathers had significantly lower satisfaction from infant sleep (r=-0.36, N=48, p<0.05 and r=-0.44, N=41, p<0.05) and lower self-efficacy in sleep domain (r=-0.40, N=45, p<0.01 and r=-0.51, N=42, p<0.01). In addition, mothers felt helpless more often at nights (r=0.36, N=34, p<0.05), while fathers expressed more stress when discussing sleep, according to coders (r=0.54, N=44, p<0.01). Since amount of crying as reported in the diary highly correlated with the parental perception of difficulty of days (r=0.42, N=42, p<0.01), very similar patterns of correlations were observed between amount of crying and parental variables. Sleep tendencies of the infants in the early months of life ("good" versus "bad" sleepers early on) were not associated with any of the characteristics of the sleeping environment or parental experience variables.

For the infant temperament, very few of the Infant Behavior Questionnaire scales were related to parental choices and/or characteristics of a sleeping environment. Moreover, the causal direction of the few significant relations that were found is completely unclear. Thus, low-intensity positive affect correlated with closer sleeping location (r=0.32, N=55, p<0.05) while approach to new things correlated with closer sleeping location right after birth (r=0.38, N=50, p<0.01). Similarly, high-intensity positive affect correlated with higher involvement in nighttime awakenings (r=0.41, N=49, p<0.01) and fewer changes in sleeping environment made by parents over time (r=-0.31, N=49, p<0.05). Soothability by a caregiver during day-time had the

most associations with the sleeping environment characteristics: the more difficult it was for a caregiver to soothe an infant during daytime, the more likely the infant was sleep-trained (r=0.29, N=50, p<0.05), had parents who waited longer before responding at night (r=0.29, N=49, p<0.05), and had lower cumulative responsiveness of the sleeping environment score (r=-0.36, N=50, p<0.01).

Use of Resources as a Major Contextual Pressure Affecting the Nighttime Parenting

To address the hypothesis that other factors than the general attitudes to childrearing or infants characteristics will play an important role in parental decisions about sleeping environment we explored the different contextual pressures mentioned by the parents in the interviews. One of the main factors identified in the qualitative analysis as important contributor to parental decisions in the sleep domain was the use of deferent types of resources by parents when making decisions. In the following sections descriptions of the qualitative analysis results on the use of resources are followed by descriptions of the results of quantitative analyses that were applied to test the effects of the use of resources.

Qualitative and descriptive analysis of the use of resources. **Three types of resources** were identified in the qualitative analysis: (1) talking to other parents/having a parents support group; (2) reading books, magazines or online articles about infant sleep; (3) talking to professionals and/or hiring a sleep consultant. 37.9% of the parents (both mothers and fathers) described their decisions in the sleep domain as mainly based on other sources rather than personal beliefs or intuitions. Though slightly more mothers seemed to be influenced by the other sources compared to fathers (39.6% versus 31.8%), the difference was not significant and the parents were combined for the descriptive analysis of the different sources. Thus, of all the parents in the sample, 15.2% based their decisions on literature (books, magazines, online articles), 6.2% - on personal professional advice (of pediatrician, doula, nurse, sleep consultant), 14.1% - on advice from other parents (family, friends, support group), while the majority of parents (64.1%) still based their decisions on personal beliefs, intuitions or baby demands.

Contrary to expectations most parents (72.6%) found the available resources on sleep to be very useful even though admitting the abundance of contradictions between the different sources. However, a major problem was raised during the qualitative analysis related to the **timing of the resources use.** In many cases it seemed that the resources just did not reach the parents at the right time. Indeed, after coding for reactive use, 44.4% of the parents were found to turn to recourses after a sleep problem was already encountered in their family. Moreover, some of the families that used the resources in a reactive way seemed to have a history of uneducated choices in the sleep domain, which in turn could be responsible for their children having the sleep trouble in the first place. Though difficult to quantify the uneducated choices stand out in the qualitative analysis. One of the clearest examples of such a choice was an interesting and somewhat popular among parents phenomenon of using a swing to get the baby to sleep in the early months of life.

Here is an example of how a mother described handling the sleep issue in the first month of her child's life:

> Well we were ridiculous when he was first born [parent laughs]. And, and did not know, I mean, we laugh about it now, but [pause] I mean, there were times when we literally held him all

> night [parent laughs]. Yeah, and I do not know what we were thinking, but it was just so hard to put him down [pause] but then [pause] then we have discovered the magic of the swing [pause] And, um [pause] we would do the whole, swaddling, shooshing, swing thing and it worked great, so we did that.

This mother later described that the baby outgrew the swing and she would nurse him to sleep until she was tired and then she went to look for information online. As a result the mother tried sleep training her son when he was 6 months old using "cry it out" method but had to stop it because it was too stressful for her.

Here is a father from a different family describing the use of a swing:

> Well, well you know at one point we took her out of the swing and moved her to a crib, cause we had her in a, an electronic swing for that was [pause] incredible [pause] Um for you know, a good 4, 5 months, and then we moved her to the crib, you know and that's when she started you know she was already waking up but that's when we actually you know really had to uh to [pause] to spend a lot more time um making sure she went to sleep and in the chair she you know, we could put her in there sleepy and she would fall asleep so once when we started incorporating the crib, we would have to actually get her asleep and then put her down.

And then a little later:

> Uh but she, she grew out of the [pause] the chair, grew out of the swing, um at that point you know, we decided we wanted to move her to the crib uh in [pause] in [pause] in her room [pause] and, and but she wouldn't fall asleep by herself in the crib, because it was not moving, it did not have a lot of music. And so at that point, we'd have to actually get her to fall sleep by rocking her or uh you know other means. And we'd put her down and she'd sleep um you know she'd wake up 2 or 3 times during the middle of the night. And my partner would generally go in and get her, and feed her, and come back.

These parents eventually sleep trained their daughter to get her to sleep by herself through the night, after getting advice from a pediatrician.

In these two cases one can see an example of parents teaching the baby unhealthy sleep habits in the early months just because it seems the easiest way to get the baby to sleep. Most of the times parents do not realize that these habits cannot work for long and would be difficult to unlearn. On the other hand, they seem to lack the knowledge of other means to have the newborn fall asleep or do not expect the newborn to be able to fall asleep without any intervention. Thus the main conclusion of the qualitative analysis was that not just the type or the quality of resources is important but also the timing of the exposure to the resources.

Comparison between the use of resources in nighttime versus daytime parenting. The reliance on resources seemed to be higher in sleep-related decisions. Thus, taken together the decisions regarding day-care arrangements, feeding or daily schedules were mostly based on parental beliefs (82.4%), while only in 9.9% of cases – on literature, 5.5% - on personal professional advice, and 2.2% - on other parents' advice. The differences in distributions can be observed in Figure 6. Moreover, compared to the daytime domains discussions, when discussing the sleep domain parents referred significantly more frequently both to books/articles, $t(83)=-7.26$, $p<0.001$, and to specialists who advised them in person, $t(84)=-4.83$, $p<0.001$. The means, as well as standard deviations and range of the references can be found in Table 12.

Figure 6

The differences between use of resources in daytime and nighttime parenting

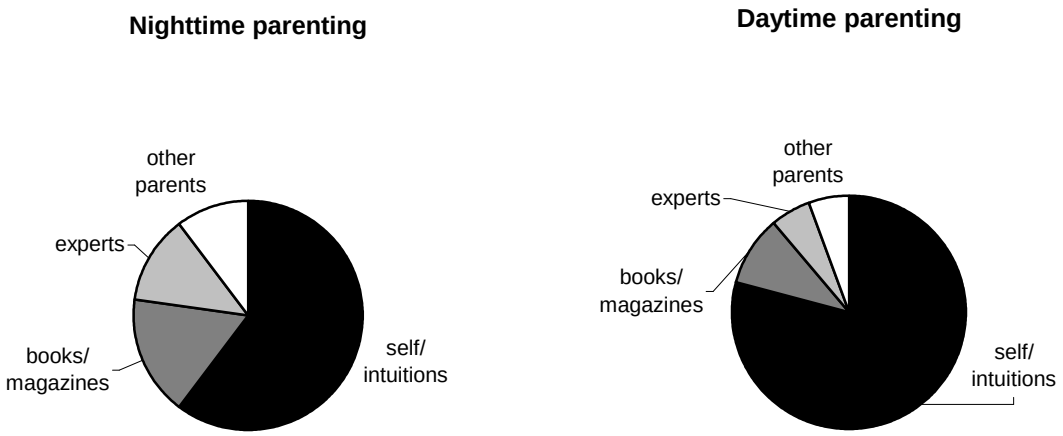


Table 12

Means, standard deviations and range of parental references to different sources

	N	Minimum	Maximum	Mean	Std. Deviation
References to literature in daytime discussions	85	.00	4.00	.67	.92
References to a professional in daytime discussions	86	.00	3.00	.16	.48
References to literature in sleep discussions	89	.00	15.00	2.74	2.74
References to a professional in sleep discussions	89	.00	12.00	1.25	2.21

Thus, resources constitute an important factor involved much more in decisions related to nighttime parenting than in decisions related to any other domains of parenting. To examine the

possible effects of the use of resources on the nighttime parenting we used a series of quantitative analyses. In the following sections the results of analyses examining the effect of general reliance on resources as well as the effects of using different types of resources, while taking into account the timing of the use, will be presented.

The general reliance on resources and nighttime parenting. First, using t-test, we looked at the differences in characteristics of sleeping environments between parents who were following their intuitions/beliefs (29 mothers and 30 fathers) and parents who followed other sources (19 mothers and 14 fathers) when making sleep related decisions. The effects were different for fathers and mothers. **Based on fathers' reliance on resources**, families in which fathers relied on resources more than on themselves did not seem to differ much in their infant sleeping environment from families where fathers relied mostly on themselves, except of the night-waking strategy. Families in which fathers relied on resources more than on their own beliefs had lower involvement in the middle of the night awakenings, $t(42)=2.12$, $p<.05$, and longer time before responding at night, $t(41)=-2.25$, $p<.05$.

Based on mothers' reliance on resources, on the other hand, the families differed on most of the characteristics of the sleeping environment, except from the night-waking strategy and feedings at night. The means, standard deviations and t-test values for the 2 groups of mothers are presented in Table 13. As can be seen in the table, mothers who relied on resources more than on themselves tended to have less responsive environment, more changes in the sleeping environment over time, more sleep training, less involvement at bedtime, farther sleeping locations and fewer exceptions in the locations.

Table 13

Sleeping environment: means, standard deviations and t-test values by mothers' use of resources

	Rely on self/intuitions		**Rely on resources**		
Sleeping environment characteristics	**Mean**	**SD**	**Mean**	**SD**	**Test values**
Sleep training implementation	1.26	.45	1.55	.51	t(41.6)=-2.06*
Number of changes made overtime	3.41	1.72	4.67	1.75	t(45)=-2.41*
Closeness of sleep location after birth	4.83	1.10	4.05	1.22	t(46)=2.28*
Closeness of current sleep location	3.00	2.05	1.32	1.00	t(43.2)=3.78**
Exceptions in sleeping locations	1.81	.78	1.25	.45	t(41.1)=2.63*
Bedtime involvement	2.83	1.39	1.84	1.26	t(46)=2.49*
Cumulative responsiveness	6.79	1.01	6.00	.81	t(46)=2.85**

$+p<0.08$. $*p<0.05$, $**p<0.01$

Moreover, the mothers who relied on resources also tended to have higher expectations from the baby. Though many mothers couldn't tell a specific age when babies should be able to fall asleep alone without an adult assistance, among those who could, mothers who relied on resources reported much earlier expected age (in months), $M=4.56$, $SD=1.02$ versus $M=11.7$, $SD=7.49$, $t(19)=2.69$, $p<0.05$. Though the mothers did not differ in parental self-efficacy in sleep domain, satisfaction or stress, the mothers who relied on resources did feel helpless more often at nights, $M=2.29$, $SD=1.14$ versus $M=1.55$, $SD=0.89$, $t(45)=-2.12$, $p<0.05$. Moreover, the

difference was still significant even after controlling for reactive way of use of the resources using unvariate analysis of variance (ANOVA), $F(1,45)=3.85$, $p<0.05$. Thus, it did not seem that the mothers turned to the resources because they felt helpless in the first place.

*The effects of different types of resources on nighttime parenting***.** To test whether different resources had different effects on the parents we looked at the number of parental references to different sources when discussing sleep related decisions. These effects were not possible to be tested using reliance on sources since very small groups of parents relied solely on one type of resource and not another. The extent of referencing to a specific source, on the other hand, was available for every parent. To see whether extent of referencing to literature or to professional advice was associated with any of the parental decisions or other aspects of nighttime parenting we used a correlation analysis. Since the results were similar between mother and fathers, we present the combined results for all of the parents together.

The number of references to **professional advice** was only related to a farther sleeping location of the baby from the parents right after birth ($r=-0.31$, $N=89$, $p<0.01$), but not to the current sleeping arrangement or any other characteristics of the sleeping environment or nighttime parenting. The extent of references to **literature on sleep**, however, did show significant associations with many variables. The more literature sources were mentioned by parents the earlier in age the parents expected the baby to be able to self-soothe in the middle of the night ($r=-0.38$, $N=35$, $p<0.05$), had farther current sleeping location of the baby ($r=-0.35$, $N=89$, $p<0.001$), were less involved at bedtime ($r=-0.23$, $N=89$, $p<0.05$) as well as in nighttime awakenings ($r=-0.24$, $N=87$, $p<0.05$), waited longer before responding at night ($r=0.28$, $N=87$, $p<0.05$), were more likely to do a sleep training ($r=0.29$, $N=89$, $p<0.05$), did much more changes in different aspects of the sleeping environment overtime ($r=0.35$, $N=87$, $p<0.01$), and had a lower cumulative score of the responsiveness of the sleeping environment ($r=-0.37$, $N=89$, $p<0.001$). In addition, the more the parents referred to literature, the more often they felt helpless at night ($r=0.24$, $N=81$, $p<0.05$) and more self-contradictions were found in their discussions of sleep by the coders ($r=0.24$, $N=87$, $p<0.05$).

The effect of timing of the use of resources. When we compared the choices of parents who used the resources in a reactive way (only when having a sleep problem) with those who read the resources ahead of time we found that the reactive users had less involved bedtime and nighttime strategies, $t(89)=-2.23$, $p<0.05$ and $t(87)=-2.26$, $p<0.05$; had farther sleeping location of the baby from parents, $t(89)=-2.22$, $p<0.05$; and felt angry more often at night, $t(66)=-2.20$, $p<0.05$. To see whether the extent of use of resources or the timing of the use were responsible for the more strict nighttime strategies and farther sleeping location we conducted a linear regression with using both extent and timing as predictors. For the sleeping location, the timing of the use of resources lost significance as a predictor when entered into a regression equation together with the extent of referencing of sleep literature ($B=-0.75$, $SE=0.59$, $\beta=-0.20$; $t=-1.28$, $p=0.21$). However, both for bedtime and nighttime strategy the timing of use was a better predictor ($B=-0.72$, $SE=0.34$, $\beta=-0.25$; $t=-2.13$, $p<.05$ and $B=-0.41$, $SE=0.21$, $\beta=-0.25$; $t=-1.95$, $p<.05$), and the effect of extent of referencing was reduced to non-significant ($B=-0.75$, $SE=0.59$, $\beta=-0.20$; $t=-1.28$, $p=0.21$ and $B=-0.18$, $SE=0.22$, $\beta=-0.11$; $t=-0.86$, $p=0.39$).

Summary on the use of resources by parents. Based on the analyses described above, resources seem to play an important role in parental decision-making regarding sleep environment. Many parents rely on resources more then on their own beliefs and intuitions in the

sleep domain, which is less likely in other domains of child-care. Moreover, parents who rely on resources more differ form others in stricter nighttime strategies (based on most of the characteristics of the sleeping environment). as well as higher expectations from infant self-regulation abilities. However, mother' reliance on resources has more associations than fathers and the associations are different. While fathers' reliance mostly relates to nighttime involvement, mothers' – relates to all other characteristics.

Based on the qualitative analysis the resources often do not reach parents at the right moment and when used in a reactive way should be assessed differently. Thus, based on quantitative analysis, it turns out that the association between literature referencing and stricter sleeping strategies is mostly explained by reactive use of the literature, meaning these families already could have uneducated choices/sleep problems before turning to resources. In general, literature on sleep topics seemed to affect parental decisions as well as parental well being more than professional help.

Parental Disagreement as Another Contextual Pressure Affecting the Nighttime Parenting

Qualitative and descriptive analysis of parental disagreement. First of all, based on the qualitative analysis sleep related issues were heavily discussed in families and often were source of conflicts. In 91.8% of families the parents reported having "a lot of discussions" about sleep related issues, in 6.1% - briefly talking, and only in 2% - no discussions at all. Moreover, in 18% families both parents reported having a "definite disagreement" about decisions, while in 42% parents said they "somewhat disagreed" about it. To compare to daytime domains, only 10.4% of families had definite disagreements about day care arrangements (day-care, nanny), and only 8.8% - about day schedule/routines strictness and daytime activities planning.

More than half of the disagreements on sleep issues (38.3% out of all families) were related to **sleeping location**, while the rest was related to **sleep training** and not responding right away/letting the baby cry when awakened in the night. Contrary to expectation, the qualitative analysis showed that fathers were not overwhelmingly stricter than mothers in sleep issues and some fathers actually tended to be more responsive and less oriented to sleep training than mothers. Even though in the disagreements about locations in 84.6% of the families mothers wanted the baby to sleep closer than the fathers, in all other disagreement only 61.9% of mothers tended to be more responsive to the infant nighttime awakenings and cries versus 38.1 % of fathers.

Here is an example of how a mother describes her partner not being sure about sleep training (this family was coded as "somewhat disagreeing"):

> I was kind of like, it's okay if he cries tonight because I [pause] have been [pause] sleep-deprived for six months. And I just can not, you know, I just… he's going to be okay. He'll cry and he'll, he'll be okay. So it [pause] I [pause] e [pause] I [pause] Actually my partner had a harder time with it than I did. You know, my partner was like: "Are you sure? We shouldn't go, you know, rescue him?" And I was like: "No, we really can not. I really want to try this and I want to give it a good try because I really need to [unintelligible]". So [pause] it was hard I did not like

hearing him cry but I also [pause] I thought it was for the best.

Quantitative analysis of the effects of disagreement on nighttime parenting. In families that had disagreements about sleep issues the mothers expressed higher stress when discussing sleep issues, $t(39.83)=-2.18$, $p<0.05$, and reported more conflicting feelings, $t(43.20)=-2.57$, $p<0.05$, based on coders' judgment. There were no differences in fathers' discussions of sleep based on disagreement in family. However, in general, the families with disagreement were more likely to have a change in sleeping location in the history of their sleeping environment, $t(42)=-2.32$, $p<0.05$. In addition, *the amount* of disagreement significantly correlated with fathers' higher frequency of feeling angry at nights ($r=0.36$, $N=32$, $p<0.05$), and lower satisfaction from a sleeping arrangement ($r=-0.35$, $N=39$, $p<0.05$).

*Summary on spousal disagreement***. S**leep constitutes an important source of spousal disagreements. Most of the disagreements in the sleep related issues seem to be related to the sleeping location with fathers favoring separate sleeping locations more than mothers. On the other hand, fathers only slightly tend to be more in favor of sleep training than mothers. Overall, disagreements are associated with fathers' lower satisfaction from sleeping arrangement and feelings of anger at night, while for mothers the disagreement is related to stress and conflicting feelings about sleep issues.

Interrelations Between the Factors Affecting Parental Decisions: Infant Characteristics, Use of Resources and Parental Disagreement

Use of resources by mothers was not related to any infant characteristic but fathers tended to use resources in a reactive way more often if the infant was characterized by both parents as a "bad sleeper" from early months of life ($r=0.44$, $N=42$, $p<0.01$). Parental disagreement were not related to any of the child characteristics but the nature of disagreement was: the more colds the baby had overtime and the more he/she vocalized during daytime the more often the mothers were on the responsive side of the disagreements about sleeping environment in general ($r=0.40$, $N=29$, $p<0.05$ and $r=0.45$, $N=29$, $p<0.05$ respectively). Mothers' use of resources was not related to the amount of disagreement, but fathers' was: fathers who were referencing to literature in sleep more often also disagreed with the mothers more often about the sleep issues ($r=0.35$, $N=39$, $p<0.05$). On the other hand, among those who disagreed, mothers who referred to sleep literature more often were on the less responsive side in the disagreements, while fathers were more responsive ($r=0.45$, $N=29$, $p<0.05$).

The Moderating Effect of the Use of Resources on the Link Between General Parental Attitudes and the Nighttime Parenting

To test the hypothesis that parents with higher levels of contextual pressures will have weaker relations between their general parental attitudes toward child rearing and the specific choices of the nighttime parenting, we tested the moderating model with the use of resources serving as a moderator. Since the patterns of results related to the relations of the sleeping environment with parental attitudes as well as with the use of resources were different for mothers and fathers, the moderating effects were tested separately for the genders. The centering of attitude scales (subtracting the mean from every score) was also done separately for fathers and mothers as their means were significantly different.

The moderating effect of the parental reliance on resources in general. To be able to test the moderating hypothesis based on Baron and Kenny (1986) we made sure the reliance fitted the **main criteria to serve as a moderator** in three ways. First, we made sure the reliance on others (the moderator) was not significantly related to the measurement error of the sleeping environment. There were no significant differences between parents who relied on others and those who relied on self in the reliability of the sleeping environment measures, expressed as the percentage of cases where the mother's description of the environment matched that of the father's. Second, we made sure the variance in the attitudes did not differ between the two groups of parents based on reliance on others using the Levene's Test for Equality of Variances.

Third, we looked whether the reliance on others (as a moderator) was not significantly related to the attitudes (independent variable). But, the group of parents who was relying on others more than on self had higher independence fostering among the mothers, M=4.53, SD=0.65 versus M=3.95, SD=0.89, $t(46)$=-2.42, p<0.05; and lower dependency value in fathers, M=5.10, SD=0.49 versus M=5.60, SD=0.39, $t(42)$=3.76, p<0.01. Even though the reliance was related to some of the attitude scales and couldn't be classified as a classical moderator we still tested the **interaction between reliance and attitudes in the effect on sleeping environment**. We tested the interaction effect using regression analysis while entering the interaction term of attitudes and reliance simultaneously with both of the variables separately as predictor of different characteristics of the sleeping environment. None of the interactions were significant.

The moderating effect of parental referencing to literature and professional advice. First of all we made sure the reference to literature as well as to professional advice satisfied the criteria to be moderators. Based on both variables, the groups neither differed in the measurement error nor in variance of the attitudes. The attitudes were not significantly related to the use of literature or advice either, which is a desirable condition for a moderating model. Thus we conducted the moderator analyses. The interaction term of attitudes with **professional advice** did not predict any of the characteristics of the sleeping environment.

However, one interaction was significant between mothers' attitudes and **referencing to literature**. When entered simultaneously with literature referencing and facilitative attitude, the interaction terms of the facilitative attitude with the literature referencing significantly predicted the closeness of the current sleeping arrangement. While more facilitative attitudes were significantly related to a closer current sleeping location for mothers who did not use/mention much literature in their discussions (r=0.54, N=25, p< 01), the relation was not significant for mothers who referred to literature more often (r=-0.16, N=23, p=0.46). The results of the regression analysis are presented in Table 14 and a scatterplot of the scores can be observed in Figure 7. The interaction terms did not significantly predict any of the characteristics of the sleeping environment among fathers.

Table 14

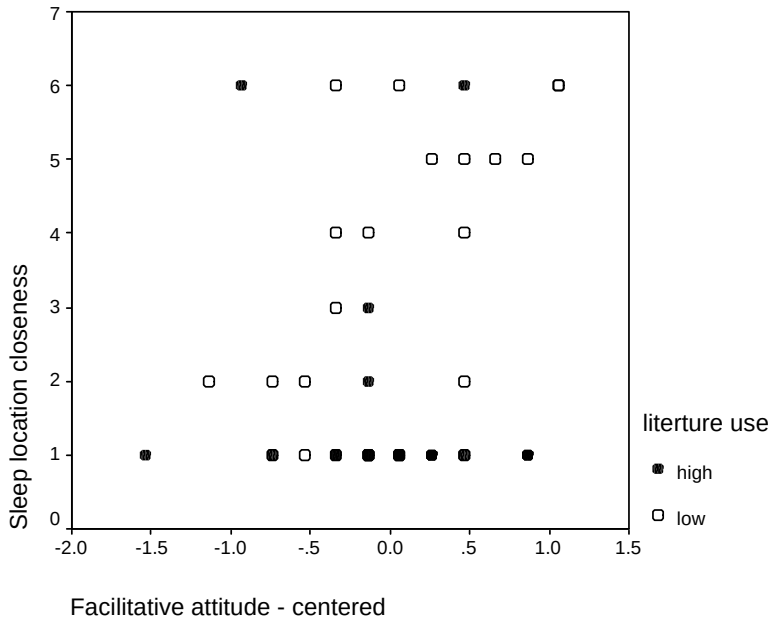
Regression coefficients predicating closeness of sleeping location by use of literature and maternal facilitative attitude

	Unstandardized Coefficients		Standardized Coefficients	t	p
	B	**Std. Error**	**Beta**		
Constant	3.014	.321		9.386	.000
Literature Use	-1.445	.464	-0.385	-3.115	.003
Facilitative Attitude	1.888	.572	.562	3.299	.002
Literature Use by Attitude Interaction	-2.302	.832	-0.471	-2.766	.008

Regression MS=18.44, F (3,44)=7.16, p<0.001

Figure 7

Closeness of sleeping location by mothers' facilitative attitude separately for mothers with high versus low literature referencing



Moderating Effect of Spousal Disagreements on the Link Between General Parental Attitudes and the Nighttime Parenting

Effect of disagreements about sleeping arrangement. The groups neither differed in the measurement error nor in variance of the attitudes. Neither mothers' nor fathers' attitudes were significantly related to the spousal disagreement on arrangement. However, when entered into regression equations predicting different characteristics of the sleeping environment, the interaction terms of attitudes and parental disagreement did not significantly predict any of the characteristics. Hence, there were no significant interactions between the disagreement and

general parental attitudes in the effect on sleeping environment.

Effect of disagreements about sleep issues in general. We then tested the moderating effect of any disagreements in sleep domain (not only related to sleeping arrangements) on the different characteristics of the sleeping environment. The groups with and without disagreement did not differ between each other on the error measurement or means and variances of attitudes. However, none of the interactions between the attitudes and disagreements in sleep domain in general were significant either.

Discussion

First of all, the results of the study demonstrate that sleep regulation is one of the most difficult aspects of parenting, surrounded by stress, feelings of helplessness and sometimes of guilt. Moreover, mothers' self-reflections on sleep related parenting constitute an important part of their general feeling of parental self-efficacy. Interestingly, fathers' general feeling of self-efficacy does not seem to be affected by their self-reflections on functioning in sleep domain. This finding suggests that mothers might be more sensitive to specific aspects of their experience in their self-efficacy assessment, while fathers have some kind of a buffering effect: no matter how they feel about their functioning in specific aspects of parenting, either at daytime or at night, they feel pretty good about themselves as parents in general.

Another conclusion of the study is that sleep also constitutes an important source of spousal conflict or disagreements between parents. Most of the disagreements in the sleep related issues seem to be related to sleeping location with fathers favoring separate sleeping locations more than mothers, while fathers only slightly tend to be more in favor of sleep training than mothers. The spousal disagreements are associated with more frequent feelings of anger at night in fathers, and with higher stress as well as more conflicting feelings about sleep issues in mothers. But most importantly, the disagreements lead to instability in infant sleeping arrangements, which seems to be natural part of the process of finding a single solution that would satisfy all members of the family.

The findings also emphasize the role of fathers in the sleep development of infants, which has been overwhelmingly ignored in the previous research on infant sleep. The nature of the sleeping environment of infants in the present study was strongly associated with fathers' general parental attitudes to childrearing, while having very little relation to mothers' attitudes. Most characteristics of the infant sleeping environment, including current sleeping arrangement, bedtime involvement and responsiveness to awakenings at night, were related to fathers' valuing of independency versus dependency in parenting. On the other hand, maternal attitude toward infant independence was only related to the bedtime involvement and flexibility of making exceptions, while attitude toward regulation in parenting was only responsible for the sleeping arrangement choice right after birth, but not for the current choice of a sleeping arrangement.

It could be that mothers just tend to be less expressive about their preferences for stricter style of parenting and exaggerate the dependency/facilitation values in their explicitly stated attitudes, following social norms. However, the finding that the general attitudes of the mothers have been found to predict many characteristics of the daytime parenting in this study does not support such an interpretation. A better assessment of attitudes, such as implicit attitudes testing, is still warranted in future studies on this matter. The other explanation of the limited relation

between maternal attitudes and the infant sleeping environment, could be that some types of contextual pressures affect the relation, as was suggested by one of the main hypotheses of the study. This hypothesis has been only partially supported. Neither spousal disagreement nor exposure/use of resources seems to moderate the relation statistically, with only one exception. Mothers' attitude toward facilitation in childrearing does predict closer current sleeping location of their infants, if the mothers do not rely much on literature about infant sleep (do not refer to different sources much in their discussion of sleep in the interviews).

However, despite of a very limited demonstration of statistical moderation effect, the fact that both fathers' attitudes and resources on sleep seem to affect the final decisions about sleeping environment more than maternal attitudes, somewhat supports the hypothesis indirectly. Indeed, based on the findings of the current study many parents rely on resources more then on their own beliefs and intuitions in the sleep domain, which is less likely to happen in other domains of child-care. Moreover, families where parents rely on resources more than on their own beliefs also differ from others in all of the characteristics of their infants' sleeping environment being stricter, including having higher expectations from the infants' self-regulatory abilities.

However, mothers seem to be most affected by the resources. While fathers' reliance on resources was only related to middle-of-the-nighttime strategies, mothers' reliance was associated with most characteristics of their infant sleeping environment in the current study. Thus, mothers' reliance on resources predicted even the sleep training implementation, which was not associated with any other factors, including both mothers' and fathers' general parental attitudes to childrearing. These findings are in line with the results of the review by Ramos and Youngclarke (2006), demonstrating that the majority of literature endorses strict nighttime strategies.

In addition, based on the qualitative analysis, the resources do not always reach the parent at the right time or might not be used correctly by the parents, thus creating even more extreme experience for an infant. One of the repeating patterns discovered in qualitative analysis was that parents taught the infant to fall asleep only with high parental involvement or mechanical help of a swing from the very beginning due to lack of education, then, after turning to resources (in a reactive rather than proactive way) the parents made very dramatic changes in the infant sleeping environment. Here is, for example, a description of an attempt to change a sleeping location in combination with sleep training by a mother, whose infant was fed or rocked to sleep and spent the whole night in a working swing for about 4 to 5 first months of his life until he outgrew the swing:

> *Parent*: We did, um [pause] just from talking to the people who have done it, and um…you know, trying to get an idea of what we might expect, um [pause] I think I expected that the first night he, would probably cry for [pause] certain amount of time, say half an hour, expected [pause], or, if he needs, up to 45 minutes, and I expected that with each night he would cry less [pause] Until, he is sleeping [pause] That's not what happened, it was really hard [long pause]
> *Interviewer*: Do you think it was a bit hard for the baby as well?
> *P*: Oh I know it was [parent laughs].

> *I*: Ok, but do you feel like his sleep pattern changed, after the transition?
> *P*: Yeah, I definitely noticed that [parent says something hard to decipher] so, what happened was, the first night he cried for half an hour, the second night he cried for an hour, he was really pissed…Like, 20 minutes, 10 minutes, the 4th night, from there on [parent says something hard to decipher] and then, uummmm [pause] And then I do not remember what happened, why I decided to start feeding him, um, he might have had a rough night or whatever [pause] I went back to, feeding and rocking him to sleep….
> *I*: Ok, so would you say that your transition was a one time thing, like it just happened? Or was it more gradual?
> *P*: Oh no, it was cold turkey like, "Ok, you are in your crib now" [parent laughs].I look back now, I think, god, what were we thinking….
> *P*: Te whole crying it out thing, it just felt like torture to me, it just ripped my heart out and he sounded so sad, and [pause] it was just terrible, and so [pause] um [pause] I just said, I'm just going to feed him, because [pause] there will come a day when, you know, he does not want this anymore [pause] and so [pause] that's just what we did.

It is important to note the extremely long duration of time the infant is left to cry in this example, which also was not a big exception from other families implementing sleep training. It is possible that the resources are also distorted when they reach the parents, since in the scientific literature, even coming from pediatric or clinical background, much shorter times are suggested for letting the infant cry to learn to self-soothe (Anders et al, 1992). Thus both infants and parents go through very dramatic experiences without real professional help. Based on the resources mentioned by parents in the interviews, literature is most widely used relative to little professional help. Moreover, even in cases where parents turn for help to "sleep experts", those do not seem to have any sleep or infant development related credentials and in majority have education in nursing or birth preparation, since no regulation of this professional area exists in the United States.

At the same time, the parents heavily rely on the different resources and the reliance also has an effect on their general experience of parenting: for both parents it is associated with more frequent feelings of helplessness at night and more self-contradictions in their discussions of sleep issues. These effects still hold true even when controlling for a reactive way of use of the resources (as a response to a sleep problem). Thus, it does not look like the parents turn to the resources because they feel helpless in the first place. This interpretation seems to be most likely also in light of the qualitative analysis and the way some parents describe the effects. Here is an example of an effect of advice given to parents by a hired "sleep expert":

> After, we saw the nap clinician, and she suggested we followed a schedule where he would nap at 10AM and 2:30PM [pause]. So at 10AM, this was earlier this week, it might have been Monday, I

> said it's 10, and I am putting him in his crib for a nap, and I took a shower and did some other stuff. And he cried for over an hour, and it's just heart-wrenching and I felt like a really terrible parent, and today he did not even sleep this morning so I'm wondering if he was not tired at all, if I just kind of made him stay in his crib for an hour and 15 minutes, crying. And this is where I feel at a loss, and I'm not so confident about it and did not know if he needed to nap no matter what. So after an hour and a half I felt pretty crummy and I went and got him. Those are the times when I do not feel in tune with my baby. He's asking for something and I'm not getting it and so I kind of think I handled that wrong. And I've done that more than once. There's probably been 10-12 times when I've let him cry, and I feel like I let him cry for way to long, so I feel like, Oh ghee, I've done it wrong.

Interestingly, the resources are also associated with the level and even the nature of disagreements in families. In families where fathers had the most exposure to resources (were referencing to literature on sleep more often than others), there were much more disagreements about the sleep issues between the spouses. Since fathers in general had stricter general attitudes with higher preference for distant sleeping arrangement, it is possible that the resources bolstered their opinions and created even more difference with the mothers. This interpretation is supported by the findings that use of resources in both parents led to stricter parental strategies in this study. Moreover, in families where mothers referred to sleep literature more often than others, the mothers were actually on the less responsive side when disagreeing with fathers, while fathers were more responsive. Here is how a mother described the effect of online literature on her attempt at a sleep training implementation:

> At first [pause], well like I said the first night was kind of heart breaking, but [pause], after [pause], during the research the next day, and realizing that my feeling was correct, then I felt more, more [pause] I guess empowered and, well not empowered, confident that I was doing the right thing and making the right choice.

Contrary to expectations and conclusions of the qualitative analysis, infant characteristics did not seem to play a very important role in parental decision making regarding sleeping environment when their effect was tested statistically. It is possible that other variables, not assessed in the current study, might show a different pattern of relation with sleeping environments. In this study, only a few associations were found. Infant tendency to have more frequent colds was related to higher involvement at bedtime, possibly suggesting different parental interpretation of infant difficulties of settling to sleep or higher sensitivity to the infant. Boys seemed to have more exceptions for sleeping locations than girls. Though some associations were also found between infant daytime behaviors and sleeping environment, it seems more likely that the behaviors are rather results than the causes of the sleeping environment characteristics.

Thus, current closer sleeping location was associated with more frequent low-intensity positive affect expressions in infants, while closer location after birth was associated with higher

approach to new things. Higher involvement in nighttime awakenings was related to high-intensity positive affect expressions in infant, while sleep training and longer wait time before responding at night was related to lower soothability of an infant by a caregiver during daytime. It is less likely that infant approach to new things could influence the location right after birth just because of the reverse timing of these variables. As for the other effects, the nature of the effects is opposite from what would be expected if the behavioral characteristic of infants affected their sleeping environments. As exemplified in the qualitative analysis, difficult to sooth infants should be protesting more and thus getting higher and faster parental attention during the nighttime awakenings, rather than the opposite, which is what was found.

It is important, though, to keep in mind the limitations of the current study. There could be bias of sampling toward special type of families where both fathers and mothers were interested in participating without a substantial reward. The data about fathers could be especially biased, since fathers who agreed or were able to participate could be also fathers who were more than others involved in parenting. It is also important to improve the assessment of attitudes and have more objective measures of the sleeping environment in future studies. However, given all the limitations, this study contributes to the awareness of the role of fathers in infant sleeping environment and raises new important questions related to resources available to parents. Tin addition, the qualitative methodology gave an advantage to discover aspect that wouldn't otherwise receive attention, such as for example, the problem of resources not reaching the parents at the right time.

Chapter 4: Parental Attitudes, Sleeping Environment, Sleep and Development in Infancy

"If three quarters are spent in sleep who sleeps by whom is not a trivial matter…" Caudill & Plath, 1966

This research program explores different types of sleeping environments experienced by infants in the United States as well as possible developmental outcomes of the different types of sleeping environment. Most infants in United States sleep solitary (without parents nearby) by age 3 to 6 months. While recommended by many experts in the United States, this arrangement is different from caregiver-infant co-sleeping practiced in many countries around the world. Recent psychological and anthropological research has questioned the benefits of solitary sleeping arrangement both for a healthy sleep and a proper socio-emotional development (McKenna, 2000). However, the results remain controversial as to whether one sleeping arrangement is more beneficial than another for (1) infant sleep, and (2) infant socio-emotional development. Similarly, the assessments of the effectiveness and developmental outcomes of different parental behaviors and strategies at night, independently of the sleeping arrangements, are not very conclusive either.

This research attempts to add to the understanding of the effects of different sleeping experiences on the behavioral aspect of sleep and other developmental processes through a functional definition of a *sleeping environment* using two dimensions. The first dimension is the *general responsiveness* of the sleeping environment that incorporates both a physical arrangement and parental behaviors in the sleep context. The second dimension is the *consistency* of the parental sleeping environment with general parental attitudes toward childrearing. Since sleeping environment constitutes a part of a general parental strategy of childrearing it should not be taken out of the context without considering the different reasons that might influence parental choice of one strategy over another. It is proposed here that because of number of reasons parental choices of strategies in the sleep context might be either consistent or not with the general parental attitudes of the primary caregiver, thus leading to qualitatively different experiences of the same strategy by different infants and parents.

Most research in infant sleep has been conducted by clinical, pediatric and psychiatric professionals and targeted the problem of sleep disturbances in infancy (Sadeh & Anders, 1993; Burnham, Goodlin-Jones, Gaylor & Anders, 2002; Godfrey & Kilgore, 1998). The main purpose of this research has been to develop interventions for solving infant sleep problems by teaching infants to sleep through the night. Furthermore, since awakening during nocturnal sleep is a natural phenomenon, sleeping through the night for an infant then means being able to fall back to sleep when awakened by self-soothing without an adult intervention (Anders et al, 1992). Thus, according to these professionals, minimal adult intervention or presence at the time of falling asleep for the night, as well as in the middle of night, facilitates the ability to self-soothe thus also minimizing nighttime sleep disturbances. It is suggested to give the infant time to try to self-soothe and avoid an intervention or picking up the infant from a crib in response to the infant cry, since the intervention might reinforce the "negative" behaviors and will lead to excessive dependency of the infant at night (Cohen, 1999).

However, the ability to self-soothe involves both regulation of a physical state and emotional-behavioral regulation that depend on multiple factors. When and how such ability develops are clearly developmental questions. Surprisingly, most of the research in this domain

is not conducted in a framework of developmental psychology and accordingly does not incorporate its fundamental concepts. From the attachment developmental theory perspective (Bowlby, 1969) a caregiver serves as a secure base for an infant and whenever the caregiver is not available the infant is alerted and his attachment behaviors are activated with the goal of keeping proximity to his attachment figure – a process which is vital to the infant's survival. The attachment behaviors start to become more evident in the second half of the first year of life as the attachment relationship with the caregiver is being formed. Since night is associated with greater danger and vulnerability for survival in the environment of evolutionary adaptiveness, proximity seeking at night should be considered a normal phenomenon during this age.

Furthermore the task of falling asleep alone might become even more complicated if one takes into account the cognitive and motor developmental transitions taking place in the second half of the first year of life. The development of locomotion around 7-9 months brings a wealth of changes (Campos et al, 2000) that also might result in difficulties in falling and staying asleep, which have recently been documented (Scher, 2005, see also previous chapter). Even assuming that falling asleep is not a problem for a 3 months old baby, it can still posit a different task demanding a range of skills for an older infant. Thus, according to the developmental perspective "sleep disturbances" might constitute a normal developmental phenomenon and not a clinical problem to be treated.

Moreover, the developmental perspective suggests an opposite way of dealing with the "sleep disturbances". According to the attachment theory caregiver responsiveness is crucial for an infant to form a secure attachment that in turn will allow him to be independent by using a caregiver as a secure base. Unresponsive caregiving behaviors by contrast might elicit anxieties and more dependency on a caregiver. Thus, a developmental-evolutionary perspective emphasizes the adaptive value of the closeness between the caregiver and the infant at night (McKenna, 2000). According to this perspective, the isolation of the infant at nighttime and unresponsiveness of the caregiver might be the cause of the disturbances in infant sleep, since it violates the infants' fundamental need for proximity to a caregiver in an ambiguous situation of the night. Similarly, from a social learning theory perspective (Bandura, 1997) the contingent responsiveness of a caregiver to infant clues provides the infant with a feeling of the ability to control an environment/caregiver and is crucial for infant development through self-efficacy. According to these perspectives minimum adult intervention and presence at night might lead to the opposite outcomes than it targets by creating night related anxieties and insecurity which can complicate the task of separation at night.

Previous research does not fully support either the clinical or the developmental perspective. Numerous studies suggest that parental strategies with high involvement in the falling asleep contribute to more awakening and less self-soothing behaviors at night (Anders et al, 1992; Burnham et al, 2002). However, bed-sharing infants are excluded in these studies by the preliminary criteria considering the bed-sharing as a confound. Since many parents bed-share in the recent years (McKenna & McDade, 2005), the ecological validity of the findings is questionable.

Moreover, these studies are based on correlations and the causal direction is not completely clear since parents might have no other choice but to become involved if the infants have difficulties falling asleep. Even though some interventional studies in which parents are instructed to minimize excessive involvement at night teaching infants to self-soothe show

positive effects on infant sleep (Chervin, Dillon, Archbold, & Ruzicka, 2003; Sadeh, 2005), it is not clear whether similar effects are observed when parents engage in self-taught interventions without a professional quality assistance and supervision.

At the same time, the data from research comparing the sleep outcomes of different sleeping arrangements is very controversial too (see Mao, Burnham, Goodlin-Jones, Gaylor, & Anders, 2004 for a review). One of the possible explanations of this controversy is that due to the anthropological nature of this research the aspects of parental behaviors were largely ignored. It is likely that neither physical arrangement nor single parental behaviors can fully explain the variability in infant sleep. Only taken together and defined functionally as a more or less responsive environment can these elements contribute to our understanding of parental influences on infant sleep, especially on the behavioral aspect of it. For example, parents might sleep in a separate room but have a remote monitor and be very responsive to the infant calls even though it might be more difficult for a parent to attend to an infant by going to another room. At the same time, parents who sleep in the same room with an infant because they do not have an extra room might not be as responsive to the infant and train the infant to self-soothe, while not responding to his cries. Thus, while physical arrangement is usually associated with parental behavioral strategies it cannot be used alone as a proxy to define the environment.

Furthermore, even when thoroughly explored parental strategies at night should be viewed even in a wider context of the parenting as a whole. It is proposed here that there is no single sleeping strategy that is good for every family; rather the goodness of fit between the strategies is the key to optimal sleep outcomes. For instance, parents who value child's independence and self-reliance development may show that a solitary less responsive arrangement with minimal adult intervention does not lead to any sleep disturbances since it is consistent with their general strategy of fostering independence. However, less responsive strategies can create a problem for families where closeness and responsiveness are valued the most. In this case, the lack of the fit between the general childrearing attitude and the sleeping strategy can negatively affect both the parents and the children.

Parents who value closeness and responsiveness might feel uncomfortable with leaving their child to deal with his nighttime difficulties alone; they also might have more doubts about their strategies, feel less confident and behave in less consistent ways. At the same time infants who are used to the close proximity and responsiveness of his primary caregiver during the day-time interactions with a caregiver might be frightened by the unexpected lack of availability and closeness of a caregiver at night. Thus the consistency/inconsistency of the sleeping environment with the general parental attitudes was assessed as another factor defining the outcomes in infants' sleep, in addition to the responsiveness of the sleeping environment, in the present study.

Another purpose of the present study was to explore possible correlates of the different sleeping environments beyond sleep. Based on the nature of the previous research most of the studies concerning different sleeping arrangements or parental strategies have concentrated on outcomes related to infant ability to sleep through the night without considering effects on other developmental domains. Indirect evidence that nighttime experiences might be important for infant emotional development comes from Israeli kibbutzim research (Sagi at al, 1994). In this research more infants from kibbutzim with non-familial communal sleeping arrangement were found to be insecurely attached to their mothers in comparison to infants from kibbutzim without such an arrangement. A follow-up study showed that adolescents with non-familiar sleeping

history were mostly insecure (had non-autonomous adult attachment representations) and had higher separation anxiety compared to other adolescents (Scharf, 2001). However the experience of out of home sleeping might be much more aversive than sleeping in a separate room, thus caution should be taken when making conclusions based on this research.

More direct studies of the developmental correlates of the nighttime experiences only looked at the different sleeping arrangements independently of the parental behavioral strategies. Moreover, these studies were also retrospective in nature and reported long term consequences, which creates a problem in interpretation of the results. The evidence that comes from this kind of research supports the benefits of co-sleeping arrangement. Thus, Heron (1994) found that preschool children with solitary sleeping history were harder to handle, dealt less well with stress, were less happy and exhibited a greater number of tantrums than children with a history of co-sleeping. Moreover, he found that those children who never were permitted to bed-share were more fearful than children who always slept in their parents' bed, for all of the night. Similarly, Keller and Goldberg (2004) reported that children who co-slept in the first year of life were more self reliant and exhibited more social independence at ages 3-5 years.

However, no research to date directly examined the relationship between a sleeping environment, including both the physical arrangements and the parental behavioral strategies, and ongoing day-time developmental processes in infants. The nighttime battles could constitute a very stressful experience for an infant in light of such developmental phenomena as separation and stranger anxieties characteristic to the second half of the first year of life. Thus even if some infants succeed in learning to fall asleep alone or sleep through the night, the other question to ask is what are the other outcomes of this kind of learning beyond the sleep context? How is this learning related to the different day-time behaviors, such as soothability, expression of anxieties, and overall positive and negative emotional reactivity?

To summarize, four main hypotheses were examined in this research project based on the theoretical assumptions described above. The first hypothesis was that the sleeping environment as defined by sleeping arrangements and parental nighttime behaviors taken together would explain the infant outcomes better than either the arrangement or the behaviors separately. The second hypothesis was that the effect of a sleeping environment on an infant would depend on the consistency of the sleeping environment with the general parental attitudes of the primary caregiver. In other words, we hypothesize that infants would show different patterns of sleep if they experienced four different types of sleeping environment based on the two dimensions of responsiveness of their sleeping environment and its consistency with the general parental attitudes: (1) unresponsive - consistent with general parental attitudes, (2) unresponsive - not consistent with general attitudes, (3) responsive – consistent, (4) responsive – not consistent.

The third hypothesis was that the type of sleeping environment experienced by an infant would lead to different developmental outcomes beyond sleep. More specifically, the nature of infant nighttime experience was expected to be related to day-time soothability, expression of different fears and anxieties, overall positive emotional reactivity and overall negative emotional reactivity. The fourth hypothesis was that the association between a type of sleeping environment and different infant outcomes will be mediated by inconsistency in parental behaviors and by parental subjective experiences of the sleeping environment related to feeling of self-efficacy in the domain of sleep, satisfaction with sleep situation, stress and conflicting feelings.

Methods

Sample

This study was a part of a bigger project and was based on the same sample of participants described in the previous chapter (Chapter 3). Unlike the study described in Chapter 3, all 54 families recruited for the project participated in this study. Even though, assessments for 5 infants were not completed fully due to parental unavailability for interviews, these infants were not excluded in this study since it focused more on infants rather than parents. Thus, even without data from parental interviews, the completed part of the assessments of the 5 infants could serve for analyses of a number of research questions. The 5 cases with missing data thus were excluded analysis by analysis. One family also had twin infants making the total number of 55 infants in the sample.

All 55 infants were healthy firstborns between 6.5 and 9 months of age (M=7.99, SD=0.74) As described in the previous chapter, the families were recruited through the list of volunteer participants in the Bay Area maintained by the Institute of Human Development of the University of California, Berkeley. Participation criteria for this study included healthy infants between the ages of 6 and 9, with no developmental delays from 2 parents family from Caucasian population to limit any confounding effects. The research was presented to parents as a study of parenting and infant development with an emphasis on parental difficulties, feelings, resources used and family services provided. The parents thus were not aware of the study interest in sleep to allow an unbiased assessment of both general attitudes and sleeping strategies.

Both mothers and fathers took part in the study when possible, however most of the information was obtained from the primary caregiver. The status of a primary caregiver was assigned based on parental self-definition. In 4 out of the 54 families the parents defined the father as a primary caregiver instead of the mother. The mothers (aged M=34. 31years, SD=5.44) had primarily higher than college education and held graduate degrees, (63.6% of the sample), 23.6% had college education and 12.7 % had only a high school diploma. The fathers (aged M=35.21 years, SD=5.51) had primarily college education (38.9% of the sample), 37% had higher than college education and 11.1% had only a high school diploma. The sample of infants consisted of 28 boys and 27 girls mainly from White Caucasian population (80%). The rest of infants had one Caucasian parent and another from a different ethnic group: 15% had a second parent of an Asian origin, 5% - of a Hispanic origin. The ethnic minority parents were at least from a second generation of immigrants.

Assessments

This research employed assessments based on 3 types of parental report: (1) a set of questionnaires completed by the infant's primary caregiver, (2) a 7 days Baby's Diary completed by all caregivers in charge during the 7 days, (3) phone interviews with both parents separately. The Questionnaires were used to assess demographic information, general parental attitudes and non-sleep related developmental outcomes. The questionnaire for assessing general parental attitudes was completed by both parents but for most of the analyses only the primary caregiver's responses were used. The Diary's main purpose was to assess infant sleep and sleeping locations, however the sleep related questions in the diary were integrated with non-sleep related questions to control for parental bias by preventing the parents from concentrating on sleep issues so that the research does not take a form of an intervention study instead of a naturalistic one. Thus the

diary also includes other information about infant's and caregiver's behaviors which was used for cross-validation with measures from other types of reports.

The Interviews explored parental attitudes and choices/strategies related to childrearing in general and in 4 specific domains: childcare choice, feeding, daily activities and sleep. However, only analysis of the part on sleep was used for the purposes of the current study. Though fathers were not part of the research questions in this study, having both parents to be interviewed made it possible to get a clearer picture of the sleeping environment, since 2 respondents were expected to provide more information and being more objective about it. For details on interviews coding procedures and reliability information see Chapter 3 (methods section).

Different sets of measures used in the analyses of the research questions were based on multiple types of reports and are described next.

General parental attitudes. The attitudes were assessed through a Parental Attitudes Questionnaire but the measures were validated using interview-based assessments. The questionnaire was based on an integration of Goldberg's Questionnaire on Parental Attitudes (1990) and Raphael-Leff's Facilitators and Regulators Questionnaire (1991) and includes 24 items. The items express explicit general beliefs and approaches to parenting and are rated by parents on a scale from 1 ("strongly disagree") to 6 ("strongly agree"). The questionnaire yielded measures for 4 scales based on 4 theoretical constructs: (1) value of dependency, (2) fostering of independence, (3) facilitating style of parenting, and (4) regulating style of parenting. The reliabilities of the scales (α Cronbach) ranged between .62 to .77. The detailed tests of validity and reliability of the scales are described in Chapter 3 (see Table 9).

In addition to separate scales an overall scale of general responsiveness of attitudes was calculated based on all four of the scales in this study to make the analysis of consistency with sleeping environment possible. Since the scales differed between themselves in means we first transformed the scales into binary variables to make them comparable. We used median split for the transformation so that parents who scored above the median on a scale received a score of 1 and parents who were below the median received the score of 2. The split of the variables based on median was chosen as the most appropriate method after an examination of the distributions of the scales. Independence Fostering and Regulative scales were then reversed and a sum of all four of the scales was calculated for a general responsiveness of attitudes. Thus, the minimum responsiveness score of 0 meant the parent was below medians on both Facilitation and Dependency, while also above medians on both Regulation and Independency scales. The maximum responsiveness score of 4, on the other hand, meant that the parent was above medians on both Facilitation and Dependency, while also below medians on both Regulation and Independency scales.

Sleeping environment. The sleeping environment was assessed both based on the 7 days Baby's Diary and on the part of Interview related to sleep domain. Three sets of measures were used to define the sleeping environment: (1) measures related to sleeping arrangement/locations, (2) separate parental strategies, and (3) measures of the general responsiveness of the sleeping environment. Sleeping arrangement measures included current sleeping location (relative to parents), as well as location right after birth, and number of changes in locations. As described in the previous chapter, two families changed the location of their infant sleep after completing diary. Unlike the previously described study, the current location was assessed based on diary

and not interviews in this study, since most of the analyses were related to infant sleep based on diary and the location at that same point of time was more appropriate for the analyses.

Separate parental strategies were assessed based on interviews with both parents (see Chapter 3 for details) and included involvement in the falling asleep for the night/bedtime strategy, nighttime awakenings involvement/middle of the night strategy, wait time before responding to nighttime awakenings in minutes, and implementation if "cry it out" sleep training (teaching the infant to self-soothe to sleep by letting him/her cry for prolonged periods of time). Parental involvement was assessed based on parental presence and behaviors from 1 - no involvement or presence at all, 2 - mere presence of a parent, 3 being actively involved (holding, rocking, or feeding/nursing). All interview measures were assessed by 2 independent coders, and any disagreements were resolved through discussions. Between-coders reliability ranged from .89 to 93.

The general responsiveness of the sleeping environment was defined in three ways: (1) cumulative score of overall stability in the sleeping environment - the number of changes parents made over time both in parental strategies and arrangements; (2) judgment of 2 trained coders of the overall responsiveness of the sleeping environment (from 1 to 7) as described by the primary caregiver; (3) cumulative score of the general responsiveness based on 3 categories: current sleeping location, parental involvement in nighttime awakenings, and implementation of sleep training involving "cry it out". Unlike the previous study, the sleeping location right after birth was not included in the cumulative score due to the nature of questions in this study, which were related to the link between the responsiveness and the corresponding sleep patterns of the infant.

All of the categories were converted into binary scales and the sum was calculated. Thus the minimum score of 3 meant least responsiveness (separate room sleeping location, minimum parental involvement in nighttime strategies, and implementation of sleep training); while the maximum score of 8 meant more responsiveness (close first and current location, high involvement at night and no sleep training). The 2 coders agreed in their subjective judgments in .85% of the cases and all the disagreements were resolved through discussion. The subjective responsiveness as defined by coders highly correlated with the cumulative score based on the sum of the 4 categories (r=0.61, N=50, p<0.001).

Sleep. The sleep patterns were assessed using two kinds of parental report: 7 days Baby's Diary and Interview. Parental reports were previously validated using different methods (Sadeh's, 2004): (1) finding high and significant correlations between parental reports' measures and objective actigraphy measures for clinical and control groups of infants; (2) comparing results of a large Internet survey with existing literature on developmental sleep patterns. In the current study Diary provided the main assessment of sleep. In the Diary parents were asked to record the time it takes the infant to fall asleep for the night, time of night sleep onset, time of waking up in the morning, number of awakenings, and time it takes to fall back to sleep when awakened in the middle of the night.

The following mean scores were obtained from the 7 days period: (1) mean duration of the entire night sleep period from the sleep onset to the morning wakening (in minutes); (2) mean duration of settling for night-sleep - time it takes to fall asleep for the night (in minutes); (3) mean number of awakenings per night; (4) mean time spent awake at night - number of awakenings multiplied by the time of falling back to sleep; (6) pure sleep per night – time spent

asleep out of the entire night's sleep period, defined as duration of the entire sleep period minus the time awake at night in (in minutes). Along with the means we also computed log transformed coefficients of variation for each of these measures; these scores provided an index of variability in of the sleep measures that was independent of the mean.

The interview information was coded both for cross-validation with the diary and for parental subjective perspective on infant sleep over the infant development. For validation the parents were asked about their infant average sleep patterns and these scores highly correlated both between two parents of the child (α Cronbach ranged between .73 and .89) and with the diary scores (r ranged between .64 and .81, all *ps*<0.01). For subjective perspective parents were asked about their child being a good or a bad sleeper, both currently and early in life. The coded measure was ranging from 1 to 3 (1 meaning "great sleeper", 2 – "ok for his/her age", and 3 – "bad sleeper"). The parents were also asked about abilities/behaviors of the child related to falling asleep alone, going back to sleep alone, and sleeping through the night. In addition, the parents were asked to recollect the ages when these behaviors were first observed. Only primary caregiver interviews were used to obtain these subjective measures in the current study, however both parents' reports were used for validity test. Agreement between parents ranged from 91 to 100% on these measures, and most of the disagreements between parental reports were related to the difference between high versus medium involvement (only presence versus talking/patting).

Developmental outcomes/infant daytime behaviors. Infant behavioral measures of possible developmental outcomes were assessed in 3 ways. First, infant daytime behaviors were assessed using a brief slightly modified version of the Infant Behavior Questionnaire – Revised (Gartstein & Rothbarth, 2003). In this Questionnaire primary caregivers were asked to rate on a scale from 1 to 7 how often they observed a specific behavior during the last week. Part of the questionnaire also includes questions related to a 2 weeks span. This questionnaire is a well-established assessment of a range of infant behaviors that are clustered into meaningful dimensions. The modification for current study purposes included addition of a few items of specific interest, such as fear of the dark and selfsoothing abilities. The following scales were included in the assessment: (1) fear: general as well as fear of dark, of stranger and of separation (2) distress to limitation; (3) general sadness; (4) positive affect expression (both low and high intensity); (5) approachability to new things; (6) vocal reactivity; and (7) soothability across contexts (with caregiver's help as well as self-soothing).

Second assessment included Anxieties Questionnaire in which parents were asked whether or not their infant expressed negative reactions when the parent tried to leave a room, or a house, when an unfamiliar adult approached the infant in a variety of situations, or when the infant was taken outside to a new place. If answered yes to any of the questions the parent was asked to provide the age when the negative reaction was first observed. In addition, the parents were asked if the child reacts differently to women and men. Third assessment was based on the diary information and pertained to the mean amount of crying during daytime. The mean amount of crying was computed from number of incidents the infant cried for longer than 3 minutes during the day over the 7 days period, as recorded by the caregivers.

Parental subjective experience of the sleeping environment and behavioral inconsistency. Parental subjective experiences were represented by parental self-efficacy in the sleep domain, parental satisfaction with the sleeping environment, parental stress and conflicting feelings in the sleep domain. The self-efficacy and satisfaction were assessed through direct questions in the

interview that required a responder to give a numerical rating from 1 to 7. The sleep self-efficacy was calculated based on the average of parental responses to a number of specific questions targeting self-confidence in specific areas/behaviors. For example, the parents were asked: “how confident do you feel about putting your child to sleep”, or “how confident do you feel about choosing the right sleeping arrangement for your baby”.

Stress and conflicting feelings were assessed by the coders based on parental spontaneous expressions of stress and conflicting feelings when discussing nighttime parenting and were coded on a scale from 1 –no conflicting feelings/stress at all, to 3 – a lot of conflicting feelings/stress. The behavioral inconsistency of the parents in the sleep domain was assessed through the diary based log transformed coefficients of variance in sleeping arrangements and interview based measures of stability or the number of changes in parental strategies and sleeping arrangements over time.

Approach to Analyses

First, the relations between both parental behaviors and sleeping arrangements with sleep/behavioral outcomes were examined separately based on correlations mainly, however t test was used instead for comparisons of sleep patterns and other behaviors between groups of infants based on 2 categories or nominal variables. For all correlation analyses being conducted the scatterplots were examined to make sure the relationships were linear and curve-fitting tests were applied when appropriate.

To test the hypothesis that parental behaviors and sleeping arrangement would explain outcomes better if considered together 3 sets of analyses were conducted: (1) groups with different combinations of arrangements with parental behaviors were compared for the outcomes; (2) overall judged responsiveness (based on coders) was correlated with the outcomes; (3) the cumulative measures of the general responsiveness of the sleeping environment was correlated with the outcomes. Given the exploratory nature of the study, the different ways of testing the effects of the sleeping environment created proliferation of statistical analyses, however these were necessary for comparison of the different ways of testing the effects.

To address the hypothesis that the effect of a sleeping environment on an infant would depend on the consistency of the sleeping environment with the general parental attitudes of the primary caregiver we divided the families into four groups according to both the responsiveness of a sleeping environment and its *consistency* with parental attitudes. First, all the infants were divided into two groups according to *responsiveness* of the sleeping strategy, and then every one of the two groups was divided into two more groups based on consistency of the sleeping environment with parental attitudes thus creating 4 groups with different environments for comparison. Then we compared infants from the four different groups on behavioral sleep patterns and behavioral outcomes using One Way ANOVA. The groups were also compared on the potential mediating variables (parental subjective experiences and behavioral consistency) and on a variety of control variables to make sure that the differences were not accounted by confounding factors. The effect of potential mediating variables, if any identified, was assessed according to the methods of Baron and Kenny (1986). Cases with missing data for some of the variables (when parents omitted a question) were excluded analyses by analysis.

Results

Sleeping Environment, Sleep and Daytime Behaviors

Sleeping arrangement. First we looked whether the sleeping arrangement solely can explain some variability in the **sleep patterns of infants** and/or other behavioral outcomes. First we looked at the correlation between the closeness of the *current* sleeping location to parents and the outcome measures and found a number of significant associations. The closer the infants slept to their parents the earlier in age they started to fall asleep for the night on their own (r=-0.36, N=33, p<0.05), cried less during the night (r=-0.36, N=41, p<0.05), had less variation in their number of awakenings per night (r=-0.36, N=55, p<0.05) and woke up in a better mood (r=0.58, N=55, p<0.01) with less variation in the mood (r=-0.59, N=55, p<0.01). However, on the other side, they had less pure sleep per night (r=-0.41, N=55, p<0.01), started to self-soothe later in age according to parental recollection (r=0.39, N=35, p<0.01), had less self-soothing per awakening according to the current diary input (r=-0.38, N=54, p<0.01), and slept through the night less often based on parental perception (r=-0.39, N=49, p<0.01).

To test the possibility that the better mood in the morning and worse sleep measures of the infants who were sleeping in the same room with the parents were the function of a better parental awareness rather than the infant actual mood/sleep, we excluded the infants with current solitary/separate room locations. Even though the sample size dropped significantly with only same room locations included (N=18), the correlations remained significant between the closeness of the infant sleeping location to parents and less variation in number of awakenings per night (r=-0.58, N=19, p<0.01), better waking mood (r=0.49, N=19, p<0.05), as well as lower mood variation (r=-0.52, N=19, p<0.05). Moreover, closer location in this analysis also correlated with earlier age of sleeping through the night (r=-0.60, N=19, p<0.05). On the other side, the correlation with pure sleep, self-soothing per awakening and age of going back to sleep on their own did loose significance. The crying at night measure had a ceiling effect in this analysis as all of the infants sleeping in the same room with parents had the same rate (minimum) of crying at night, namely they did not tend to cry at night.

Another way to test the possibility that the shorter sleep of room-sharers is just a function of a better parental awareness was looking at the reported times of infants' going to sleep and waking up. Room-sharing parents (N=19) did not report earlier waking times for their babies than parents sleeping in separate rooms (N=36). However, they did report significantly later bedtimes (M=8:49pm, SD=1.5 versus M=7:36pm, SD=0.71, t(22.42)=-3.11, p<0.01). Moreover, later bedtime significantly correlated with shorter night period (r=-0.66, N=55, p<0.01) and less pure sleep (r=-0.65, N=55, p<0.01). Thus, when entered into a regression equation after bedtime which was a significant predictor of the pure sleep (R^2=0.43, F(1,53)=39.21, p<0.01 ; B=-28.12, SE=4.92, β=-0.62; t=-5.72, p<0.01), the sleeping location did not add to the variability explained by the bedtime (ΔR^2=0.01, ΔF (1,52)=0.79 , p=0.38; B=-4.35, SE=4.91, β=0.09; t=-0.89, p=0.38).

Beyond sleep, closer *current* sleeping location was associated with more low intensity positive affect expressions in the infants during daytime interactions (r=0.33, N=55, p<0.05), and interestingly, also with higher preference of adult males over females by the infants (r=0.27, N=55, p<0.05). Importantly, closeness of sleeping location did not correlate with daytime self-soothing (r=-1.17, N=47, p=0.25), and the daytime self-soothing did not correlate with the

nighttime self-soothing either (r=0.09, N=49, p=0.56). Closeness of the *first* sleeping location (right after birth) correlated with approach to new things (r=0.38, N=50, p<0.01). Interestingly, number of changes in locations over the infant's life correlated with earlier age of expressions of a separation anxiety within a house (r=-0.50, N=20, p<0.05).

For control purposes we also tested the possibility that general parental style or some other parental qualities might be responsible for both the sleeping location choice and positive infant behavior outcomes or waking mood we looked at the correlations between some of the parental variables (attitudes, age, education and employment) and both sleeping locations and related behavioral outcomes. Only dependency valuing by fathers was associated with higher male preference/approach (r=0.28, N=53, p<0.05), as well as higher rate of low intensity positive affect expressions (r=0.28, N=53, p<0.05), while also being related to closer sleeping arrangements (r=0.30, N=53, p<0.05). However, when sleeping location was entered into a regression equation after father dependency attitude, both seemed to contribute independently to the explained variability in male approach (ΔR^2=0.08, F(1,52)=4.43, p<0.05 for the attitude and ΔR^2=0.08, F(2,51)=5.15, p<0.05 for sleeping location) and in low intensity positive affect (ΔR^2=0.08, F(1,52)=4.74, p<0.05 for the attitude and ΔR^2=0.09, F(2,51)=5.43, p<0.05 for the location).

Identical results were seen when the infants sleeping in separate rooms (N=38) were compared with infants sleeping in the same room/bed with parents (N=17) using T-tests on both sleep and behavioral measures. The results were the same when infants with mixed sleeping locations were excluded from the sample (6 infants had separate room mixed with same bed location, 4 infants had same room mixed with same bed location). The only exception was an additional significant difference between infants sleeping in separate rooms versus the same rooms as parents in the average crying during the daytime, t(38.38)=2.16, p<0.05). Solitary sleeping infants cried more (M=1.08, SD=1.11) than infants sleeping in the same room/bed as parents (M=0.55, SD=0.37) based on the 7 days of the diary report. This difference was not explained by differences in parental variables (attitudes, age, education and employment).

To summarize, among the room-sharing infants the physical closeness to parents (from crib in a distance, to crib by parental bed, to bed-sharing) seemed to have some positive effects on sleep, namely earlier age of sleeping through the night and less variation in awakenings. However, compared to infants sleeping in separate rooms the room-sharers seemed to have less sleep and less self-soothing both based on diary and on parental perception. But, the better nighttime self-soothing of the separately sleeping infants did not seem to be related to better daytime self-soothing. In addition, shorter sleep of the room-sharing infants could be alternatively explained by a later bedtime. Moreover, among all infants in the sample the closeness of the sleeping location associated with a better mood in the morning, less crying during the daytime, higher approach to new things, more low intensity positive affect expressions, and higher approach to male adults. In addition, instability of sleeping locations overtime associated with higher separation anxiety expressed within the house.

Selected parental strategies. Falling asleep for the night/bedtime strategy had the most associations with **the infants' sleep measures**. Infants whose parents were more actively involved in the bedtime falling asleep process had more awakenings per night (r=0.46, N=50, p<0.01) and had less pure sleep per night (r=-0.35, N=50, p<0.05) based on the diary assessments. In the interviews, the parents that were more involved at bedtime process

characterized their babies as “bad sleepers” more often (r=0.44, N=50, p<0.01) and reported that their infants slept through the night less often (r=-0.42, N=49, p<0.01) and were less able to go to sleep on their own both before the night (r=-0.45, N=50, p<0.01) and in the middle of the night (r=-0.44, N=49, p<0.01). It is important to note that the correlation between parental involvement and the diary based assessment of self-soothing per awakening was not significant. Similarly, parental involvement in the awakenings/middle of the night strategy and the wait time before responding to an awakening correlated with parental perception of the ability of the infants to self-soothe (r=-0.45, N=48, p<0.01, and r=0.56, N=48, p<0.01 respectively), but not with the self-soothing measure derived from the diary.

Infants who had feedings at night (43 out of 55) spent more time awake at night (M=29.25, SD=25.17 versus M=9.60, SD=11.66, t(53)=2.62, p<0.01), but did not differ in the pure sleep per night (p=0.91). They also had less self-soothing per awakening based on diary (M=0.19, SD=0.24 versus M=0.68, SD=0.30, t(52)=-5.72, p<0.001), and lower prevalence of sleeping through the night according to the interview report (M=4.03, SD=1.73 versus M=5.23, SD=1.62, t(47)=-2.03, p<0.05). However, feeding was not associated with daytime self-soothing, suggesting that the measure of self-soothing at night mainly reflects a common pattern of infant-parent nighttime interaction rather than infant actual ability to self-soothe.

Parents who implemented sleep training using the “cry it out” method before the assessment (N=29) reported in the interview that their infants were more able to fall back to sleep in the middle of the night compared to the other 21 parents who used either “no-cry solution” or no sleep training at all (M=4.45, SD=1.47 versus M=3.29, SD=1.71, t(48)=2.55, p<0.05). However, the infants did not differ on the self-soothing per awakening based on the diary or on any other sleep measures (al ps >12). The infants did seem to differ (showed trends close to significance) in amount of crying at night, t(39)=1.86, p=0.07, and in the morning waking mood, t(48)=-1.84, p=0.07. Compared to the infants who were not trained using the “cry it out” method, the sleep-trained infants had more crying at night (M=3.04, SD=0.75 versus M=2.59, SD=0.79) and worse mood in the morning (M=3.01, SD=0.74 versus M=3.37, SD=0.61). None of the parental attitudes scales correlated with sleep-training implementation, thus general attitudes could not explain the association between the sleep training and the outcomes.

Beyond sleep, the daytime infant behaviors did not show any associations with sleep training, parental involvement in falling asleep for the night or wait time before responding at night. However middle of the night parental involvement correlated with infant high intensity positive affect expression (r=0.42, N=48, p<0.01), and had close to significant positive correlation with approach to new things (r=0.27, N=48, p=0.06) and negative - with fear of dark (r=-0.34, N=29, p=0.07), based on IBQ scores. Similarly, infants that had feedings at nights cried less during the day based on diary information (M=0.74, SD=0.72 versus M=1.43, SD=0.1.30, t(53)=-2.43, p<0.05) and also had a trend toward lower fear of dark based on IBQ (M=2.09, SD=0.82 versus M=2.89, SD=1.69, t(33)=-1.86, p=0.07). Parents that fed their children at night were not different from those who did not in age, education, employment or attitudes. Though maternal education correlated negatively with the nighttime involvement (r=-0.29, N=49, p<0.05), it had no significant relationship with the daytime infant behaviors.

In summary, sleep training, parental readiness to respond at night and actual involvement (both at the bedtime and in the middle of the night) was only related to parental

subjective perception of the infant ability to self-soothe and to sleep through the night, but was not related to the self-soothing measure based on the diary. Only the kind of parental involvement that included feeding was negatively associated with the diary measure of self-soothing. However, despite longer non-self-soothed awakenings, feeding did not seem to cost in total amount of sleep and did not seem to affect daytime self-soothing. Parental involvement *at bedtime*, on the other hand, did show an association with more awakenings and less sleep. Beyond sleep, however, parental involvement *in the middle of the night* positively associated with high intensity positive affect and approach to new things, while negatively – with fear of dark. Feeding at night also associated with less crying during daytime, while sleep training, on the other hand, associated with more crying at night and worse mood in the morning.

Interrelation between sleeping arrangements and parental strategies. Closer sleeping location of an infant correlated with all of the parental night strategies: higher involvement at bedtime (r=0.37, N=50, p<0.01) and at night (r=0.46, N=49, p<0.01), less wait time before responding at night (r=-0.34, N=49, p<0.05), less sleep training implementation (r=-0.39, N=49, p<0.01), and more feedings per awakening (r=0.62, N=55, p<0.01). (Even though the sleeping arrangements and selected parental strategies associated differently with most of infant sleep and daytime behaviors, there was some overlap of the effects, as can be seen from the previous section. Sleeping arrangements had similar effects to those of bedtime strategy on sleeping through the night and pure sleep, as well as of feeding on self-soothing and daytime crying, and of sleep training on night crying and mood in the morning. One way to disentangle the different effects was to look at the different *combinations* of sleeping locations and strategies. This analysis was possible since closer sleeping arrangement did not always correspond to more involved parental night strategies, despite the overall correlation.

The details of the *combination* analysis are presented in Appendix 2. In summery, based on the combination analysis, duration of night, pure sleep, sleeping through the night as well as night crying were better explained by the sleeping arrangement. However, time awake at night, self-soothing at night and day crying were mostly related to the night feeding, while number of awakenings – to parental involvement at bedtime, and mood in the morning – to sleep training.

In addition, the combination analyses showed that all of the co-sleeping infants were fed at night, leading to the least sleep compared to all other infants. Sleep-trained separately sleeping infants spent as much time awake at night as co-sleeping/fed infants and significantly more than separately sleeping non-trained infants. They also spent more time crying at night compared to the co-sleepers, and had the worst mood in the morning compared to all other groups in the combination analysis. Infants sleeping separately while having high versus low parental involvement also seemed to have special characteristics or needs: they had the most night-crying of all infants, and compared to other separately sleeping infants were described by their parents as more problematic in sleep and more cranky during daytime, as well as less able to self-soothe at night or being soothed at daytime, as illustrated in the Appendix 2.)

General responsiveness of the sleeping environment. To account for all aspects of the sleeping environment we also used a cumulative measure of the general responsiveness of the sleeping environment taking into account the location, the nighttime responses and the use of the "cry it out" method by the parents. The more responsive was the environment (based on the cumulative measure) the shorter was the night-sleep period (r=-0.36, N=50, p<0.01), but also a better mood when awakened in the morning (r=0.31, N=50, p<0.05) based on the diary. There

were also close to significant trends for less pure sleep (r=-0.25, N=50, p=0.07) and less selfsoothing per awakening (r=-0.26, N=50, p=0.07). Based on parental perceptions taken from interviews infants with the more responsive environment were less able to fall asleep on their own (r=-0.46, N=50, p<0.001), or go back to sleep on their own when awakened (r=-0.59, N=49, p<0.001), slept through the night less often (r=-0.48, N=49, p<0.001), but also cried less at night (r=-0.33, N=49, p<0.05).

There was also a trend for the more "responsive" parents to characterize their baby as a "bad sleeper" from earlier in development (r=0.27, N=50, p=0.06), as well as currently (r=0.26, N=50, p=0.06), pointing at the possibility that the more responsive parental strategies could be more of an adaptation to the infant trouble sleeping rather than parental choice. None of the behavioral daytime measures (including daytime selfsoothing) correlated with the general responsiveness, except from lower soothability by a caregiver (r=-0.38, N=50, p<0.01). This relation too points to rather a reverse direction of the effect with difficult to soothe infants needing more parental assistance at night. Furthermore, the cumulative measure of the general responsiveness did not correlate with any of the parental attitudes but showed positive correlation with the number of colds the child had since birth (r=0.30, N=49, p<0.05) and negatively with a number of bedrooms per person (r=-0.35, N=50, p<0.05), also supporting rather reactive character of the parental choices.

In the same vein, somewhat different results were observed when correlations were examined using the subjective rating of the responsiveness of the sleeping environment as defined by coders. This rating is different from the cumulative one since it constitutes coders judgment of the real responsive sleep attitude of the parents while taking into account parental reasoning behind it. Thus parents who start co-sleeping or have higher involvement in a reactive way, as a result of infant sleep trouble rather than their beliefs and preferences, would not be rated as very responsive by coders even if they have high cumulative responsiveness score. Indeed, unlike the cumulative score, the judged score neither correlated with infants' health/colds nor with bedrooms per person, but did correlate negatively with the mother attitude valuing independence (r=-0.30, N=50, p<0.05), which was based on self-report in questionnaire and was not available to coders.

Likewise, the judged score did not correlate with the infant daytime soothability or with the parental perception of a sleep problem in the infant. Though similarly to the cumulative score, the judged score correlated significantly with a shorter night sleep period (r=-0.34, N=50, p<0.05) and almost significantly with shorter pure sleep (r=-0.25, N=50, p=0.07), it did not correlate with the diary reported selfsoothing per awakening. The judged score did correlate negatively with the parental perception of the infant ability to fall asleep on their own (r=-0.33, N=50, p<0.05), and to go back to sleep on their own when awakened (r=-0.32, N=49, p<0.05). None of the results seemed to be related to the parental attitudes toward infant independence. None of the daytime behavioral measures correlated with the responsiveness as judged by coders.

However, another cumulative measure of overall stability in the sleeping environment - the number of changes parents made over time both in parental strategies and arrangements - did correlate positively with fear of strangers (r=0.28, N=49, p<0.05) and negatively with high intensity positive affect expression (r=-0.31, N=49, p<0.05). The number of changes was not related to any of the parental attitudes or other characteristics, except for the older age of the

mother (r=0.31, N=49, p<0.05), and also of the father (r=0.29, N=47, p<0.05). However, when entered into a regression analysis after the parents' ages number of changes the parents made in the sleeping environment still added significantly or almost significantly to the explained variability both in infant high intensity positive affect expression (ΔR^2=0.20, ΔF (1,42)=12.36, p<0.01) and infant fear of stranger (ΔR^2=0.08, $\Delta F_=$(1,43)=3.63 , p=0.06).

In summary, the general responsiveness was neither a good predictor of sleep nor of daytime behavioral measures. While the judged responsiveness (based on coders analysis) only predicted less sleep, the cumulative measure seemed to be highly confounded by infants' special characteristics/needs (such as having frequent colds or lower soothability) or home situation (bedrooms per person), making the analysis unreliable. The general instability of the sleeping environment, however, did predict lower high intensity positive affect expressions by the infant and higher fear of stranger.

Summary of the effects of the sleeping environment. The general responsiveness of the sleeping environment did not prove to be a good predictor of the different infants' outcomes. On the other hand, when assessed separately and in combinations sleeping arrangements and parental strategies did predict both infant sleep and other outcomes. Thus, compared to infants sleeping in separate rooms co-sleeping infants seemed to sleep through the night less and have less sleep, though the latest difference could be also explained by their later bedtime and night feedings, since feeding was associated with longer awakenings and less self-soothing. On the other hand, co-sleepers had less crying during the daytime, and closer sleeping location was also associated with higher approach to new things, more low intensity positive affect expressions, and higher approach to male adults.

Sleep training, on the other hand, did not seem to affect sleep measures, though the sleep-trained infants turned out to spend as much time awake at night as co-sleeping/fed infants and significantly more than separately sleeping non-trained infants in the combination analysis. But unlike the co-sleeping infants (having longer awake time mostly due to feedings), the sleep-trained infants spent more time crying at night and had the worst mood in the morning compared to all other infants.

Parental involvement at bedtime was only related to more awakenings. Though involvement in the middle of the night did not seem to affect sleep in general, an interesting pattern arose in the combination analysis. While separate location worked best with low involvement at night, it did not seem to work the same way with high involvement. The infants sleeping separately with high parental involvement had the most crying at night and compared to other separately sleeping infants were described by their parents as more problematic in sleep and more cranky during daytime, as well as less able to self-soothe at night or being soothed at daytime. In general though, parental involvement at night was related to higher intensity positive affect, higher approach to new things, and lower fear of dark.

The Effects of Consistency of Sleeping Environment with Parental Attitudes of the Primary Caregiver

Parental attitudes, sleep and daytime behaviors. When associations between parental attitudes of the primary caregiver and infant sleep measures were examined, no significant correlations were found between sleep measures and the caregiver valuing of dependency, independency or facilitation. However, regulative style of parental attitudes did show numerous

associations with sleep measures. Based on diary measures, the more regulative the primary caregiver was the less pure sleep per night her/his baby had (r=-0.29, N=55, p<0.05), and the more the amount of sleep was variable over the 7 nights of the diary both for daytime sleep (r=0.38, N=55, p<0.01) and for the night (r=0.32, N=55, p<0.05).

Interestingly though, based on the interview measures the more regulative caregivers perceived their babies sleep as less problematic (r=-0.30, N=50, p<0.05) and reported that their babies started to fall asleep alone at an earlier age (r=-0.38, N=33, p<0.05) and slept through the night more often (r=0.38, N=49, p<0.01). The overall responsiveness of attitudes was negatively associated with sleeping through the night (r=-0.49, N=49, p<0.01), but also had a close to significant positive correlation with pure sleep per night (r=0.23, N=55, p=0.09).

Only two significant associations were found between primary caregiver attitudes and infant behaviors beyond sleep. Facilitation negatively correlated with distress to limitation (r=-0.27, N=55, p<0.05), while dependency positively correlated with high intensity positive affect expression (r=0.27, N=55, p<0.05) and better soothability of the infant by a caregiver (r=0.29, N=55, p<0.05). Neither regulation nor independency valuing in attitudes predicted any of the behavioral outcomes. However, the overall responsiveness of attitudes (based on all four attitudes scales) had two close to significant trends for positive correlation with infant high intensity positive affect (r=0.24, N=55, p=0.07) and vocalizations (r=0.23, N=55, p=0.08).

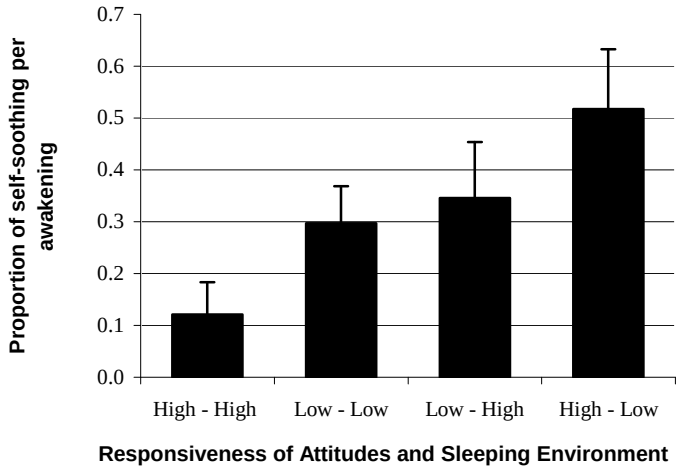
Comparisons of groups based on different combinations of sleeping environment with parental attitudes. For the group comparisons based on consistency both parental attitudes responsiveness and the responsiveness of a sleeping environment were transformed into binary variables of higher versus lower responsiveness. In the case of parental attitudes a binary variable was based on median splits of the variable termed general responsiveness of attitudes variable, which was based on all four of the Attitudes Questionnaire Scales. For the binary variable of the responsiveness of the sleeping environment we used the median splits of the cumulative measure of the overall responsiveness in sleep domain. Based on the two binary variables 4 groups were created for comparison: (1) high responsiveness both in attitudes and sleep (High-High), N=13; (2) low responsiveness both in attitudes and sleep (Low-Low), N=14; (3) low responsiveness in attitudes but high in sleep (Low-High), N=11; and (4) high responsiveness in attitudes but low in sleep (High-Low), N=12.

In sleep the groups significantly differed between each other in the duration of the night sleep period, $F(3,49)=3.09$, p<0.05, number of awakenings, $F(3,49)=4.92$, p<0.01, and self-soothing per awakenings, $F(3,49)=3.34$, p<0.05. Scheffe Post-Hoc test showed that the group of infants that had caregivers with responsive attitudes but strict sleeping environments differed the most from all other groups and was responsible for the significant between-group differences. Contrary to expectation, this group of infants had relatively low number of awakenings, best self-soothing rates and longest night sleep period. Infants with consistently responsive caregivers, on the other hand, had the most awakenings and least self-soothing, but did not differ in pure sleep or time awake at night from other groups. Interestingly, infants of consistently less responsive caregivers did not seem to fare much better in sleep. Their sleep measures were not too far from the group with consistently responsive caregivers, and their time awake at night was actually even longer (though not significantly so, perhaps due to a small group size). The differences can be observed in Figure 8 where means for the major sleep measures are presented.

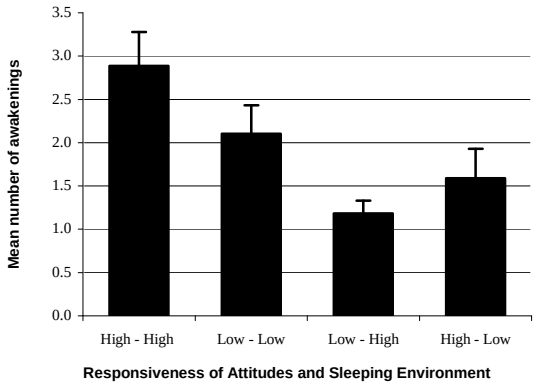
Figure 8

The Means and Standard Errors for sleep measures based on consistency of responsiveness between parental attitudes and sleeping environment

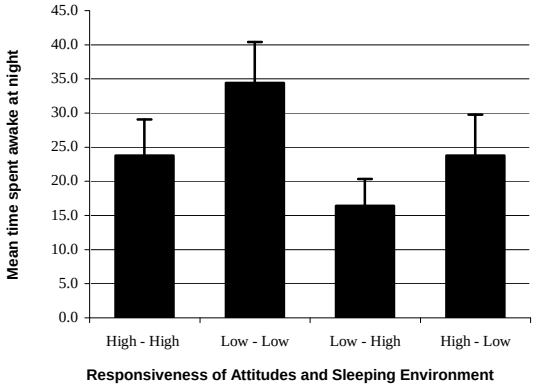
a) self-soothing per awakening



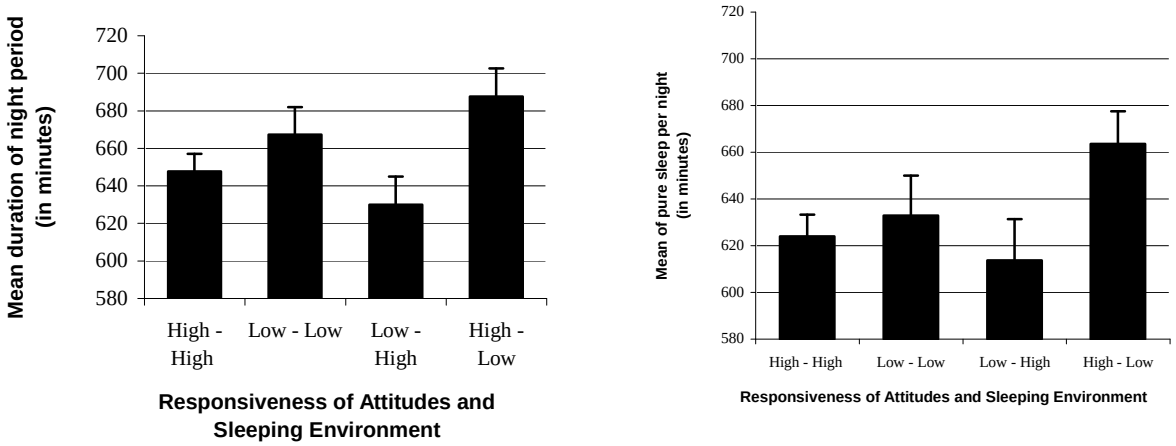
b)number of awakenings



c)time spent awake at night



d)duration of night sleep period *e)pure sleep per night*



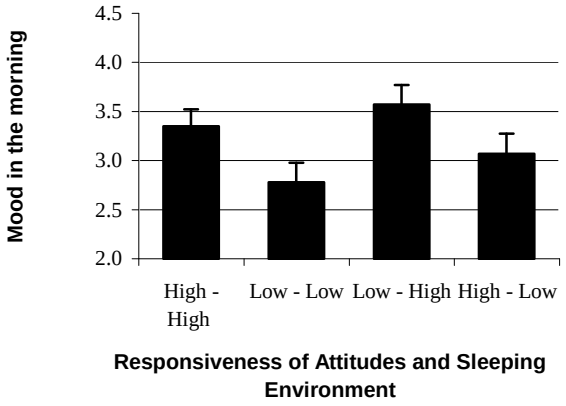
The groups did not differ significantly in the daytime behaviors, however there was a significant difference between the groups in their mood upon waking up in the morning, $F(3,49)=3.48$, $p<0.05$. As can be seen in Figure 9(a) the two groups with responsive sleeping environment seemed to have a better mood than the groups with less responsive environment independently of parental attitudes. Indeed, contrast analysis between the two pairs of groups showed a significant difference, $t(49)=-2.91$, $p<0.01$. The groups also differed on gender preferences with the consistently responsive primary caregivers preferring male adults to female more often than the other groups, $F(3,49)=3.06$, $p<0.05$. Moreover, the same group also seemed to differ from other groups in highest low-intensity positive affect and least daytime crying, as can be seen in Figure 9(b,c,d). Though the overall difference between all groups was only close to significance, when the group was contrasted with the three others the differences were significant: $t(46)=-2.05$, $p<0.05$ for positive affect and $t(36.78)=2.35$, $p<0.05$ for daytime crying.

The four groups did not differ on any demographic measures. When the groups were compared on parental variables thought it turned out that the group of consistently responsive primary caregivers had the least satisfaction from the sleep situation, $F(3,47)=5.79$, $p<0.01$. This group also had a close to significant trend for having the most stress and conflicting feelings around sleep topic, $F(3,47)=2.49$, $p=0.07$ and $F(3,46)=2.26$, $p=0.09$ respectively (see Table 15 for details). The groups did not differ in the consistency of sleeping arrangement and in the number of changes parents made over time in general or in locations specifically with the p values ranging between .21 and .78. Since the inconsistency hypothesis was not supported mediation analysis was not carried out.

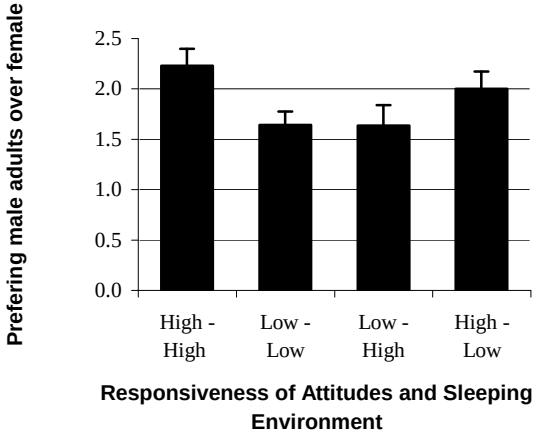
Figure 9

Daytime behavioral outcomes (Means and SE's)based on consistency of responsiveness

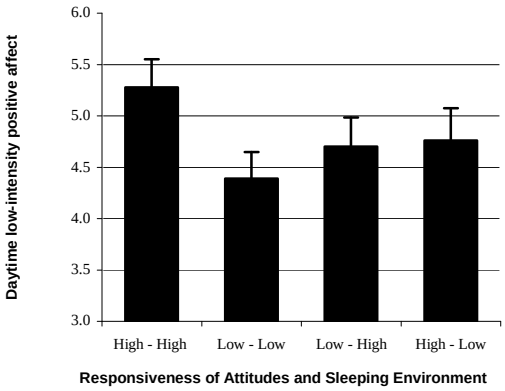
a) mood in the morning



b) preference for adult males over females



c)daytime lo-intensity affect



d)daytime crying

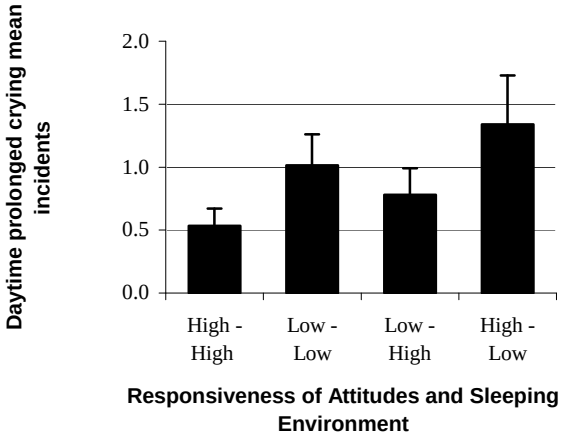


Table 15

Means and Standard Deviations of parental variables based on consistency of responsiveness between parental attitudes and sleeping environment

Outcome measure	High-High Mean (SD)	Low-Low Mean (SD)	Low-High Mean (SD)	High-Low Mean (SD)
Parental satisfaction from sleep	4.33 (1.25)	5.88 (.92)	6.27 (.79)	5.50 (1.64)
Parental stress around sleep	1.92 (.69)	1.38 (.65)	1.27 (.65)	1.41 (.51)
Conflicting feelings about sleep	1.67 (.78)	1.08 (.29)	1.36 (.50)	1.41 (.51)

To summarize, a stricter sleeping environment was associated with better sleep measures in the infant when the primary caregiver had more responsive general parental attitudes, despite of the theoretical inconsistency between the sleeping environment and the attitudes. The strict sleeping environment, however, was not related to a better sleep when the primary caregivers held less responsive attitudes in general. The infants who had consistently responsive caregivers, both in attitudes and in sleeping environment, seemed to fare the least well in sleep. Their parents also seemed to have the least satisfaction and the most stress and conflicting feelings despite the theoretical consistency of their attitudes with the sleeping environment. But this group also differed from others in having better mood in the morning and more positive infant behavioral daytime measures.

Discussion

The first hypothesis of this study was that the sleeping environment as defined by sleeping arrangements and parental nighttime behaviors taken together would explain the infant outcomes better than either the arrangement or the behaviors separately. This hypothesis was only partially supported. The general instability of the sleeping environment (both in arrangements and parental behaviors) did not predict any sleep measures, but did predict some of the infant daytime behaviors: lower high intensity positive affect expressions by the infant and higher fear of strangers. However, an overall measure of the responsiveness of a sleeping environment, which was combined from both sleeping arrangements and parental behaviors, was not a good predictor of either daytime behaviors or infant sleep, and seemed to be somewhat confounded by infants' special characteristics/needs or home situation (bedrooms per person).

Separate parental practices and sleeping arrangements, on the other hand, showed many associations with different characteristics of both infant sleep and daytime behaviors. But at the same time, the effects on sleep overlapped in most of the cases, thus testing the different combinations of sleeping arrangements with different parental nighttime practices/behaviors did shed more light on the specific effects of the arrangements and parental behaviors on sleep, independently of each other. Thus, a closer sleeping arrangement was related to a shorter duration of night, less pure sleep and sleeping through the night, as well as less night crying when compared to parental practices. However, time spent awake at night as well as self-soothing at night were mostly related to the night feeding.

The analysis of the different combinations of arrangements with parental practices also showed that the fit of the combination is important too. Though involvement in the middle of the night did not seem to affect sleep in general it did show different effects depending on the sleeping location. While separate location worked best with low involvement at night, it did not seem to work the same way with high involvement. Since the majority of co-sleeping infants had parents who were highly involved at night, it was difficult to separate the effects of involvement and closeness of the location. Similarly, the effects of feeding and location are difficult to disentangle since all co-sleeping parents fed their infants at night in this sample. Since feeding was mainly responsible for longer awakenings and less self-soothing when compared to lack of feeding in separate locations it is logical to assume that the shorter pure sleep of co-sleeping infants is at least partially explained by feedings. Similar explanation was also suggested by McKenna and McDade (2005), who stressed the natural interrelation between feeding/nursing and co-sleeping, especially bed-sharing type of co-sleeping.

Interestingly, co-sleeping infants also tended to have shorter night periods mostly due to their later bedtime. It is possibly much easier for co-sleeping parents to go to sleep together with the baby and thus to push the infant bedtime to later time to accommodate their adult schedule. Waking time did not differ between infants sleeping in the different locations, which could be explained by the effect of the morning light affecting the melatonin production (Zhdanova, Lynch, Wurtman, 1997) and leading to a similar waking time in all infants, depending on the sunrise and not on the sleeping location/parental strategies. Thus, having comparatively later bedtime, while at the same time having early waking time, the co-sleeping infants had the shortest sleep period. The finding is novel and, if this interpretation is true, can have important implications. For example, co-sleeping infants might improve their sleep if their parents are made aware that the late bedtime decreases the amount of infant sleep because they would still wake up at about same time. Interestingly, some parents in this study explained that they tried to put the baby to sleep later to have a later waking time in the morning. Such an approach might not work, but more studies are needed to explore this possibility.

Thus, given shorter sleep period originating in later bedtimes, with high parental involvement and feedings within the period (presumably leading to longer time awake and less selfsoothing events), co-sleeping infants seem to have the least sleep and self-soothing compared to all other groups. Taken together the results suggest that it is not the closeness of the location per se that makes the infant sleep less, but the tendency of the co-sleeping parents to have their infant go to sleep later, get more involved in awakenings and feed the infants at night. This interpretation is also somewhat supported by the finding that within parental room, closeness of infant sleeping location to parents had, in contrast, a positive effect on sleeping through the night and led to less variation in awakenings.

Another possible explanation of this finding is that co-sleeping parents are just better aware of their infants sleep patterns and especially their wake-time. But this explanation is less likely since the parents did not report different wake times for the infants suggesting they are equally aware of the time the infants wake up in the morning. Earlier bedtime of the separately sleeping infants, on the other hand, is not likely to be explained by parental unawareness since the parents would be still awake while the infant is falling asleep. Moreover, the fewer self-soothing events of the co-sleeping infants cannot be explained by parental unawareness, since this measure was calculated as a proportion of awakenings that ended without parental intervention. Thus for this assessment parents had to be aware that the infant woke up in the first place. In addition, previous studies using objective sleep assessments also found that co-sleeping is associated with shorter sleep and less self-soothing (Mao et al, 2004).

Yet, another interpretation of these findings is that when sleeping separately an infant has less interruption from parents and also has more chances to learn to self-soothe thus indeed is getting the most efficient sleep. However, separately sleeping infants did not exhibit better self-soothing abilities compared to co-sleeping infants during daytime. Thus the more likely interpretation of this finding is that the co-sleeping infants are not less able to self-soothe but simply have fewer chances to demonstrate self-soothing as the room-sharing parents tended to intervene faster (wait less time before responding to the infant). Moreover, the self-soothing of nighttime and daytime did not correlate between each other in this study. This lack of the relation between day and night selfsoothing is another important finding, since it raises the question whether self-soothing at night is indeed a skill that is related to a better self regulation and not

just a mere learning of helplessness in a specific context or a measure of parental immunity to infant cry. Since if it is a real learning of a self-regulation it should be generalized by the infant into other contexts. Understanding the nature of the nighttime self-soothing is very important, as this "ability" might be less desirable for most parents if interpreted in the other way.

At the same time, just having the infant sleep in another room does not automatically make him to sleep better, or learn to self-soothe. As mentioned earlier, based on the analysis of different combinations of arrangements with parental behaviors, some of the separately sleeping infants still were perceived by their parents as bad sleepers and demanded a high involvement from parents. The separate location seemed to work only when combined with low involvement. However, it is likely that the level of parental involvement was not a purely parental choice. It seems that some of the infants' characteristics played an important role, since infants sleeping separately with low parental involvement also differed from other separately sleeping infants in that they were "good sleepers" from early on and also relatively easy babies (having less difficult days and better soothability by a caregiver during daytime). It is possible that these infants were just accepting separate location more easily and did not demand much parental attention at night.

On the other hand, infants sleeping separately while having high parental involvement also seemed to have special characteristics/needs: these infants had the most crying at night and compared to other separately sleeping infants were described by their parents as more problematic in sleep and more cranky during daytime, as well as less able to self-soothe at night or being soothed at daytime. Thus these infants did not seem to benefit as much from separate sleeping location and still demanded involvement. This conclusion is in line with the finding of Burnham et al (2002), who reported that about 43% of separately sleeping infants in their study remained "signalers" (demanding adult intervention to fall back to sleep) and seemed to be unable to learn to "self-soothe" till one year of age, even after a clinical intervention.

Except night feedings, only parental involvement at bedtime was related to the diary based sleep measures, which was consistently reported in previous studies (Cohen, 1999; Hall, 2006; Goodlin-Jones et al, 2001). Higher parental involvement at bedtime was associated with more awakenings per night. The involvement at bedtime is different from nighttime involvement since it is not related to parental responsiveness to infant distress, rather it is the way parents teach the infants to fall asleep. Unfortunately, many parents get highly involved in the bedtime process because they want the infant to go to sleep by any cost, but then expecting form infants to fall back to sleep in the middle of the night without disturbing the parents. Some parents even implement sleep training in the middle of the night, while at the same time rock or feed the baby to sleep before the night, unaware or their own inconsistency.

This could be one of the possible explanations for the finding that sleep training did not seem to affect any sleep measures. As a matter of fact, in the combination analysis, the sleep-trained infants who slept separately turned out to spend as much time awake at night as co-sleeping infants, and significantly more than separately sleeping non-trained infants. But unlike the co-sleeping infants (having longer awake time mostly due to feedings), the sleep-trained infants spent significantly more time crying at night and had the worst mood in the morning, compared to all other groups. This effect of sleep training is especially intriguing, since it is also a very stressful process for many parents as well as for infants (see Chapter 3). The effect is also not likely to be explained by difficulty of the infants' temperament or initial sleep problem since infants who were sleep trained did not differ from others on any other variables.

Consistently with the study hypothesis some of the characteristics of the sleeping environment showed associations with infant ongoing daytime behaviors and experiences. The closeness of the current sleeping location was associated with more low-intensity positive affect expressions and higher approach to male adults, while closeness if the location right after birth - with higher approach to new things. Instability of sleeping locations overtime was associated with higher separation anxiety expressed by infant within the house. Parental involvement in the middle of the night was associated with more high-intensity positive affect expressions and less pronounced fear of dark, while feeding at night associated with less crying during daytime.

Even though the analysis is correlational the daytime behaviors do not seem to be the causes of the parental strategies. It is unlikely, for example, that infants with less fear of the dark would demand more parental involvement at night. Even if parental perception of the infant being fearful is not objective, it is still unlikely that parents who perceive their babies as less fearful of dark would engage with the infant more at night, the reverse direction is more logical. Similarly, it is not likely that parents feed the baby at night *because* the baby does not cry much during the daytime. The effect of the first sleeping arrangement (right after birth) on approach to new things (between 7 and 9 months of age) also seems more logical than the reverse given the time sequence of the variables.

This interpretation is also supported by many theoretical assumptions. Thus, according to many scientists supporting bed-sharing, the physical proximity of the baby at night maximizes breastfeeding opportunities and physiological regulation of immature respiratory, cardiac and neurological systems throughout the night (Bergman, 2005; McKenna, 2000). In addition, the skin-to-skin contact might contribute to infant growth and development, which was documented for premature infants (Ferber, Makhoul & Weller, 2006), when stimulation of skin-to-skin contact was found to increase arousals, hear rates, thus promoting insulin secretion and weight gain. Close and responsive sleep environment is also believed to contribute to security of attachment (Porter, 200). However, caution should still be taken when making conclusions about the causality of the effects since some other parental qualities could be both responsible for closer sleeping arrangements and positive developmental outcomes in infants. Even though the parental attitudes did not seem to play such a role, it is possible other parental qualities that were not assessed in this study still could.

Most importantly the main hypothesis of the study that the effect of a sleeping environment on an infant would depend on the consistency of the sleeping environment with the general parental attitudes of the primary caregiver was only partially supported. While the general responsiveness of the sleeping environment was not a good predictor of infant sleep by itself, when its consistency with the general parental attitudes of the primary caregiver was taken into account, some significant effects were observed. However, the direction of the effects was opposite to the one expected. Stricter sleeping environment was associated with better sleep measures in the infant when the primary caregiver had more responsive general parental attitudes, despite of the theoretical inconsistency of the sleeping environment with the attitudes. On the other hand, consistent with less responsive attitudes, stricter sleeping environment was not related to a better sleep. Moreover, the infants who had consistently responsive caregivers, both in attitudes and in sleeping environment, seemed to fare in sleep the least well. But this group also differed from all others in having better mood in the morning and more positive infant behavioral measures.

It is possible that parents with more responsive general attitudes to childrearing just manage to set a more balanced limit setting for the night situation and thus even when using strict strategies they succeed in having a better sleep for their infants. The less responsive in general parents, on the other hand, might apply more extreme measures at night instead of a simple limit setting, thus leading to even more frustration in the infants. Sadeh, Flint-Ofir, Tirosh and Tikotzky (2007), for example, also reported that parental cognitions played an important role in the parental ability to set limits at night consistently, which in turn affected infant sleep. On the other hand, more responsive caregiving in general might have a buffering effect allowing the infant to deal with the separations of night, trusting the parents to be available when needed.

Similarly, more responsive caregivers with consistently responsive nighttime strategies might just have a problem with limit setting, as suggested by Sadeh et al (2007). However, these infants also seem to benefit from the responsive sleeping environment in the ongoing daytime experiences. Thus, more interrupted sleep might not be a really clinical problem but a normal phenomenon, characteristic to the phase of the most intense development of relationships between the parents and the infants. Interestingly, while studying sleeping patterns Scher (2001b) found that infants who were more positively engaged in interaction with their mothers during a daytime observation had also more troubles sleeping, hence did more "signaling" at night, based on objective measures using actigraphy. Similarly, in other study the securely attached infants had more difficulties in settling for the night compared to insecurely attached infants, while avoidant infants had fewer awakenings, or less "signaling", consistently with the attachment theory (Scher & Asher, 2004).

However, most surprisingly and least expected based on the study hypothesis, the consistently responsive parents seemed to have the least satisfaction from sleep and the most stress and conflicting feelings about it, despite the consistency of their attitudes with the sleeping environment. Most probably these parents are not aware of the benefits their infants are getting from such a parental approach, while their infants' interrupted sleep is obvious to them. The interrupted sleep, which very well can be normal, might still be perceived by the parents as problematic while compared to other infants' sleep or the "norms" as presented in the sleep literature available to parents (see Chapter 3). The parents might be also stressed, as their strategies do not seem to work in teaching their "signaling" infants to "self-soothe" or "sleep through the night". They might also have conflicting feelings because their approach might be perceived by them as neither culturally "normal" nor recommended by professionals, as suggested by McKenna (2000).

It is important to stress the limitations of the current study. It is based on a relatively small sample size and subjective measures. Some f the measures retrospective so that longitudinal design with objective measures is desirable in future studies. Our insistence on participation of both parents in this study may have also led to a somewhat skewed sample of families in which the father is more involved in child care and therefore more willing to participate in the study. This bias could have affected the results in ways that could not be estimated. Given the exploratory nature of this study numerous measures were used, which created the possibility of sporadic effects. However, the different ways of analyzing the effects of the sleeping environment provide a foundation for more focused future studies. This study also contributes to the knowledge about the development of sleep patterns in infancy in general, and suggests new ways of both looking at and "treating" sleep disturbances in infancy.

Chapter 5: Conclusions

The goal of this dissertation was to explore from a developmental perspective the nature of infant sleep and its relation to waking experiences. First, this dissertation sought to address questions regarding the relations between some of the major developmental transitions related to self produced locomotion and behavioral patterns of sleep. The second purpose was to put sleep into a more general context of development and parenting, by learning about different parental practices related to infant sleeping environment and parental reasoning behind choosing one approach over another. More specifically, the consistency of the infant sleeping environment with the general parental attitudes to childrearing was questioned in families, due to many contextual pressures affecting parental decisions related to sleep. Finally, another goal was to explore whether the different sleeping environments, as well as their consistency with the general parental attitudes, can have an important effect both on behavioral patterns of sleep and on other developmental outcomes of the infants.

The first two studies described in Chapter 2 demonstrated that the development of crawling in the second half of the fist year of life constitutes a major developmental shift that affects the infant sleep patterns. Crawling on hand and knees, but not other ways of locomotion, including walking, was associated with major sleep disturbances related to shorter and more interrupted sleep at night. Moreover, not crawling per se, but its onset was found to be the best predictor of sleep during this period, while even the age of the infants did not explain any of the sleep variation. The sleep disruption around the crawling period was explained by a spurt of infant behaviors related to seeking proximity with a caregiver, which closely followed the crawling onset. Moreover, infants who slept in the same room with their parents did not seem to be affected by the onset of crawling, as they did not need to seek proximity due to their already close location relative to parents at night.

Thus, the combined findings suggest that not just the progress in motor development, but the change from being immobile to being effectively mobile profoundly affects infant sleep, through other changes, resulting from the mobility, and related to the proximity seeking with a caregiver. Thus, based on the findings, the regression in sleep during this age period, which has been documented earlier in other studies (Armstrong et al, 1994; Goodlin-Jones et al, 2001), might be a normative developmental transition and should not be considered as a clinical problem to be treated. The most important implication of the findings is that if the disruption is normal and is indeed related to the child heightened sensitivity to separation and proximity seeking, parents should be made aware of the phenomenon and be sensitive to the infants during this transitional time. Applying sleep training techniques by letting the infants cry to learn to self-soothe (fall asleep without a caregiver's help), as widely recommended to parents (Ramos & Youngclarke; 2006), might actually worsen the situation and be even potentially harmful for the child's development, according to this perspective.

Chapter 3 showed that, many parents do apply sleep training techniques precisely during the second half of the first year, especially in a reactive way when infant' sleep becomes more disrupted. Most importantly, the decisions regarding infant sleeping environment, including sleeping arrangements, sleep training or other related parental nighttime behaviors, do not seem to stem from the mothers' general attitudes to childrearing, in contrast to daytime behaviors. The use of resources on sleep such as literature or professional advice, on the other hand, predict

most of the characteristics of sleeping environment, and especially the implementation of sleep training while letting the infants cry for prolonged periods of time.

Moreover, fathers' general attitudes toward childrearing predict the infant sleeping environment better than the mothers', suggesting the fathers play an important role in the decisions. The fathers tend to be stricter than mothers and prefer separate sleeping arrangement over co-sleeping, especially if exposed to resources on sleep that are available to parents. Thus infant sleep becomes a source of marital conflicts, and is perceived by many parents as one of the most difficult aspects of parenting, surrounded by stress, and feelings of helplessness. As a result, some mothers, who are in majority the primary caregivers of the infants, apply strategies that are not in line with either their general attitudes or their daytime approach to parenting, creating an inconsistent experience for themselves, and especially for the infants.

Moreover, chapter 4 demonstrated that infant sleep and other developmental outcomes differ depending on the consistency of the sleeping environment with attitudes of their primary caregivers. But the effect of consistency was unexpected. Consistency of responsive sleeping environment with responsive attitudes was found to be related to better outcomes in infant daytime behaviors, but was also related to more interrupted sleep. However, this finding might not seem as surprising if more interrupted sleep is not considered to be a clinical problem, but rather is perceived as a normal phenomenon, characteristic to the phase of the most intense development of relationships between the parents and the infants.

Unexpectedly however, among all the parents, the consistently responsive parents seemed to have the least satisfaction from their infants' sleep and the most stress and conflicting feelings about it, despite their infants having the best daytime outcomes, which they could not be aware of as much as of the sleep disturbances. Their stress could be explained by the inconsistency of their approach with the recommendations offered in literature on sleep and by many professionals, which are on the whole inclined toward a less responsive sleeping environment: stricter strategies and separate sleeping location (Ramos & Youngclarke; 2006). However, the findings presented in Chapter 4 do not support the benefit of the recommended approach. Independently of parental attitudes, analyses of the sleeping environment, while taking into account both sleeping location and separate parental strategies, shed more light on the factors affecting infant sleep.

Even though close sleeping location was indeed associated with less sleep, the results suggest that it is not the closeness of the location per se that makes the infant sleep less, but the tendency of the co-sleeping parents to have their infant go to sleep later, get more involved in awakenings and feed the infants at night. At the same time, just having the infant sleep in another room did not automatically make him or her to sleep better, or learn to self-soothe, since many of the separately sleeping infants still were perceived as bad sleepers by their parents and demanded a high involvement from parents. Moreover, higher parental involvement at night and closer sleeping location was associated with better daytime behavioral outcomes and interestingly with higher preferences of male adults over female by the infants.

Most importantly, sleep training did not improve any aspects of sleep. Instead, sleep-trained infants spent as much time awake at night as co-sleeping infants did, but unlike the co-sleeping infants who seem to spend it on feeding, the sleep-trained infants spent it crying as they had the most crying at night compared to all not sleep-trained infants. Similarly, they also had the

worst mood in the morning. Night feeding, on the other hand, was associated with less crying both at night and during the day. Even though it was also associated with more time awake and less self-soothing, it did not seem to relate to the overall amount of sleep. In addition, the nature of self-soothing as a self-regulatory ability was questioned by the findings, since it was not related to the daytime self-regulatory abilities.

Overall, the research findings described in this dissertation give insight into the broad topic of sleep development in infancy. More specifically the findings add to our understanding of the nature of the "sleep disturbances" characteristic of infancy. The studies also suggest new ways of both looking at and "treating" sleep disturbances in infancy. The findings might help to construct a more flexible approach by clinicians and pediatricians to help parents, by matching children's needs and parenting values with appropriate practices, so that fewer parents will have to go through as much stress as this mother did to arrive at the same conclusion:

> The whole crying it out thing, it just felt like torture to me, it just ripped my heart out and he sounded so sad, and [pause] it was just terrible, and so [pause] um [pause]. I just said, I'm just going to feed him, because [pause] there will come a day when, you know, he does not want this anymore [pause] and so [pause] that's just what we did…

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Appendixes

Appendix 1: Significant and close to significant results of analyses using the original sleep scores (not regression corrected for age)

I. Hands-and-knees and belly crawlers comparison

a) significant difference in the time spent awake at night, $t(63.95)=-2.44$, $p<0.05$;

b) close to significant difference in prevalence of sleeping through the night, $t(48.97)=-1.89$, $p=0.06$.

II. Belly crawling and sleep

1. Non-crawling infants comparison:

a) Significant difference in the nap durations $t(54)=-2.18$, $p<0.05$);

b) Close to significant difference: belly crawlers had slightly longer naps during the day time, $t(56)=-1.77$, $p=0.08$.

2. New belly crawlers and non-crawlers:

a) close to significant in total day time sleep between the non-crawlers and new belly crawlers $t(37)=-1.90$, $p=0.06$.

III. Hands-and-knees crawling and sleep

1. Significant differences between crawlers and non-crawlers: see Table 16.

Table 16

Sleep comparison of infants who crawled on hands-and-knees with those who did not

	Non-crawlers		**Crawlers**		
	Mean	SD	Mean	SD	Test values
Parental perception of sleep problem	.26	.51	.50	.59	t(201)=-2.42*
Sleeping through the night	1.73	1.07	1.42	1.10	$t(202)=1.82^{+}$
Settling for night duration (min)	12.22	8.75	15.64	11.30	t(137.40)=-2.27*
Pure sleep per night period	630.48	54.41	613.85	74.28	$t(153.09)=1.78^{+}$
Total time of nap sleep per day	153.79	62.54	137.81	57.59	$t(202)=1.78^{+}$

$+p<0.08$. $*p<0.05$, $**p<0.01$

2. Significant differences found between original sleep scores of new crawlers and all other groups (contrast in ANOVA):

a) of awakenings, $t(187)=-2.03$, $p<0.05$;

b) time awake within the night sleep period, $t(185)=-2.79$, $p<0.01$;

c) pure sleep per night $t(187)=2.23$, $p<0.05$;

d) sleeping through the night, t

e) parental perception of infant sleep being problematic, t

3. Significant differences found in pair-wise comparisons between new crawlers and non-crawlers:

a) duration of night sleep period, $t(197)=1.98$, $p<0.05$;

IV. Pulling up to stand and sleep

1. Significant differences between infants able to pull up and those who can not: see Table 17.

Table 17

T-values for comparison of infants able to pull up versus not able to pull up

Sleep measure	Test values
Parental perception of sleep problem	t(93.86)=-2.25*
Settling for night duration (min)	t(192)=-2.10*
Duration of night sleep period	t(200)=1.70+
Number of awakenings per night	t(108.70)=-2.60*
Pure sleep per night period	t(184)=1.74+
Number of naps	t(202)=2.40*
Total time of nap sleep per day	t(202)=2.28*
Parental bedtime strategy	t(200)=-2.61*
Feeding at night	t(77.05)=-2.38*

+$p<0.08$. *$p<0.05$, **$p<0.01$

Appendix 2: Analyses of the effects of different combinations of sleeping arrangements with parental strategies

While little variation in strategies existed among infants sharing a room/bed with parents, the solitary sleeping infants experienced different strategies. The distribution of infants by sleeping locations and parental strategies is presented in Table 18. Interestingly, even among infants sleeping in the same room 5 out of 18 had sleep training using the "cry it out" method, meaning the parents either did not respond to their infant crying while being in the same room, or ended up being in the same room after trying the sleep training.

Table 18

Distribution of infants based on different sleeping locations and parental strategies

		Bedtime involvement		Middle-night involvement		"Cry it out" training		Feeding	
	Total infants	**low**	**high**	**low**	**high**	**yes**	**no**	**no**	**yes**
Same room	18	4	14	1	15	5	11	0	18
Separate	37	16	20	17	16	24	10	12	25

Bedtime involvement and sleeping arrangement

To see whether bedtime involvement or sleeping arrangement, or both, were responsible for the differences in sleeping through the night we compared 3 groups based on the combination of sleeping location with parental involvement at bedtime using one way ANOVA: (1) infants sleeping separately with low parental involvement (Sep-Low), (2) infant sleeping separately with high involvement (Sep-High), and (3) infants sleeping close with high involvement (Cls-High). All relevant significant contrasts are presented in Table 19 with the Means and the Standard Deviations for the 3 groups.

Table 19

Means, Standard Deviations and Contrasts for comparison by location and bedtime involvement

Outcome measure	**G1: Sep-Low Mean (SD)**	**G2: Sep-High Mean (SD)**	**G3: Cls-High Mean (SD)**	**G1 - G2 t(47)**	**G2 - G3 t(47)**
Through the night	5.00(1.36)	4.58(1.67)	3.07(1.59)	.79	2.74**
Pure sleep	662.25(49.89)	639.02(44.03)	593.37(51.10)	1.44	2.73**
Duration of night	679.67(55.80)	662.12(43.43)	630.41(46.38)	1.08	1.88+
Self-soothe - diary	.32(.36)	.45(.34)	.11(.18)	-1.20	3.12**
Number of awakenings	1.24(.89)	2.16(1.32)	2.57(1.28)	-2.30*	-0.97

+p<0.09. *p<0.05, **p<0.01

As can be seen from the table, when location was held constant (separate), the bedtime parental involvement only explained number of awakenings per night. The differences in pure sleep and in sleeping through the night, as well as self-soothing, were mainly explained by sleeping location. In other words, even when parental involvement at bedtime was similar (high), infants sleeping separately had more sleep and more of their awakenings were self-soothed (not needing parental intervention).

Middle of the night involvement and sleeping arrangement

Even though middle of the night strategy correlates did not overlap with the correlates of the sleeping arrangement we still tested whether different combinations of the arrangement with nighttime involvement could have different effects. Unlike the bedtime strategy, middle of the night strategy is much more dependant on the sleeping location. Thus the group of infants with separate sleeping arrangement but high parental involvement could be very different since parents in this group would get involved in the awakenings not *because* of the physical allowance but *in spite* of the distance. Indeed, when we compared the 3 groups based on the fit of arrangement with nighttime involvement an interesting pattern arose. All significant contrasts from the group comparisons are presented in Table 20 with the Means and Standard Deviations.

The table suggests that the close sleep location with high parental involvement results in the least sleep and least night self-soothing abilities, while infants sleeping in separate rooms with low parental involvement seem to fare the best in sleep. However, even though infants with high parental involvement but sleeping in separate rooms seem to fare better than room-sharers

in sleep, they also have the most crying at night in contrast to all other infants combined together, $t(36)=-2.56$, $p<0.05$. Moreover, compared to other separately sleeping infants the high involvement separately sleeping infants are perceived by their parents as more problematic in sleep and less able to self-soothe. They also differ in lower daytime soothability by a caregiver, and highest proportion of difficult days in the dairy (being described as cranky by the parents).

Table 20

Means, Standard Deviations and Contrast for comparison by location and night involvement

Outcome measure	**G1: Sep-Low Mean (SD)**	**G2: Sep-High Mean (SD)**	**G3: Cls-High Mean (SD)**	**G1 - G2 t(47)**	**G2 - G3 t(47)**
Pure sleep	659.25(52.08)	644.99(48.02)	607.41(49.11)	.74	2.35*
Self-soothe - diary	.40(.35)	.38(.36)	.16(.24)	.14	2.04*
Self-soothe - parents	5.88(.35)	3.94(1.23)	2.93(1.91)	3.41**	2.21*
Night crying	2.75(1.05)	3.14(.65)	2.30(.67)	-1.26	2.93**
Through the night	5.78(.44)	4.29(1.63)	3.47(1.84)	2.43*	1.60
Sleep problem now	1.00(00)	1.50(.53)	1.63(.72)	-2.43*	-0.63
Soothability by adult	6.41(.43)	5.75(.88)	5.60(.89)	2.05*	.58
Difficult days	1.07(.11)	1.25(.35)	1.23(.20)	-1.72+	.32

+$p<0.09$. *$p<0.05$, **$p<0.01$

Night feedings and sleeping arrangement

Since feeding at night is also closely related to sleeping arrangement and constitutes one of the major types of parental involvement we also compared groups based on combination of the sleeping arrangement with feeding on all of the outcomes. But first, we looked weather the differences in self-soothing (based on diary) and daytime crying were better explained by sleeping arrangement or feeding, since these effects overlapped based on the previous analyses. The results are presented in Table 21 for the 3 groups: (1) infants sleeping separately and not being fed at night (Sep-NFed), (2) infant sleeping separately but being fed (Sep-Fed), and (3) infants sleeping close and being fed (Cls-High). According to the results the differences in self-soothing and daytime crying were mainly the function of the night feeding, while location did not matter much for infants that were fed.

It is important to note that the effect of feeding on self-soothing observed in this analysis is different from the effect of the more general involvement at night (see previous analysis), suggesting that only feeding and not *any* parental involvement is associated with lower proportion of self-soothed awakenings. Interestingly though, unlike parents with high general involvement, parents who feed their separately sleeping babies at night do not seem to differ from parents who do not feed in their subjective perception of their babies' abilities to self-soothe, suggesting a different parental reasoning behind the choices of feeding versus involvement at night. This suggestion is also supported by the fact that unlike the group of separately sleeping babies with high parental involvement, the fed babies did not differ much from other groups based on other measures. Another important point coming from this analysis is that while feeding seemed to be responsible for longer time spent awake at night, closer location

was more related to shorter night period duration. Thus, it seems natural that infants sleeping in the same room with their parents and also having feedings have the least pure sleep per night.

Table 21

Means, Standard Deviations and Contrast values for comparison by location and feeding

Outcome measure	**G1: Sep-NFed Mean (SD)**	**G2: Sep-Fed Mean (SD)**	**G3: Cls-Fed Mean (SD)**	**G1 - G2 t(52)**	**G2 - G3 t(52)**
Daytime crying	1.43(1.29)	.82(.78)	.62(.61)	1.99*	.73
Self-soothe - diary	.70(.30)	.23(.25)	.15(.22)	5.40**	1.02
Self-soothe - parents	4.5(1.28)	4.36(1.43)	3(1.86)	.24	2.66*
Time awake at night	9.59(11.66)	27.22(17.53)	32.08(33.42)	-2.17*	-0.67
Duration of night	656.23(36.38)	672.32(56.94	631.79(48.85)	-0.91	2.59*
Pure sleep	646.59(45.35)	644.99(54.28)	599.71(53.58)	.09	2.80**
Night crying	3.00(.89)	3.06(.73)	2.30(.67)	-0.19	2.51*
Through the night	5.18(1.40)	4.45(1.59)	3.43(1.78)	1.21	1.90+

$+p<0.09$. $*p<0.05$, $**p<0.01$

Sleep training and sleeping arrangement

To test the separate contributions of sleeping arrangement and sleep training for crying at night and mood in the morning, as well as to see whether separate location works differently with sleep training versus without it, we compared the following 3 available groups based on the combination of sleep training with a sleeping arrangement: (1) infants sleeping separately with sleep training (Sep-T), (2) infant sleeping separately with no training (Sep-NT), and (3) infants sleeping close with no training (Cls- NT). The means as well as all relevant significant contrasts are presented in Table 22. Since only 5 infants were sleep trained when sleeping in the same room with parents, these were not included in the statistical analysis due to such as small group size.

As can be seen from the table, night crying was mostly related to a separate location, while mood in the morning – to sleep training. Noteworthy is the fact that the difference in mood between Group 1 and Group 2 cannot be a function of a different parental awareness since both groups had a separate location and were similarly distanced from their parents in the mornings. Given same sleeping location these groups did not differ in their sleep patterns except from sleep trained infants actually having longer time spent awake at night. As a matter of fact, the sleep-trained infants spent awake as much time as co-sleeping infants. Beyond sleep, the sleep trained infants also had the most crying during the daytime, but did not differ on any other measures including parental perception of sleep problem or difficulty of days or nights.

Table 22

Means, Standard Deviations and Contrast values for comparison by location and sleep training

Outcome measure	G1: Sep-T Mean (SD)	G2: Sep-NT Mean (SD)	G3: Cls-NT Mean (SD)	G1 - G2 t	G2 - G3 T
Night crying	3.11(81)	2.9(.74)	2.00(.63)	t(35)=0.71	t(35)=2.34*
Mood in the morning	2.87(.69)	3.39(.56)	3.51(.58)	t(46)=-2.11*	t(46)=-0.45
Time awake at night	24.76(19.55)	12.76(12.09)	24.42(15.45)	t(29.6)=2.2*	t(18.9)=-1.97+
Daytime crying	1.19(1.18)	.67(.54)	.75(.66)	t(31.9)=1.8+	t(19.2)=-0.33

+p<0.09. *p<0.05, **p<0.01

Summary

When holding either parental strategies or sleeping arrangements constant in the analyses of different combinations the overlapping effects of the different strategies with the sleeping location were somewhat clarified. In addition, the analyses of the different combinations provided some insights into more specific effects of the different strategies. Duration of night, pure sleep, sleeping through the night as well as night crying were better explained by the sleeping arrangement. However, time awake at night, self-soothing at night and day crying were mostly related to the night feeding, while mood in the morning – to sleep training. Thus, compared to infants sleeping in separate rooms co-sleeping infants seemed to sleep through the night less and have less sleep, though the latest difference could be also explained by their later bedtime. On the other hand, co-sleepers had less crying during the daytime, and closer sleeping location also was associated with higher approach to new things, more low intensity positive affect expressions, and higher approach to male adults.

All of the co-sleeping infants were also fed at night and the night feeding was associated with longer awakenings and less self-soothing, leading to the least sleep in co-sleeping infants given their shorter night period. However, infants that were fed at night had less crying during the day. Sleep training, on the other hand, did not seem to affect sleep measures, though the sleep-trained infants turned out to spend as much time awake at night as co-sleeping/fed infants and significantly more than separately sleeping non-trained infants in the combination analysis. But unlike the co-sleeping infants (having longer awake time mostly due to feedings), the sleep-trained infants spent more time crying at night and had the worst mood in the morning compared to all other groups. Parental involvement at bedtime was only related to more awakenings.

Though involvement in the middle of the night did not seem to affect sleep in general, an interesting pattern arose in the combination analysis. While separate location worked best with low involvement at night, it did not seem to work the same way with high involvement. However, the infants sleeping separately while having high parental involvement also seem to have special characteristics/needs: these infants have the most crying at night and compared to other separately sleeping infants are described by their parents as more problematic in sleep and more cranky during daytime, as well as less able to self-soothe at night or being soothed at daytime.