The Pennsylvania State University

The Graduate School

College of Health and Human Development

THE ROLE OF INFANT TEMPERAMENT, PARENTING, AND THEIR INTERACTION IN PREDICTING INFANT SLEEP BEHAVIOR

A Thesis in

Human Development and Family Studies

by

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Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Master of Science

August 2010

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ABSTRACT

Sleep difficulties are a common concern for parents of infants of all ages. Research identifying the intrinsic (temperament) and extrinsic (parenting) factors that influence infant sleep quality has produced mixed findings. The present study examined how temperament and parenting individually influence infant sleep quality as well as how these factors interact in predicting sleep quality. Participants included 36 families of infants between the ages of 3 and 24 months. Temperament was assessed using the Revised Infant Behavior Questionnaire (IBQ-R). Parent behaviors were assessed through maternal report from the Sleep Practices Questionnaire (SPQ) and through observations from overnight video recordings. Sleep quality was assessed from Sleep Diaries completed by the parents over the course of a full week. Results indicated that the temperament characteristic of soothability was significantly associated with fewer night wakings whereas perceptual sensitivity was associated with more frequent night wakings. Mothers' self-reported use of consistent bedtimes and bedtime routines was significantly associated with fewer infant night wakings. Self-reported rates of roomsharing and instability of the infant's sleep location were associated with more frequent night wakings. Observational measures of parenting behaviors were not directly related to infant sleep quality. Several significant interactions emerged between temperament and parenting in predicting infant sleep quality. These interactions suggested that infant temperament moderates the relationship between parenting and infant sleep quality. The results reflected a common pattern indicating that parenting behaviors were significantly associated with sleep quality for infants with less reactive temperaments, but parenting was not significantly associated with sleep quality for infants with more reactive temperaments. The results provided support for the organismic specificity hypothesis in the context of infant sleep. These findings suggest that a complex relationship exists between temperament, parenting and sleep, such that parenting behaviors impact infants differently depending on their temperament. A complete understanding of infant sleep development cannot be achieved without considering the interactive relationship between these factors.

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ACKNOWLEDGMENTS

I would like to express my gratitude to my committee members Dr. Doug Teti and Dr. Cindy Stifter for their assistance and guidance in developing this thesis. I extend my sincere appreciation for sharing their expertise and insight throughout the writing and scientific process. I greatly value the contribution of Dr. Stifter's expert knowledge of infant temperament, as well as Dr. Teti's proficiency in parent-infant relationships and infant sleep development. In particular, my advisor Dr. Teti's suggestions, revisions, and expert feedback have been an invaluable contribution toward the superior quality of this thesis. A heartfelt thanks to Dr. Teti for the significant amount of time and effort he contributed in providing the assistance necessary to make the completion of this thesis possible. His professional wisdom and input played a crucial role in the development of my ideas. I am deeply grateful to Dr. Teti for his continuing guidance in shaping me into a skilled researcher, for his continuing dedication to my success in the field, and for his continued mentorship towards my professional development. His commitment to and belief in my excellence have been apparent from the beginning of my graduate studies. Dr. Teti has provided the meaningful and ongoing encouragement I needed throughout the duration of my research, my appreciation for which cannot be expressed in words. In addition, I must acknowledge my appreciation to Dr. Teti for providing the data for this thesis, thus making this work possible.

INTRODUCTION

Chronic infant sleep disruption is associated with family stress and developmental problems. It is associated with higher rates of maternal depression, fatigue, parenting stress, and caregiving overload (Meltzer & Mindell, 2007). In addition, poor sleep quality has been linked to higher rates of problem behaviors in children (Bates, Viken, Alexander, Beyers, & Stockton, 2002) as well as poor neurobehavioral functioning (Sadeh, Gruber, Raviv, 2002). Although infant sleep regulation improves across the first year, signaled night waking persists in an estimated 30% to 40% of infants by the end of the first year (Sadeh & Anders, 1993).

The development of infant sleep patterns has been attributed to 2 factors: infant temperament variation, and individual differences in parenting practices. Although prior research shows some support for each of these factors, linkages between infant temperament, parenting practices, and infant sleep quality, are at best, mixed, and studies to date rarely consider the joint impact of temperament and parenting on infant sleep quality. Indeed, the field lacks a comprehensive theoretical framework for understanding the constitutional and caregiving contributions to the development of infant sleep regulation. The present study attempts to develop such a framework, drawing on extant theoretical formulations about the interplay of organismic-environmental interactions in predicting development.

Temperament and Infant Sleep Quality

There is considerable literature examining the link between temperament and sleep quality in children. Linkages between infant temperament and infant sleep quality are, at best, mixed. Many studies have found significant relationships between temperament and infant sleep quality, indicating that infants who have better sleep quality are rated as more rhythmic, more adaptable, more positive in mood, more likely to approach new stimuli, and having a higher

sensory threshold (Atkinson, Vetere, & Grayson, 1995; Carey, 1974; Halpern, Anders, Garcia-Coll, & Hua, 1994; Jimmerson, 1991; Sadeh, Lavie, & Scher, 1994; Scher, Epstein, Sadeh, Tirosh, & Lavie, 1992; Sprunger, Boyce, & Gaines, 1985; Spruyt et al., 2008; Van Tassel, 1985; Weissbluth, 1981; Weissbluth & Liu, 1983). However, studies have also failed to replicate some of these relations (Atkinson et al., 1995; Burnham, Goodlin-Jones, Gaylor, & Anders, 2002; Carey, 1974; Hayes, Parker, Sallinen, & Davare, 2001; Jimmerson, 1991; Lotan & Yirmiya, 2002; Sadeh et al., 1994; Scher et al., 1992; Van Tassel, 1985; Weissbluth, 1982; Weissbluth, Davis, & Poncher, 1984) and other studies have found links in the opposite direction (Keener, Zeanah, & Anders, 1988; Kelmanson, 2004; Scher, Tirosh, & Lavie, 1998; Spruyt et al., 2008). Clearly, the findings relating infant temperament to sleep quality are inconsistent.

Parenting and Infant Sleep Quality

Certain behaviors that parents engage in have been associated with poor outcomes in infant sleep quality, including parent presence as the infant falls asleep (Adair, Bauchner, Phillip, Levenson, & Zuckerman, 1991; Lotan & Yirmiya, 2002), and co-sleeping (Crowell, Keener, Ginsberg, & Anders, 1987; DeLeon & Karraker, 2007; Johnson, 1991; Mao, Burnham, Goodlin-Jones, Gaylor, & Anders, 2004; Van Tassel, 1985). However, other behaviors that parents engage in have produced mixed results, including the use of bedtime routines (Crowell et al., 1987; Mindell, Telofski, Wiegand, & Kurtz, 2009), active physical comfort (Johnson, 1991; Morrell & Cortina-Borja, 2002; Morrell & Steele, 2003; Teti, Kim, Mayer & Countermine, in press), rapid responses to infant night wakings (Burnham et al., 2002; Keener et al., 1988), and feeding at bedtime or during the night (Burnham et al., 2002; DeLeon & Karraker, 2007; Keener et al., 1988; Teti et al., in press; Van Tassel, 1985; Zuckerman, Stevenson, & Bailey, 1987).

Contradicting results abound not only in the literature linking infant temperament and sleep but also in the literature linking parenting and infant sleep quality.

Theories of Organismic-Environmental Transactions

Mixed findings linking both infant temperament and parenting behaviors to infant sleep quality suggest that the prediction of infant sleep regulation may benefit from extant theories of organismic-environmental transactions, which stipulate that the impact that environmental conditions have on a particular organism depends on the characteristics of the organism.

Organismic specificity. Wachs' (1985) hypothesis of organismic specificity states that the same environment will have different influences on different individuals. The impact the environment has on the individual will vary according to particular organismic characteristics of the individual. Through this hypothesis, Wachs presents the argument that research that involves only environmental influences and ignores the attributes of the individual on whom the environment acts, portrays a misleading representation of the impact environments have on development (Wachs, 1983). Research findings have shown support for this hypothesis. For example, research has shown that cognitive development may be associated with the quality of the physical and social environment for infants who are rated as temperamentally easy but not for infants who are rated as temperamentally difficult. Thus, easier babies are more reactive to the physical and social environment (Wachs & Gandour, 1982). Other evidence indicates that one characteristic of the home environment, too many people in the home, is associated with more off-task behavior, less object premastery and less object mastery for infants rated as temperamentally difficult, but not for infants rated as temperamentally easy (Wachs, 1987).

Activity level is commonly examined as the organismic attribute that may determine the nature of the impact of environment on a particular outcome. For example, parent object-naming

appears to promote object mastery in low active children, but appears to prohibit the development of premastery in high active children (Wachs, 1987). Other research has shown that better organization of an infant's physical and temporal environment may be associated with better understanding of object properties and vocal interactions for infants who are high in activity level but not for infants low in activity level (Peters-Martin & Wachs, 1984). Additionally, low intensity of maternal stimulation may be associated with better exploratory competence for toddlers high in activity level but not for infants low in activity level (Gandour, 1989). Recently, maternal intrusiveness was shown to be associated with infant negative behavior for infants high in activity level but not for infants low in activity level (Szabó et al., 2008).

Differential susceptibility hypothesis. A more specific application of Wachs' hypothesis to parenting and child development is Belsky's (1997b) hypothesis of differential susceptibility. Specifically, Belsky argues that child temperamental characteristics moderate the link between parenting and child outcomes such that the link is stronger for children with more reactive temperamental profiles. According the this hypothesis, children with more reactive temperamental characteristics are susceptible to more negative outcomes from poor parenting than children with more reactive temperaments, and are also more likely than children with less reactive temperaments to benefit more from positive parenting than children with easier temperaments (Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2007; Belsky, 1997a). A variant of this hypothesis, the biological sensitivity to context hypothesis (Boyce and Ellis, 2005), proposes environments will have a stronger impact on children with a highly reactive neurobiological stress response systems in comparison to children with less reactive neurobiological stress response systems. When faced with adverse conditions, highly reactive

children experience worse psychiatric and biomedical outcomes than their low reactive peers. However, in protective environments, highly reactive children experience fewer health problems than low reactive children.

There is considerable evidence in support of the differential susceptibility hypothesis in a variety of domains of parenting and child outcomes. For example, Crockenberg (1981) found that, compared to less irritable infants, more irritable infants were more likely to be insecurely attached if their mother experienced low levels of social support and more likely to be securely attached if their mother experienced high levels of social support than. Belsky, Hsieh, and Crnic (1998) reported that parenting was more predictive of externalizing problems and inhibition in children who were highly negative infants than children who exhibited low negativity as infants. Stright, Gallagher, and Kelly (2008) found that poor parenting had a more negative impact on the academic competence and social skills of children with difficult temperaments than children with easy temperaments, whereas positive parenting had a more beneficial impact on the same outcomes for children with difficult temperaments.

Other research has indicated that maternal responsiveness is associated with children's cooperation for children who are more prone to anger, but it is not associated with cooperation among children who exhibited less anger (Kochanska, Aksan, & Carlson, 2005). Kochanska, Aksan, and Joy (2007) found that a positive mother-child relationship had a stronger positive impact on the moral development of relatively fearless children than relatively fearful children, and that power assertion had a more negative impact on the moral development of relatively fearful children than relatively fearless children. In a longitudinal study, Feldman, Greenbaum, and Yirmiya (1999) reported that mother-infant synchrony at 9 months of age was more strongly

related to infant self-control at 2 years among "difficult" infants than among infants with easy temperaments.

Although there is support for both organismic specificity and differential susceptibility across a variety of domains of child development, neither hypothesis has been used to examine the etiology of infant sleep development. The present study examined the interaction of temperament and parenting in predicting infant sleep quality, and specifically the role of infant temperament as a moderator of relations between parenting and infant sleep quality, to determine if these hypotheses are supported in the domain of infant sleep.

The Present Study

Interactions between infant temperament and the environment provided by parents may help to explain the inconsistencies in the body of literature describing the link between temperament and sleep as well as the literature describing the link between parenting and sleep. Approaches that incorporate the interaction between temperament and environment have, to date, not been applied to the field of infant sleep research. The present study examined the application of the Organismic Specificity Hypothesis and the Differential Susceptibility Hypothesis to the study of infant sleep quality, looking specifically at the role of infant temperamental reactivity as a moderator of linkages between parental bedtime practices and infant sleep quality at night. Three main questions were addressed in the present study.

(1) Controlling for infant age, is there a link between temperament, as measured by the Infant Behavior Questionnaire (Rothbart & Gartstein, 2000), and sleep quality in infants under 24 months of age? If so, what specific temperament dimensions are associated?

(2) Controlling for infant age, is there a link between parenting behavior (observed and parent report) during bedtime and nighttime and sleep quality in infants under 24 months of age? If so, what specific parenting behaviors are associated?

(3) Controlling for infant age, does temperament moderate the link(s) between parenting behavior (during bedtime and nighttime) and sleep quality? Finding such moderation would support Wach's (1985) organismic specificity hypothesis, regardless of the nature of the moderation. However, Belsky's (1997; Belsky et al., 2007) specific formulations regarding differential susceptibility would only be supported if linkages between parenting and infant sleep quality were stronger for more reactive than for less reactive infants.

METHODS

Participants

Thirty-six families of infants distributed across four cohorts (3, 6, 12 and 24 months) served as participants. Eight families of 3-month-olds were recruited at a local hospital post-delivery. The only criteria for participation was that the infants were healthy and full-term, in order to avoid the possible confound of sleep difficulties associated with various health problems. Twenty-two families of the 6-24 month-old infants were identified through a database of birth announcements in central Pennsylvania and first contacted for participation in a study about infant sleep behaviors through the mail, then contacted by phone and asked to participate in the study. Six families of 12-month-old infants were recruited through a newspaper advertisement. All families that participated in the study were compensated $100 for their time.

The infants' ages were evenly distributed across three of the cohorts (see Table 1): 8 infants were 3 months old (M = 2.91, SD = 0.19), 8 infants were 6 months old (M = 6.19, SD =

0.65), and 8 infants were 24 months old (M = 25.31, SD = 1.10). The 12-month cohort was somewhat larger with 12 infants (M = 12.25, SD = 1.06). Infant gender was evenly distributed within cohort, with the full sample evenly split by gender (18 male, 18 female). The majority of the participants in the sample were Caucasian (92%) and 3 of the families were Asian or Asian American (8%). The families in this study varied widely in terms of socioeconomic status, with yearly family incomes ranging from $11,000 to $200,000 ($M$ = $65,354, SD = $38,261). The majority of the parents in the sample were married and living together (97%), although one family consisted of a single mother (3%). Mothers' education levels ranged from high school graduate to Ph.D., with 36% of mothers having a Bachelor's degree and 33% having a Master's degree or higher. Fathers' education levels ranged from having attended high school without graduating to having a Ph.D., with 33% of fathers having a high school diploma, 25% of fathers having a Bachelor's degree and 36% of fathers having a Master's degree or higher.

Table 1. Participant Demographics.

Cohort	Mean Age (*SD*)	Number of Males	N
3 months	2.91 (*.19*)	4	8
6 months	6.19 (*.65*)	4	8
12 months	12.25 (*1.06*)	6	12
24 months	25.31 (*1.10*)	4	8

Procedure

Each family was visited in their home 3 times over the course of about one week by research assistants. The research assistants were a team of graduate and undergraduate students who were mentees of the Principal Investigator. Visits were scheduled at the families' convenience. Throughout the process of data collection the families filled out several questionnaires and had their infants videotaped during one night.

Visit 1. On the first visit, parents signed forms of informed consent and received a packet of questionnaires. Mothers and fathers each received their own identical packet to complete independently, without consulting one another. Among the measures included in the packet (which will be described in detail below) was a demographic questionnaire.

Visit 2. One week after leaving the packet, the research assistants returned to the home for the second visit. During this visit, the research assistants set up video recording equipment and instructed the parents to turn the equipment on before bedtime and off upon starting the day in the morning. Mothers' and fathers' packets were checked for completeness to reduce the amount of missing data and they were collected for data entry.

Video Setup. Research assistants set up night-vision video cameras (Channel Vision, CV-5005-W) and microphones (Channel Vision, CV-5104MIC) in the families' homes to record the infant's sleep location and the location of any bedtime or nighttime parenting routine. An infrared illuminator (CS-IR200) was also placed in the rooms where video recording took place. Families typically used 2 or 3 cameras and microphones. Each camera and microphone was attached to microphone stands to hold them in place. Generally, the first camera and microphone were placed over the infant's crib and other cameras and microphones were placed in any location that the infant was taken during nighttime care. Each camera and microphone was hooked up to a digital video recorder (Telexper DVR-X4/80) that recorded the audio and video images for the entire night. The research assistants used a small TV monitor, which was also connected to the digital video recorder, to angle the cameras properly. After setting up the equipment, the research assistants demonstrated how to turn the equipment on for the parents by flipping the switch to the power source for the entire system. Parents turned on the video equipment before any bedtime routine began so that this interaction would be recorded on video.

The equipment remained on throughout the night until the child awoke in the morning. Depending on the age of the child, the parent turned the video equipment off after the child either got up or was taken out of bed in the morning to start the day.

Visit 3. The final visit occurred the morning following visit 2, when research assistants returned to the families' homes to collect the video equipment and recordings.

Measures

The measures described below were selected from the larger dataset of measures collected from the sample. They include only measures that will address the research questions of this study, including a measure of infant temperament, infant sleep quality and parenting behaviors in the sleep context.

Demographics. Parents completed a demographics form which inquired about the target child's age and gender, the parent's education level, household income, and whether the child was currently breastfeeding some or all of the time.

Temperament: The Infant Behavior Questionnaire – Revised (IBQ-R). Mothers and fathers both completed the IBQ-R (Rothbart & Gartstein, 2000), which is a 191-item measure of infant temperament. The scores on this measure represent 14 subscales of infant temperament: activity level, distress to limitations, fear, duration of orienting, smiling and laughter, high pleasure, low pleasure, soothability, falling reactivity/rate of recovery from distress, cuddliness, perceptual sensitivity, sadness, approach, and vocal reactivity. Reliability of all 14 subscales has been established; each of the subscales has a Cronbach's alpha of at least .70 for infants between 3 and 12 months. Perceptual sensitivity has a Cronbach's alpha of .81 for 3-6 month-old infants, .84 for 6-9 month-old infants, and .83 for 9-12 month-old infants. Rate of recovery from distress has a Cronbach's alpha of .84 for 3-6 month-old infants, .79 for 6-9 month-old infants, and .83

for 9-12 month-old infants (Rothbart & Gartstein, 2000). For each item, parents rated how often their infant exhibited the particular behavior during the previous week on a scale of 0-7, where 0 means the item does not apply, 1 means they never observed their infant exhibiting the behavior, and 7 means they always observed their infant exhibiting the behavior. After reverse-scoring some items, the scores were summed for each of the 14 subscales. Missing values were replaced with the mean for each subscale.

The 14 subscales were combined to form the 3 temperamental superfactors of Surgency/Extraversion, Negative Affectivity, and Orienting/Regulation. Surgency/Extraversion includes 6 subscales: approach, vocal reactivity, high intensity pleasure, smiling and laughter, activity level, and perceptual sensitivity. Negative Affectivity includes 4 subscales: sadness, distress to limitations, fear, and falling reactivity (reverse coded). Several items were eliminated from the falling reactivity subscale because they pertained directly to sleep behavior. After these items were removed, the Cronbach's alpha was .74. Orienting/Regulation includes the remaining 4 subscales: low intensity pleasure, cuddliness/affiliation, duration of orienting, and soothability. The combination of the 14 subscales into these 3 superfactors was based on the results of the factor analysis of the subscales found in Gartstein & Rothbart (2003). Infants high in Surgency/Extraversion and Negative Affectivity and infants low in Orienting/Regulation are considered highly reactive infants. Four individual subscales were also analyzed individually, including perceptual sensitivity, distress to limitations, soothability, and activity level.

Parenting: The Sleep Practices Questionnaire (SPQ). Both mothers and fathers also completed the Sleep Practices Questionnaire. This measure was adapted from Keller & Goldberg (2004) and evaluates several aspects of parents' perceptions of their infants' sleep behavior and their sleep arrangements, as well as specific parenting practices at bedtime and during night

wakings. There are 80 total items; those that were used in this study are listed in Table 2. The first item, reflecting infant sleep location, was scored according to whether the infant slept in the same room as the mother (receiving a score of 1 for roomsharing) or separately from the mother (receiving a score of 0 for roomsharing). This item was also scored according to the stability of the infant's sleep location, such as whether the infant stayed in one room all night (receiving a score of 0 for instability of sleep location) or spent part of the night in one room and part of the night in another room (receiving a score of 1 for instability of sleep location).

Table 2. Items on the SPQ.

Item	Reponses
"Where does you baby usually sleep at night?"	In his/her own room all night In my bed all night In a crib in my room all night Part of the night in my bed and part of the night in his/her own room
"To what extent does your baby follow a consistent bedtime routine"	from 1 (never) to 5 (always)
"To what extent does your baby go to bed at the same time each night?"	from 1 (never) to 5 (always)
"At 'lights out,' what do you do to help your baby fall asleep?" "Nurse baby" "Give baby a bottle" "Rock baby to sleep" "Walk baby to sleep"	from 1 (never) to 5 (always)
"When your baby awakens during the night, what do you do to put him/her back to sleep?" "Nurse baby" "Give baby a bottle" "Pick up and rock/hold baby"	from 1 (never) to 5 (always)

Parenting: Digital video recordings. The videos were coded for the amount of time parents spent engaging in a variety of behaviors, both at bedtime and during the night. The behaviors that were analyzed in the present study included the amount of time infants were nursed or bottle fed and the amount of time mothers engaged in close contact (holding the baby or having the majority of the infant's body touching the mother). The amount of time mothers

spent engaging in these behaviors was summed and divided by the total length of the video to account for differing video lengths across dyads. Thus, proportions of each behavior in the videos served as units of analyses. These behaviors were coded separately for bedtime and nighttime. The distinction between bedtime and nighttime was determined by the moment the infant fell asleep for the first time on the video. All interactions that took place before the infant had initiated sleep were bedtime interactions and all those that took place after sleep had previously been initiated were nighttime interactions. The videos were coded by two research assistants, and reliability was established on 10 families. Intraclass correlations were conducted to determine the interrater reliability for each behavior that was coded. Reliability for nursing was $r = .998$, $p < .001$ at bedtime, and $r = .984$, $p < .001$ during the night. Reliability for bottle feeding was perfect ($r = 1.00$) at bedtime, and $r = .998$, $p < .001$ during the night. Reliability for close contact was $r = .997$, $p < .001$ at bedtime, and $r = .998$, $p < .001$ during the night.

Infant sleep quality: The infant sleep diary (adapted from Burnham et al., 2002), completed by parents, provided a summary of infant sleep behavior across seven consecutive days. Either the mother or the father was allowed to complete the diaries, although with one exception mothers always completed these diaries. The diary asks parents to report where and when the infant fell asleep the night before and where and when the infant woke up in the morning, as well as how many times the infant awoke throughout the night, and how long the night wakings lasted. The number of times parents reported that the infant woke up after falling asleep was summed across all seven diaries to reflect the frequency of night wakings across a full week. The length of time infants were awake during night wakings was created by summing the number of minutes that parents reported their infants were awake for each night waking across the full week. The total length of time infants slept was calculated by determining the number of

minutes between parents' reports of the infant falling asleep and waking up. These scores were summed across the full week, and infants' scores for length of time awake during night wakings were subtracted to reflect total amount of sleep, after accounting for night wakings.

Reports of infants' sleep location from the sleep diaries were also coded to reflect the instability of infants' sleep location and their frequency of roomsharing. When parents reported that infants woke up in a location other than the location they were reported as falling asleep in, they received a score of 1 for sleep instability. When parents reported that their infant woke up in the same location that they fell asleep in, they received a score of 0 for instability of the sleep location. When parents reported that infants either fell asleep or woke up in the parents' bed, they received a score of 1 for roomsharing. Separate sleeping received a score of 0. Roomsharing and sleep instability scores were summed across all seven diaries to reflect the frequency of roomsharing and sleep instability across a full week.

DATA ANALYSIS PLAN

Data Organization and Reduction

Temperament. Because not all of the 14 subscales of infant temperament are conceptually relevant to infant sleep, those subscales that were expected to be linked to infant sleep based on their conceptual relevance were analyzed individually, in addition to the 3 temperamental superfactors previously described. The subscales that were analyzed individually include perceptual sensitivity, distress to limitations, soothability, and activity level.

Parenting.

Consistent bedtime routine. The variables that address the use of a consistent bedtime routine were from the SPQ items "To what extent does your baby follow a consistent bedtime routine" and "To what extent does your baby go to bed at the same time each night?" These

variables were combined to create the Bedtime Routines variable. Higher scores on this variable indicate a more consistent bedtime and bedtime routines.

Sleep location. Roomsharing and the instability of the sleep location were determined by mothers' responses to the SPQ item "Where does your baby usually sleep at night?" and the Sleep Diary items reflecting the location of the infant when he or she fell asleep and when he or she woke up in the morning. Rates of roomsharing and instability of the infant's sleep location were analyzed separately.

Physical comfort. Self-report of physical comfort at bedtime comes from mothers' responses of "Rock baby to sleep" and "Walk baby to sleep" to the SPQ item "At 'lights out,' what do you do to help your baby fall asleep?" Self-report of physical comfort during the night comes from mothers' response of "Pick up and rock/hold baby" to the SPQ item "When your baby awakens during the night, what do you do to put him/her back to sleep?"

Rates of observed physical comfort at bedtime came from the amount of time mothers spent in close contact with their infants from the bedtime portion of the overnight video. Rates of observed physical comfort during the night came from the amount of time mothers spent in close contact with their infants from the nighttime portion of the overnight video. Observed physical comfort at bedtime and during the night were analyzed separately.

Feeding. Self-report of feeding at bedtime came from mothers' responses of "Nurse baby" and "Give baby a bottle" to the SPQ item "At 'lights out,' what do you do to help your baby fall asleep?" Self-report of feeding during the night came from mothers' response of "Nurse baby" and "Give baby a bottle" to the SPQ item "When your baby awakens during the night, what do you do to put him/her back to sleep?" Rates of observed feeding at bedtime came from the amount of time mothers spent either nursing or bottle feeding their infants from the bedtime

portion of the overnight video. Rates of observed feeding during the night came from the amount of time mothers spent either nursing or bottle feeding their infants from the nighttime portion of the overnight video.

Preliminary Analyses

Preliminary analyses were conducted to examine the relations between infant sleep quality, parenting behaviors, temperament, and demographic characteristics, including infant age and gender, parental education level, and household income. Infant sleep quality was analyzed using three different indicators from the infant sleep diary. Each indicator was averaged across a full week; these indicators include number of night wakings, duration of night wakings, and total sleep duration. These variables were selected as indicators of infant sleep quality based on their frequent use in the literature. Intercorrelations among the temperament subscales were also examined, as well as intercorrelations among the parenting categories and composites.

Research question 1

The first research question, which asks whether there is a link between infant temperament and sleep quality, was analyzed using hierarchical multiple regression. Infant age was entered into the regression as a covariate. Infant temperament was entered as the independent variable, in the form of individual subscales in some analyses and in the form of superfactors in other analyses. The infant sleep quality indicators listed above were entered as the dependent variables. Significant main effects for temperament indicated a link between temperament and sleep quality.

Research question 2

The second research question, which asks whether there is a link between parenting behaviors and sleep quality, was analyzed using hierarchical multiple regression. Infant age was

entered into the regression as a covariate. Each parenting category or composite was entered as the independent variable. The infant sleep quality indicators listed above were entered as the dependent variables. Significant main effects for parenting indicated a link between parenting and sleep quality.

Research question 3

The final research question, which asks whether infant temperament moderates the link between parenting behavior and infant sleep quality, was also addressed through hierarchical multiple regressions. In these regressions, infant age was entered into the regression as a covariate. The infant temperament subscale scores or superfactor and the parenting composites were centered around their means and entered into the regression as the independent variables. Interaction terms were calculated between each individual temperament subscale or superfactor and each individual parenting behavior, and each individual interaction term was entered into the regression with its corresponding independent variables. The infant sleep quality indicators listed above were entered as the dependent variables. Significant interaction terms from these regressions indicated a moderated relationship between infant temperament and parenting in predicting infant sleep. Follow-up analyses indicated the nature of the moderation between temperament and parenting.

Follow-up analyses. Following the procedure described in Aiken and West (1991), the nature of significant interactions were determined by first calculating the individual slopes of the relations between the parenting measure and the infant sleep indicator for infants high (1 *SD* above the mean) and low (1 *SD* below the mean) on the temperament subscale or superfactor. The statistical significance of the slopes was then determined by converting them to *t*-scores. All of the above analyses were conducted using SPSS.

RESULTS

Preliminary Analyses

Preliminary analyses were conducted to determine the extent to which infant age, gender, and other demographics were associated with temperament and parenting measures in this study, and also to examine the interrelations between temperament measures, parenting measures, and infant sleep measures. These analyses were conducted in part for descriptive purposes, as well as to determine whether infant age, gender, and breastfeeding should be used as covariates in the analyses addressing the three main research questions.

Demographics and sleep outcomes. Infant age was significantly correlated with the frequency of infants' night wakings, $r(35) = -.44$, $p < .01$, and with the total time infants were awake at night, $r(36) = -.37$, $p = .03$. Older infants woke up less frequently and spent less time awake during night wakings than younger infants. Infant age was not significantly correlated with the total time infants were asleep at night. Infant gender, maternal education level, household income and whether infants were breastfed were not significantly associated with any of the infant sleep outcomes.

Demographics and temperament. Infant age was significantly correlated with the temperamental superfactor Surgency/Extraversion, $r(36) = .68$, $p < .001$, and the temperamental subscale of perceptual sensitivity, $r(36) = .53$, $p < .001$. Older infants were more surgent/extraverted and perceptually sensitive than younger infants. Infant gender, maternal education level, household income and whether infants were breastfed were not significantly associated with any of the temperamental superfactors or subscales.

Demographics and parenting behaviors. Infant age was significantly correlated with mothers' use of physical comfort at bedtime, $r(32) = -.51$, $p < .01$, as well as all measures of

feeding, including mothers' self-report of feeding, both at bedtime, $r(32) = -.47$, $p < .01$, and during the night, $r(33) = -.69$, $p < .001$, and observational measures of feeding, both at bedtime, $r(32) = -.44$, $p = .01$, and during the night $r(32) = -.43$, $p = .01$. Mothers engaged in significantly less physical comfort at bedtime and feeding both at bedtime and during the night with older infants as compared to younger infants.

Household income, $r(29) = .46$, $p = .01$, and whether infants were breastfed, $r(23) = .63$, $p = .001$, were significantly associated with mothers' observed rates of feeding at bedtime. Mothers who had a higher household income and mothers who breastfed spent more time feeding their infants at bedtime. Infant gender and maternal education were not significantly correlated with any of the parenting variables.

Because of the many linkages found between infant age and the parenting and temperament variables, infant age was statistically controlled in all analyses addressing the three main research questions in this study.

Intercorrelations among sleep outcomes. The frequency of infants' night wakings was significantly correlated with the total time infants were awake at night, $r(35) = .73$, $p < .001$. The total time infants were awake at night was significantly associated with the amount of time infants were asleep, $r(36) = -.38$, $p = .02$.

Intercorrelations among temperament variables. Intercorrelations among temperament variables are shown in Table 3. Among the superfactors, only surgency/extraversion and orienting/regulation were significantly correlated ($r = .41$, $p = .01$). This correlation was slightly higher than the correlation that Gartstein and Rothbart (2003) found between the same superfactors ($r = .25$), however these authors did not report the significance of this correlation. Surgency/Extraversion was not significantly correlated with negative affectivity

(r = .22, p = .20), however this correlation was similar to that found by Gartstein and Rothbart (r = .16), although the significance is also unknown. Negative affectivity and orienting/regulation were also not significantly correlated (r = -.28, p = .10), although this correlation was quite similar to that found by Gartstein and Rothbart (r = .30).

Table 3. Correlations among Temperament Superfactors and Subscales

	Superfactors			Subscales			
Temperament	Surgency/ Extra-version	Negative Affectivity	Orienting/ Regulation	Perceptual Sensitivity	Activity Level	Distress to Limitations	Soothability
Surgency/ Extraversion	-						
Negative Affectivity	ns	-					
Orienting/Regulation	.41*	ns	-				
Perceptual Sensitivity	.63***	ns	.37*	-			
Activity Level	ns	.44**	-.38*	ns	-		
Distress to Limitations	.42**	.79***	ns	ns	.62***	-	
Soothability	ns	ns	.60***	.53***	ns	ns	-

N = 36
* p < .05
** p < .01
*** p < .001

Among the individual subscales, perceptual sensitivity significantly correlated with soothability and activity level significantly correlated with distress to limitations. Surgency/extraversion was significantly correlated with one of the subscales from which it was calculated (perceptual sensitivity) and one from which it was not (distress to limitations). Negative affectivity was also correlated with one of the subscales from which it was calculated (distress to limitations) and one from which it was not (activity level). Orienting/regulation correlated with one of the subscales from which it was calculated (soothability) and two subscales from which it was not (perceptual sensitivity and activity level).

Intercorrelations among parenting behaviors. Intercorrelations among the eleven parenting variables are shown in Table 4. Bedtime routines was significantly negatively correlated with roomsharing and instability of the sleep location. Roomsharing and location instability were positively correlated. Roomsharing was also positively correlated with observed physical comfort at bedtime and during the night, and observed feeding during the night.

Instability of the sleep location was also positively correlated with observed feeding during the night. Self-report of physical comfort at bedtime positively correlated with self-report of physical comfort during the night, as well as self-report of feeding at bedtime and during the night. Self-report of physical comfort during the night positively correlated with observed physical comfort at bedtime, self-reported feeding at bedtime, and self-reported feeding at night. Observed physical comfort at bedtime correlated with self-reported feeding at bedtime, as well as observed feeding at bedtime and during the night. Self-reported feeding at bedtime was correlated with self-reported feeding during the night and observed feeding at bedtime. Self-reported feeding during the night was positively correlated with observed feeding during the night.

Research Question 1

As described above, hierarchical multiple regressions were conducted, controlling for infant age, to examine linkages between infant temperament and infant sleep quality. Results indicated that soothability significantly predicted infants' frequency of night wakings $\beta = -.36$, $t(32) = -2.46$, $p = .02$. Infants who were rated by their mothers as more soothable had fewer night wakings. Perceptual sensitivity was also associated with infants' frequency of night waking; however, this finding was in the opposite direction from what was expected, $\beta = -.43$, $t(32) = -2.36$, $p = .03$. More perceptually sensitive infants were found to have fewer night wakings.

Table 4. Correlations among Parenting Behaviors

						Physical Comfort				Feeding			
						Self-Report		Observed		Self-Report		Observed	
			Bedtime Routines	Room-sharing	Location Instability	Bed-time	Night-time	Bed-time	Night-time	Bed-time	Night-time	Bed-time	Night-time
		Bedtime Routines	-										
		Room-sharing	-.42*	-									
		Location Instability	-.36*	.67***	-								
Physical Comfort	Self-Report	Bedtime	ns	ns	ns	-							
		Nighttime	ns	ns	ns	.59***	-						
	Observed	Bedtime	ns	.46**	ns	ns	.45*	-					
		Nighttime	ns	.79***	ns	ns	ns	ns	-				
Feeding	Self-Report	Bedtime	ns	ns	ns	.42*	.51**	.62***	ns	-			
		Nighttime	ns	ns	ns	.39*	.44*	ns	ns	.42*	-		
	Observed	Bedtime	ns	ns	ns	ns	ns	.59***	ns	.58**	ns	-	
		Nighttime	ns	.38*	.44*	ns	ns	.39*	ns	ns	.68***	ns	-

* $p < .05$
** $p < .01$
*** $p < .001$

Surgency/Extraversion, Negative Affectivity, Orienting/Regulation, Distress to Limitations and Activity Level were not significantly associated with infant sleep quality.

Research Question 2

Hierarchical multiple regression, controlling for infant age, was conducted to examine the links between parenting behaviors and infant sleep quality. Mothers' reports of their use of consistent bedtimes and bedtime routines was associated with fewer infant night wakings, $\beta = -.31$, $t(32) = -2.04$, $p < .05$. Frequency of roomsharing was associated with higher frequency of infant night wakings, $\beta = .38$, $t(32) = 2.61$, $p = .01$. The instability of infants' sleep location also predicted the more infant night wakings, $\beta = .31$, $t(32) = 2.05$, $p < .05$. Mothers' use of physical comfort and feeding at bedtime and during the night, whether self-reported or observed, were not significantly associated with infant sleep quality.

Research Question 3

The final research question, which examines whether infant temperament moderates the link between parenting behavior and infant sleep quality, was also addressed through hierarchical multiple regressions, as described above, controlling for infant age. Results indicated a variety of interactions between different parenting behaviors and temperament in predicting infant sleep outcomes. Table 5 shows the significant interactions and the respective sleep outcomes which they predict.

Consistent bedtime routines. Maternal self-reported use of a consistent bedtime and bedtime routines significantly interacted with infants' negative affectivity, F_{change} (1,30) = 5.37, $p = .03$ (see Figure 1), and perceptual sensitivity, F_{change} (1,30) = 5.46, $p = .03$ (see Figure 2), in predicting infants' frequency of night wakings. A probe of the interaction (described above in Data Analysis Plan) between bedtime routines and negative affectivity revealed that the slope of

Table 5. Significant Interactions between Parenting Behaviors and Temperament in Predicting Infant Sleep.

			Superfactors			Subscales			
			Surgency/ Extraversion	Negative Affectivity	Orienting/ Regulation	Perceptual Sensitivity	Distress to Limitations	Soothability	Activity Level
		Bedtime Routines		WF		WF			
		Room-sharing		WF					
		Location Stability		WF					
Physical Comfort	Self-Report	Bedtime			TS				
		Nighttime							
	Observed	Bedtime		TA	TS		TA		
		Nighttime		TA		WF	TA		
Feeding	Self-Report	Bedtime							
		Nighttime							
	Observed	Bedtime			WF TA	TA		TA	WF
		Nighttime		WF TA				TA	

WF = Waking Frequency
TA = Time Awake during Night Wakings
TS = Total Length of Night Sleep

the link between consistent bedtime routines and night wakings was negative and significant ($p < .05$) for infants low in negative affectivity (-2.77), but was not significant for infants high in negative affectivity (.14). A similar pattern of results were obtained for perceptual sensitivity; the slope for less perceptually sensitive infants was negative (-1.87) and significant ($p < .05$), but for more perceptually sensitive infants this slope was not significant (1.64). Among infants low in negative affectivity and perceptual sensitivity, more frequent use of consistent bedtime routines was associated with fewer night wakings. However, among infants whose mothers rated them as high in negative affectivity and perceptual sensitivity, the use of bedtime routines was not significantly associated with the frequency of infants' night wakings.

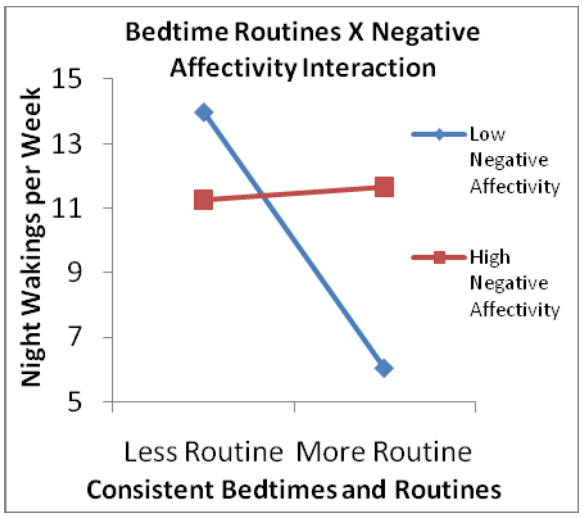

Figure 1. Bedtime Routines X Negative Affectivity

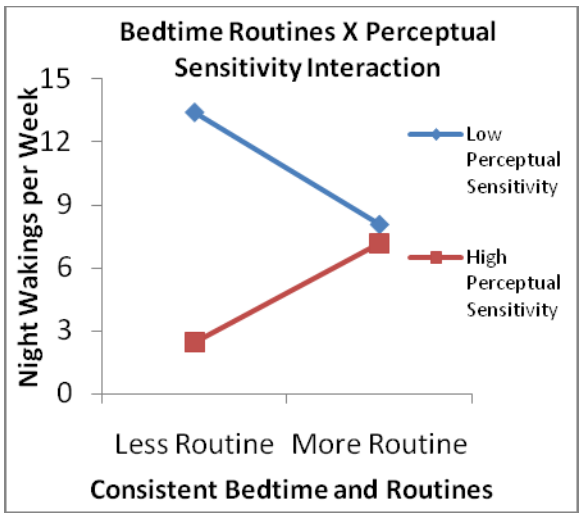

Figure 2. Bedtime Routines X Perceptual Sensitivity

Roomsharing. Maternal self-report of roomsharing significantly interacted with negative affectivity in predicting the frequency of infants' night wakings, F_{change} (1,30) = 6.16, p = .02 (see Figure 3). A probe of this interaction revealed that the slope of the link between roomsharing and frequency of night wakings was positive and significant (p < .05) for infants low in negative affectivity (3.04), but the slope was not significant for infants high in negative affectivity (.41). Thus, for infants low in negative affectivity, more frequent roomsharing was associated with more frequent night wakings. However, when infants were high in negative affectivity, roomsharing was not associated with night wakings.

Instability of sleep location. Maternal self-reported instability of sleep location significantly interacted with negative affectivity in predicting frequency of infant night wakings, F_{change} (1,30) = 4.84, p = .04 (see Figure 4). The follow-up probe of this interaction revealed that the slope of the link between instability of the sleep location and frequency of infant night wakings was positive and significant (p < .05) for infants low in negative affectivity (2.82), but the slope was not significant for infants high in negative affectivity (.84). When infants were low in negative affectivity, having a more stable sleep location was associated with less frequent

night wakings. When infants were high in negative affectivity, instability of the sleep location was not associated with frequency of night wakings.

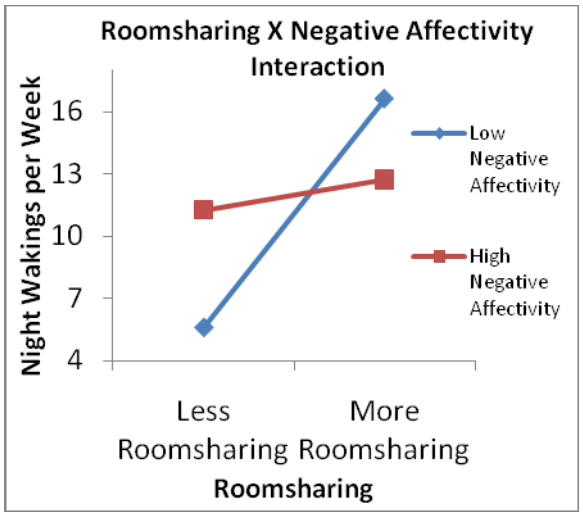

Figure 3. Roomsharing X Negative Affectivity

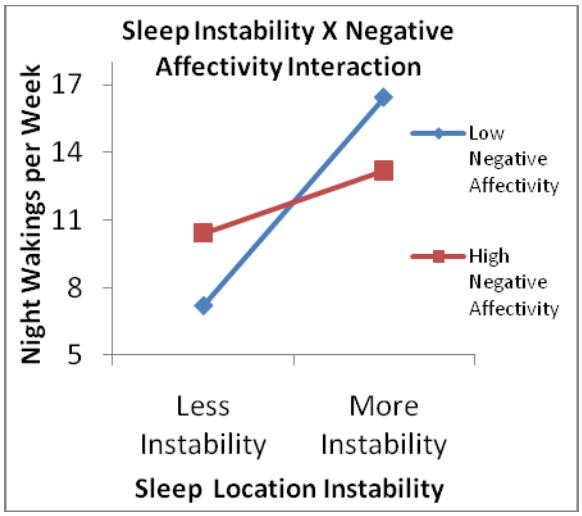

Figure 4. Sleep Instability X Negative Affectivity

Physical Comfort.

Self-reported physical comfort at bedtime. Maternal self-report of physical comfort at bedtime significantly interacted with orienting/regulation in predicting the total length of time infants slept, F_{change} (1,29) = 8.82, $p < .01$ (see Figure 5). When this interaction was probed, results revealed that the slope for the link between bedtime physical comfort and length of sleep was negative and significant ($p < .05$) for infants low in orienting/regulation (-107.3), but the slope was positive and significant ($p < .05$) for infants whose mothers reported them as high in orienting/regulation (104.96). For infants who were low in orienting/regulation, more physical comfort at bedtime was associated with fewer night wakings. For infants who were high in orienting/regulation, more physical comfort at bedtime was associated with more frequent night wakings.

Self-reported physical comfort during the night. Maternal self-reported use of physical comfort during the night did not significantly interact with any of the temperament superfactors or subscales in predicting infant sleep quality.

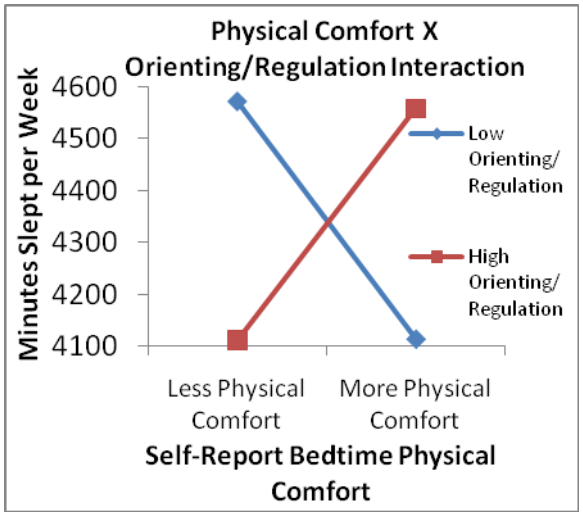

Figure 5. Self-Reported Physical Comfort at Bedtime X Orienting/Regulation

Observed physical comfort at bedtime. When physical comfort at bedtime was observed in the overnight video recordings, comforting significantly interacted with negative affectivity, F_{change} (1,27) = 4.82, p = .04 (see Figure 6), and distress to limitations, F_{change} (1,27) = 7.82, p < .01 (see Figure 7), in predicting the length of time infants were awake during night wakings. Probes of these interactions revealed that the slopes of the links between observed bedtime physical comforting and time awake during night wakings were positive and significant (p < .05) for infants low in either negative affectivity (430.69) or distress to limitations (456.87), but these slopes were not significant for infants high in either negative affectivity (-3.28) or distress to limitations (-17.31). For infants low in either negative affectivity or distress to limitations, more physical comfort at bedtime was associated with more time awake during night wakings. When infants were high in either negative affectivity or distress to limitations, rates of

physical comfort at bedtime were not associated with the amount of time infants were awake during night wakings.

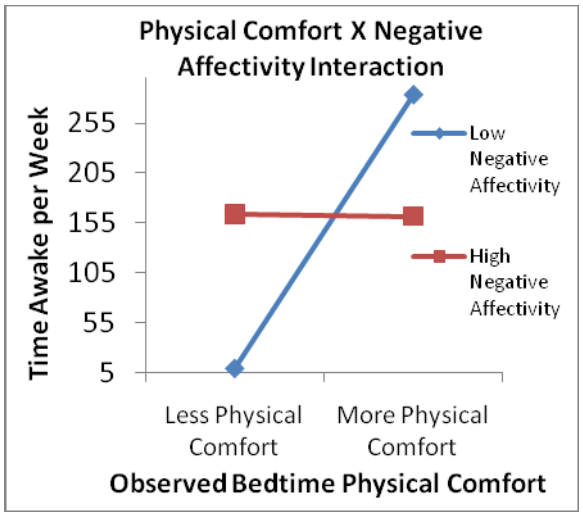

Figure 6. Observed Physical Comfort at Bedtime X Negative Affectivity

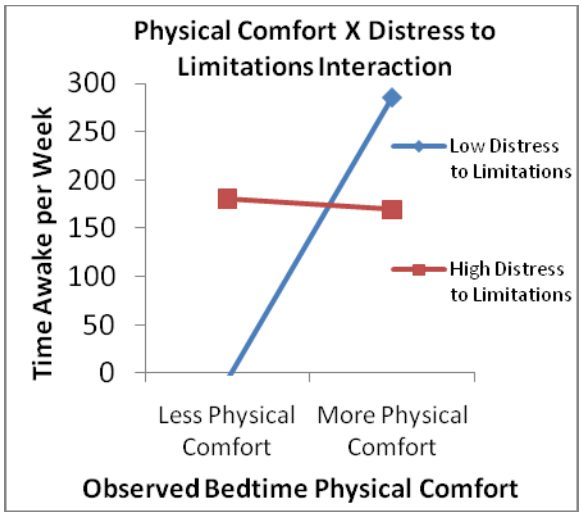

Figure 7. Observed Physical Comfort at Bedtime X Distress to Limitations

Observed physical comfort at bedtime also significantly interacted with orienting/regulation in predicting the total length of infants' sleep, F_{change} (1,27) = 5.85, p = .02 (see Figure 8). A probe of this interaction revealed a similar pattern as was found previously; the slope for the link between observed physical comfort at bedtime was negative and significant (p < .05) for infants high in orienting/regulation (-898.79), but the slope was not significant for infants low in orienting/regulation (131.68). For infants whose mothers rated them as high in orienting/regulation, the use of more physical comfort was associated with less total time sleeping. For infants low in orienting/regulation, physical comfort at bedtime was not associated with the overall amount of time infants slept.

Observed physical comfort during the night. Physical comfort during the night observed from the overnight video recordings interacted significantly with negative affectivity, F_{change} (1,27) = 6.60, p = .02 (see Figure 9), and distress to limitations, F_{change} (1,27) = 4.43, p < .05 (see Figure 10), in predicting the length of time infants were awake during night wakings. Probing

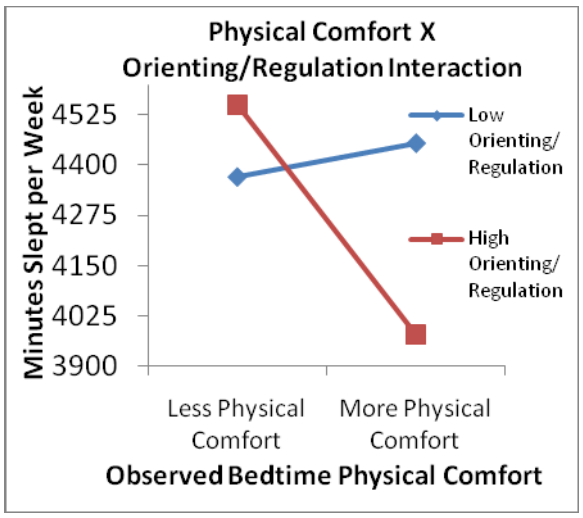

Figure 8. Observed Physical Comfort at Bedtime X Orienting/Regulation

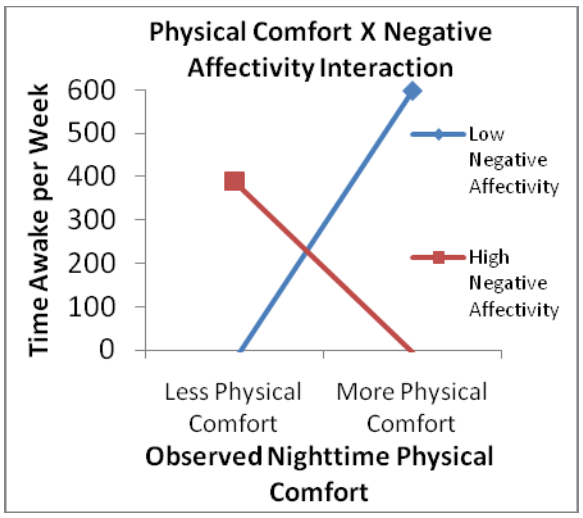

Figure 9. Observed Physical Comfort at Night X Negative Affectivity

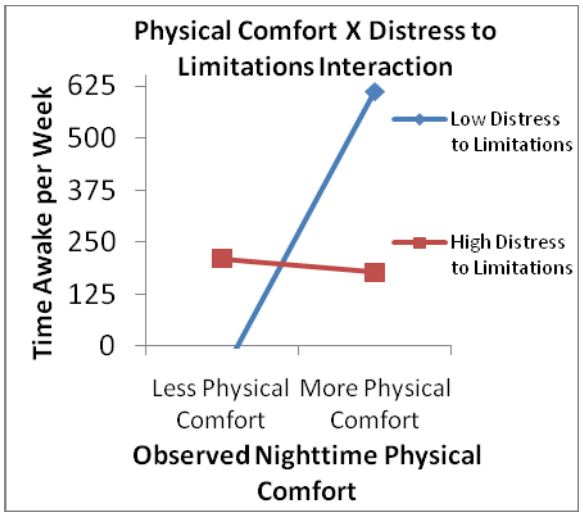

Figure 10. Observed Physical Comfort at Night X Distress to Limitations

these interactions indicated that the slope of the link between observed physical comfort during the night and time spent awake during night wakings was positive and significant ($p < .05$) for infants low in either negative affectivity (3488.66) or distress to limitations (3813.67). However, the slope was negative and significant ($p < .05$) for infants high in negative affectivity (-2208.72). The slope for the link between observed physical comfort at bedtime and time awake during night wakings was not significant for infants who were more easily distressed by limitations (-186.06) . For infants who were low in either negative affectivity or distress to

limitations, more physical comfort was associated with more time awake during night wakings. For infants whose mothers reported them as high in negative affectivity, more physical comfort was associated with less time awake during night wakings. For infants who were high in distress to limitations, physical comfort was not associated with time awake during night wakings.

A significant interaction also emerged between observed physical comfort during the night and perceptual sensitivity in predicting frequency of infant night wakings, F_{change} (1,26) = 7.22, p = .01 (see Figure 11). Follow-up analyses revealed that the slope of the link between physical comfort and frequency of night wakings was positive and significant ($p < .05$) for infants high in perceptual sensitivity (51.99). The slope was not significant for infants low in perceptual sensitivity (-33.00). Thus, for infants who were high in perceptual sensitivity, more physical comfort during the night was associated with more night wakings. However, for infants who were low in perceptual sensitivity, physical comfort during the night was not associated with frequency of night wakings.

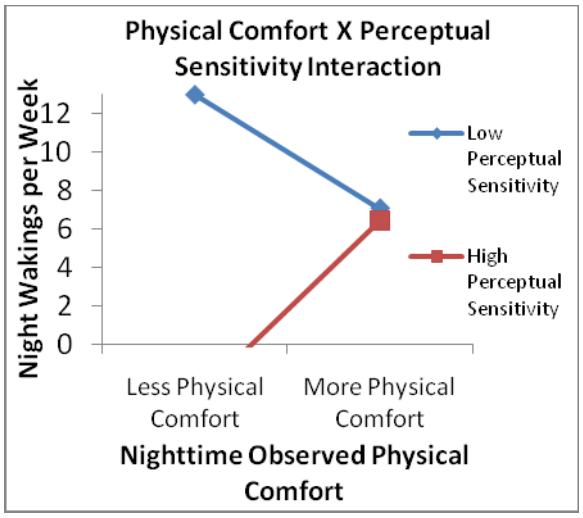

Figure 11. Observed Physical Comfort at Night X Perceptual Sensitivity

Maternal report of physical comfort at bedtime yielded only one significant interaction with temperament in predicting infant sleep quality. These findings indicate that self-report measures of parents' use of physical comfort may not accurately capture the complexity of this

parenting behavior. However, observational measures of maternal use of physical comfort, obtained from video recordings of parents and infants interacting at bedtime and throughout the night, yielded several significant interactions with temperament in predicting infant sleep quality. Observational measures of parents' use of physical comfort may be significantly more informative than self-report.

Feeding.

Self-reported feeding. Maternal self-report of feeding at bedtime and at night did not significantly interact with any of the temperament superfactors or subscales in predicting infant sleep quality.

Observed feeding at bedtime. When feeding at bedtime was observed in the overnight video recordings, feeding significantly interacted with orienting/regulation to predict frequency of infants' night wakings, F_{change} (1,26) = 5.57, p = .03 (see Figure 12). The follow-up analysis of this interaction indicated that, although the overall interaction was significant, the slope of the link between observed feeding at bedtime and frequency of night wakings was not significant for infants either low (10.61) or high in orienting/regulation (-15.64). Thus, although there was a significantly different pattern in the link between feeding and night wakings depending on whether infants were low or high in orienting/regulation, feeding was not significantly associated with frequency of night wakings for either group.

Observed feeding at bedtime also significantly interacted with orienting/regulation, F_{change} (1,27) = 4.71, p = .04 (see Figure 13), perceptual sensitivity, F_{change} (1,27) = 4.67, p = .04 (see Figure 14), and soothability, F_{change} (1,27) = 8.60, $p < .01$ (see Figure 15), in predicting the length of time infants were awake during night wakings. For both orienting/regulation and perceptual sensitivity, the follow-up analyses of this interaction indicated that, once again,

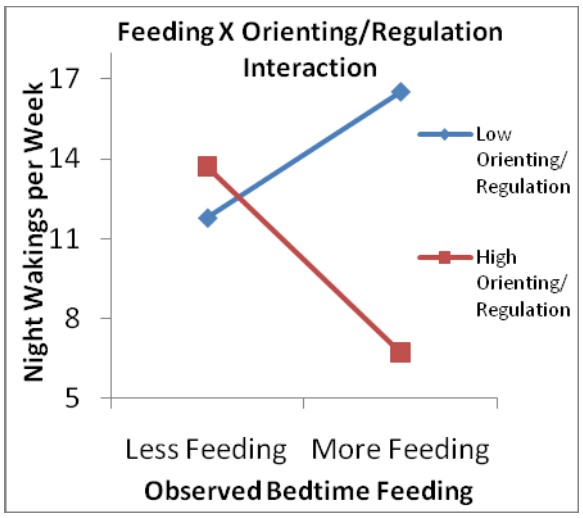

Figure 12. Observed Feeding at Bedtime X Orienting/Regulation

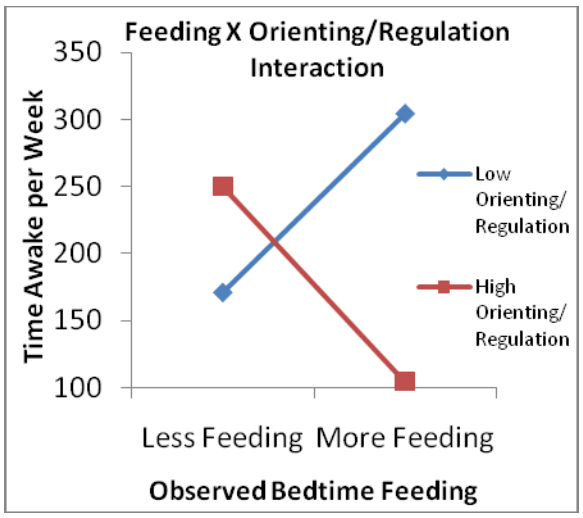

Figure 13. Observed Feeding at Bedtime X Orienting/Regulation

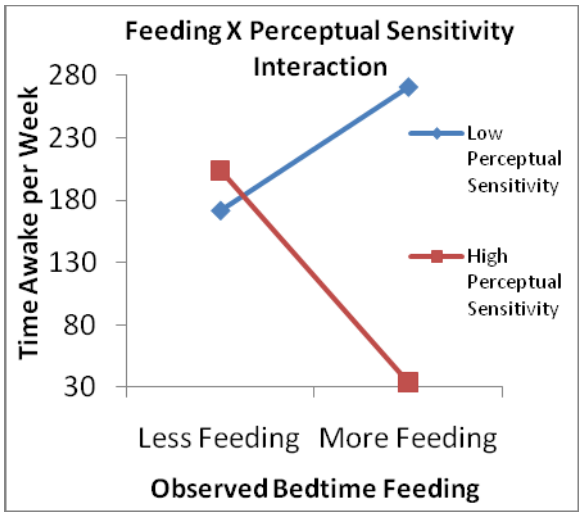

Figure 14. Observed Feeding at Bedtime X Perceptual Sensitivity

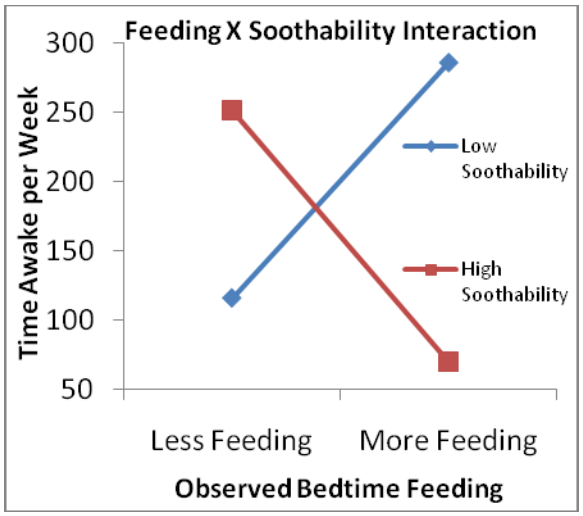

Figure 15. Observed Feeding at Bedtime X Soothability

although the overall interaction was significant, the slope of the links between observed feeding at bedtime and length of time infants were awake during night wakings was not significant for infants either low (299.37) or high in orienting/regulation (-327.09) or low (221.43) or high in perceptual sensitivity (-381.64). Again, although there was a significantly different pattern in the links between feeding and the length of time infants were awake during night wakings depending on whether infants were low or high in orienting/regulation or perceptual sensitivity, feeding was not significantly associated with time awake during night wakings for any of these groups.

However, a different pattern emerged for the interaction between feeding and soothability in predicting the length of time infants were awake during night wakings. The follow-up analysis for this interaction indicated that for infants low in soothability, the slope of the link between observed feeding at bedtime and time awake during night wakings was positive (382.16) and significant ($p < .05$). For infants high in soothability, the slope was not significant (-407.34). That is, when infants were less soothable, more feeding at bedtime was associated with more time awake during night wakings. When infants were more soothable, feeding was not significantly associated with time awake during night wakings.

An interesting interaction also emerged when feeding was examined based on the amount of time they were observed feeding at bedtime as compared to the proportion of the total video length that was spent feeding. Specifically, a significant interaction emerged between feeding and activity level in predicting the frequency of infants' night wakings, F_{change} (1,26) = 4.58, $p = .04$ (see Figure 16). The follow-up probe of this interaction revealed a positive and significant ($p < .05$) slope for the link between feeding at bedtime and frequency of night wakings for infants high in activity level (.42). For infants low in activity level, the slope was not significant (-.02). Thus, for infants high in activity level, feeding at bedtime was associated with more frequent night wakings. For less active infants, feeding was not significantly associated with frequency of night wakings.

Observed feeding during the night. Rates of feeding observed at night, taking total length of the nighttime video into account, significantly interacted with negative affectivity in predicting frequency of night wakings, F_{change} (1,26) = 10.84, $p < .01$ (see Figure 17). The follow-up of this interaction revealed that the slope of the link between feeding and frequency of night wakings was positive and significant ($p < .05$) for infants whose mothers rated them as low

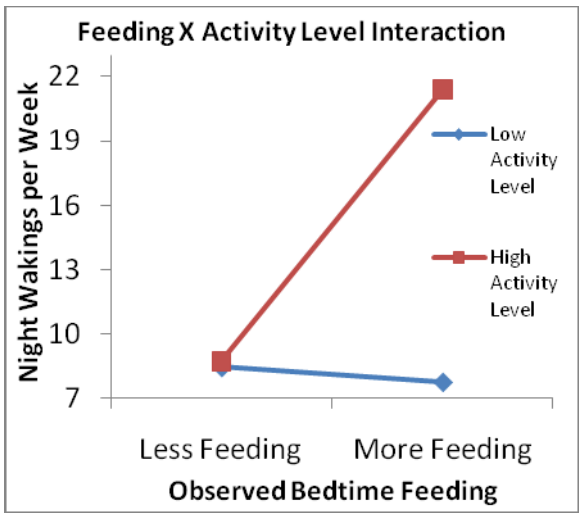

Figure 16. Observed Feeding at Bedtime X Activity Level

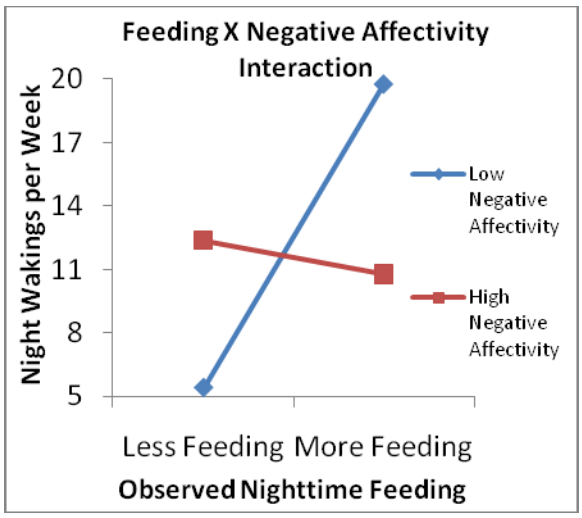

Figure 17. Observed Feeding at Night X Negative Affectivity

in negative affectivity (471.92). For infants who were high in negative affectivity, the slope was not significant (-51.98). Thus, for infants who were low in negative affectivity, more feeding during the night was associated with more frequent night wakings. For infants high in negative affectivity, feeding was not associated with frequency of night wakings.

Rates of feeding at night also significantly interacted with negative affectivity, F_{change} (1,27) = 5.13, p = .03 (see Figure 18), and soothability, F_{change} (1,27) = 6.82, p = .02 (see Figure 19), in predicting length of time awake during night wakings. Follow-up probing of these interactions indicated that the slope for the link between feeding and length of time awake was positive and significant ($p < .05$) for infants low in negative affectivity (7663.07) and for infants high in soothability (4709.88). For infants high in negative affectivity (-1259.77) and those low in soothability (-1376.39), the slope was not significant. Therefore, for infants whose mothers rate them as low in negative affectivity or high in soothability, more observed feeding during the night was associated with more time awake during night wakings. For infants high in negative affectivity or low in soothability, feeding was not associated with length of time awake during night wakings.

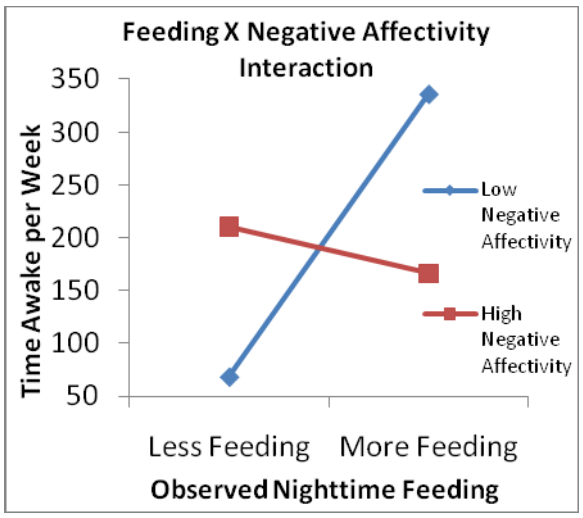

Figure 18. Observed Feeding at Night X Negative Affectivity

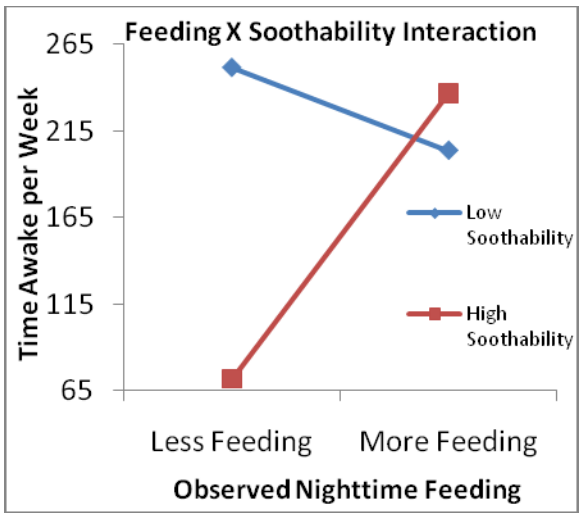

Figure 19. Observed Feeding at Night X Soothability

Several significant interactions emerged between observational measures of feeding and temperament in predicting infant sleep quality, whereas there were no significant interactions between self-report measures of feeding and temperament. Like those obtained for physical comfort, the results for feeding indicated that observational measures of maternal feeding behavior may be more informative than self-report measures.

DISCUSSION

The findings of this study provided support for the premise that infant temperament plays an important role in moderating linkages between parenting and infant sleep. Direct links between infant temperament and sleep were sparse and, like the findings of previous studies, mixed.

None of the three temperamental superfactors alone were significantly associated with any of the infant sleep outcomes. Of the four temperamental subscales that were examined, only two were significantly associated with infant sleep outcomes: Infants whose mothers described them as more soothable had fewer night wakings. This finding is supported by previous research indicating that infants with less reactive temperamental characteristics have better sleep quality

(Atkinson et al., 1995; Jimmerson, 1991; Kelmanson, 2004; Sadeh et al., 1994; Scher et al., 1992; Spruyt et al., 2008; Weissbluth, 1981; Weissbluth & Liu, 1983). However, results indicated that infants whose mothers rated them as higher in perceptual sensitivity also had fewer night wakings. This finding is supported by previous research indicating that some more reactive temperamental characteristics are associated with better sleep quality (Keener et al., 1988; Kelmanson, 2004; Scher et al., 1998; Spruyt et al., 2008).

Somewhat more consistent results were found among the direct links between parenting and infant sleep quality. Consistent bedtime and use of bedtime routines, as well as use of a separate and stable sleep location, were associated with fewer night wakings. These findings are in agreement with previous research suggesting that more consistent bedtime routines (Mindell et al., 2009), separate sleeping arrangements (Burnham et al., 2002; Crowell et al., 1987; DeLeon & Karraker, 2007; Johnson, 1991; Mao et al., 2004; Van Tassel, 1985), and a stable sleep location (Atkinson et al., 1995; Scher & Blumberg, 1999) are associated with better infant sleep quality. However, in contrast to previous research, no direct links were found between sleep quality and either physical comfort or feeding, suggesting that the links between these parenting behaviors and infant sleep quality are more complex and may depend on infant constitutional factors.

Organismic Specificity Hypothesis

A number of significant parenting X temperament interactions emerged in the analyses, supporting the organismic specificity hypothesis. As this hypothesis suggests, specific parenting behaviors have different impacts on infants, depending on specific temperamental characteristics (Gandour, 1989, Peters-Martin & Wachs, 1984, Szabó et al., 2008, Wachs, 1983, Wachs, 1985, Wachs, 1987, Wachs & Gandour, 1983). The results of this study indeed indicated that parenting

behaviors predicted infants' sleep quality differently based on the infant's individual temperamental characteristics. Although multiple patterns emerged in the interactions, the most common was one in which parents' behavior was associated with sleep quality for infants with less reactive temperamental characteristics (low negative affectivity, high orienting/regulation, low perceptual sensitivity, low distress to limitations, high soothability), but not for infants with more reactive temperamental characteristics. This finding emerged across all parenting behaviors that were examined. In all of these interactions, the more favorable parenting behavior (the use of more consistent bedtimes and bedtime routines, less roomsharing, less instability of the sleep location, less physical comfort and less feeding at bedtime and during the night), was associated with better sleep quality for infants with less reactive temperamental characteristics.

The results suggest that infants with less reactive temperaments were more responsive to parenting influences, with respect to sleep quality, than infants with more reactive temperaments. In other words, when parents of infants with easier or less reactive temperaments maintained consistent bedtime routines and a separate and stable sleep location, and limited physical comfort and feeding at bedtime and during the night, their infants appeared to develop better sleep quality. These infants may be more malleable, therefore sleep quality may be driven primarily by the parenting they receive. However, when parents of infants with more reactive temperaments engaged in the same behaviors, the sleep quality these infants developed was not significantly different from the sleep quality of infants whose parents did not engage in these behaviors.

In addition to the most common pattern described above, other patterns of interaction emerged, and although these patterns were not as easily interpreted as the one described above, they also supported organismic specificity. Specifically, for infants low in negative affectivity, more physical comfort at night was significantly associated with more time awake during night

wakings. For infants high in negative affectivity, more physical comfort at night was significantly associated with less time awake during night wakings. Further research may be necessary to uncover why such different patterns emerged in the different temperamental groups for these specific interactions. One possible explanation for this interaction may be that for infants low in negative affectivity, physical comfort was too stimulating to effectively help the infants return to sleep quickly after a night waking. When their parents provided physical comfort during a night waking, they had more difficulty returning to sleep. Conversely, infants high in negative affectivity needed physical comfort to return to sleep after a night waking. Physical comfort helped them fall asleep more quickly, resulting in shorter night wakings.

The other pattern that emerged involved interactions between observed feeding at bedtime and orienting/regulation in predicting both frequency of infant night wakings and length of time awake during night wakings, and one interaction between observed feeding at bedtime and perceptual sensitivity in predicting length of time awake during night wakings. For each of these three interactions, although the overall interactions were significant, the slopes of the links between feeding and sleep quality were not significant, regardless of the infants' temperament scores, but they were in opposite directions from one another. Although an explanation for this pattern in unclear, it appears that the pattern of association between parenting and sleep outcomes is different, albeit not significantly so, depending on the infant's temperament. For infants low in orienting/regulation or perceptual sensitivity, more feeding was associated with more night wakings or more time awake during night wakings. For infants high in orienting/regulation or perceptual sensitivity, more feeding was associated with fewer night wakings or less time awake during night wakings. Further research is necessary to clarify these patterns. Regardless of the specific patterns of the interactions, results in the main indicate that

the impact of parenting behaviors at bedtime and during the night differ significantly based on the infant's temperament, thus supporting the Organismic Specificity Hypothesis.

Differential Susceptibility Hypothesis

In addition to supporting the organismic specificity hypothesis, this study provides some, albeit limited, evidence in support of the differential susceptibility hypothesis, which as typically framed proposes that infants with more reactive temperaments are more strongly impacted by particular parenting behaviors (Belsky, 1997a; Belsky, 1997b; Belsky et al., 1998; Belsky et al., 2007; Bradley & Corwyn, 2008; Crockenberg, 1981; Feldman et al., 1999; Kochanska et al., 2005; Kochanska et al., 2007; Stright et al., 2008; van Zeijl et al., 2007). Although support for the differential susceptibility hypothesis was, in the main, not strong, three interactions that emerged in the results also supported the more specific differential susceptibility hypothesis. For infants who were high in perceptual sensitivity, more physical comfort provided by mothers during the night was associated with more frequent night wakings. Infants with the less reactive temperamental characteristic, low perceptual sensitivity, were not influenced by parents' use of physical comfort at night. Although the differential susceptibility hypothesis would suggest that more physical comfort led to more night wakings for infants high in perceptual sensitivity, the cross-sectional nature of the present study cannot eliminate the possibility that these findings were not driven by the parent's behavior, but rather by the infant's behavior. In other words, the possibility remains that some infants with more reactive temperaments, such as high perceptual sensitivity, woke up more frequently, and elicited certain parenting behaviors, such as more physical comfort, during those frequent awakenings. Additionally, for infants whose mothers rated them as low in soothability, more feeding at bedtime was associated with more time awake during night wakings. For infants with the less reactive temperamental characteristic, high

soothability, feeding at bedtime did not impact the length of time infants were awake during night wakings. Similarly, more feeding at bedtime was associated with more frequent night wakings only for more active infants. Length of time spent feeding at bedtime was not associated with frequency of night wakings for less active infants. Though it is unclear why, this interaction emerged only for amount of feeding at bedtime and not for the proportion of the bedtime video that was devoted to feeding. Perhaps, the sheer length of time mothers feed their infants at bedtime is uniquely informative and should be taken into consideration. Again, these findings do not preclude the possibility that the infant's behavior drove these linkages.

Although the findings suggested some support for differential susceptibility, the majority of the findings of this study were not in support of this hypothesis, suggesting that there may be some conditions under which this hypothesis applies and other conditions under which it does not. For example, none of the temperamental superfactors yielded significant interactions with parenting that supported differential susceptibility. All of the interactions that supported differential susceptibility involved individual temperamental subscales. Because the superfactors represent more broad characteristics of the infant's temperament, the interactions involving the individual subscales should be interpreted with caution. The robustness of these interactions may be less replicable. Gaining an understanding for the conditions under which the differential susceptibility hypothesis is supported and when it is not supported may be an important undertaking in future research.

One of the significant interactions found in this study followed a pattern that was similar to the three interactions which supported differential susceptibility, although it did not exactly fit the criteria for this hypothesis. Specifically, parent-reported physical comfort at bedtime interacted with orienting/regulation in predicting the total amount of time infants slept. Infants

low in orienting/regulation slept significantly longer when mothers reported using less physical comfort at bedtime. Infants with less reactive temperaments, high orienting/regulation, slept significantly longer when mothers reported using more physical comfort at bedtime. This interaction supports the organismic specificity hypothesis, showing that infant sleep quality responds differently to the same parenting according to the infant's temperament. However, it does not fit the pattern that is typically represented by the differential susceptibility hypothesis, as parenting impacted the sleep quality of both more reactive and less reactive infants. Again, further research may be necessary to uncover why this pattern emerged.

Self-Report vs. Observational Data

Although methods and measurement of parenting behaviors were not a primary objective of this research, the results provided interesting insight into the circumstances under which parent-report and observational measures are either feasible or relevant. For example, whereas parent-report is easily obtained across a variety of behaviors, observations must be conducted over a limited time frame. Because certain behaviors may require measurement over a period of time that is too long to observe, parent-report may be the necessary measurement method for these behaviors, as it is not feasible to obtain measures of such behaviors through observation. Specifically, the extent to which parents maintain a consistent bedtime and use a bedtime routine cannot be observed in one night; these behaviors must be aggregated over a period of several nights to several weeks in order to capture a complete understanding of the family's pattern. Similarly, roomsharing and instability of the sleep location are behaviors that vary from one night to the next. Therefore, observation of the family on a particular night may not be valid indicators of the extent to which families engage in these behaviors. For these reasons, only self-

report measures of bedtime routines, roomsharing and instability of the sleep location were used in this study.

On the other hand, there are parenting behaviors for which both self-report and observational data are more easily obtained, including mothers' use of physical comfort and feeding at bedtime and during the night. The collection of both self-report and observational data for these variables allowed for an interesting comparison between these two methods of data collection. Preliminary analyses indicated that mothers' reports of their own use of physical comfort at bedtime and during the night were not significantly correlated with observational measures of the same behaviors. Results indicated that mothers' reports of their own use of physical comfort and feeding at bedtime and during the night did not link up with infant sleep quality either directly or in interactions with temperament, with one exception: self-report of physical comfort at bedtime interacted with infants' rates of orienting/regulation in predicting the total length of time that infants slept. However, a variety of links emerged between observational measures of physical comfort and feeding, both at bedtime and during the night, and infant sleep quality in interactions with temperament. Thus, self-report of specific parenting behaviors such as physical comfort and feeding may not capture the true scope and nature of these behaviors, as observational measures are capable of doing.

Limitations

A major limitation of this study was the small sample size. With only 36 dyads in the sample, statistical power was limited. A larger sample size may yield even more robust relationships among the variables for which significant interactions emerged, and may yield additional significant interactions where they did not emerge in this sample. It is encouraging, nevertheless, that despite the small sample size, a number of statistically significant interactions

emerged between parenting and temperament, most of which indicate that parenting's links with infant sleep quality depended on infant temperamental reactivity. Another limitation of this study was the homogeneity of the sample. Because the sample was predominantly White, the results cannot be generalized to other ethnicities. Additionally, although the observational data was a strength of this study, a single night of observation may not be representative of a typical night for some families.

The results of this study suggest that maternal report may not be the optimal method of measurement of certain behaviors, including mothers' use of physical comfort and feeding. Similarly, maternal report of infant temperament and infant sleep quality may also be a limitation of this research. Specifically, as infants age, their temperamental characteristics may become confounded by patterns of interaction with their mother. When mothers are asked to reflect on their infants' temperamental characteristics, their responses may be an artifact of the relationship that has developed within the dyad over time. Maternal report of infant sleep quality may be an additional limitation of this research, considering that mothers with separate sleeping arrangements may only be aware of infant night wakings for which the infant signals for parental assistance. Research has shown that infants who develop self-regulated sleep often awaken throughout the night and return to sleep on their own without signaling to parents (Burnham et al., 2002). Obviously, if mothers are not aware of these occurrences, they cannot report them.

Another limitation of this study was its cross-sectional nature. Because the data were not longitudinal, direction of effects is unknown. Parenting practices may have led to increases in sleep problems, as the conclusions of this study suggest. However, the results of this data cannot exclude the possibility that children with more sleep difficulties elicited particular parenting practices, particularly for parenting practices such as length of time spent feeding, which may be

primarily driven by the infant. Additionally, as discussed above, interactions between parents and infants during nighttime may be primarily driven or elicited by the infant. Nevertheless, feeding and physical comfort may still be considered factors controlled by the parent because parents can choose how they respond to infant distress at bedtime and during the night. Some parents may choose not to feed or provide physical comfort at bedtime and during the night, or they may choose to set limits on the amount of time they will interact, despite their infants' efforts at eliciting such attention.

Finally, because all of the data for these analyses was collected from families within the span of one week, the results indicate only the short-term impact of parenting on infant sleep quality. Generalizations about the long-term impacts of parenting on infant sleep development or other related outcomes cannot be extrapolated from these results. Furthermore, the organismic specificity and differential susceptibility hypotheses are framed around long-term developmental outcomes, whereas the present study predicted outcomes across a span of 10-12 hours by examining parenting behaviors at bedtime and during the night and infants' subsequent sleep quality. Although these hypotheses suggest that more long-term predictions of child sleep outcomes can be drawn based on parenting behaviors and temperament, such conclusions should be made with caution, as the time span of the current data was greatly limited.

Future Directions

Future research examining the relationships between infant temperament, parenting and sleep quality should include longitudinal data, in order to shed light on the direction of effects among these variables. Additionally, father involvement at bedtime and during the night may also contribute significantly to the development of infant sleep quality; certainly attention should be given to the role that fathers play in bedtime and nighttime infant care. Future research should

also consider a more ethnically diverse sample, to distinguish the role that ethnic and cultural background and beliefs may play. Upcoming studies may also consider extending observations over multiple nights, to ensure a representative pool of data. Additionally, the findings of this study speak to the importance of observational measures of parenting behaviors. Observational measures may also be particularly important for measures of infant temperament and sleep outcomes, and future research should incorporate observational data when it is feasible, because maternal report of these measures may be biased or incomplete.

Conclusions

The findings of this study suggest that infant sleep quality is not a simple function of parenting or infant temperament alone. Rather, a complex, interactive relationship appears to exist between parenting and temperament in the prediction of infant sleep. This study was the first to examine and identify infant temperamental characteristics as moderators of relations between specific parenting practices and infant sleep quality. The approach taken in this study is supported by well-established theoretical perspectives that view developmental outcomes as products of organismic-environmental transactions. Future work, assessing the impact of parenting-temperament transactions on infant sleep from birth onward, would be valuable to the field.

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