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A Longitudinal Examination of Bedtime Routines and Sleep in Toddlers

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A LONGITUDINAL EXAMINATION OF BEDTIME ROUTINES AND SLEEP IN TODDLERS

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Ample research has examined the impacts of sufficient and high-quality sleep on children's health, development, and well-being (Chen, Beydoun, & Wang, 2008; Gregory & Sadeh, 2012; Touchette et al., 2009), yet less research has focused on the factors that contribute to sufficient and high-quality sleep in early childhood. The bedtime routine is one environmental influence on children's sleep that has received little attention in the literature base and therefore is the focus of the current study.

In a sample of 399 30-month old toddlers studied over the course of one year, three aims were investigated: the within-age consistency of the bedtime routine on a nightly basis and how bedtime routine consistency impacts sleep outcomes; the longitudinal stability of bedtime routines across time; and the child characteristics, specifically temperamental negative affect, that impact the bedtime routine and sleep outcomes. Five main findings emerged: (a) children experience variability in their bedtime routines when measured on a nightly basis; (b) nightly variability in the length of the bedtime routine is more important for sleep outcomes than is nightly variability in the activities of the bedtime routine; (c) nightly sleep does not impact bedtime routines the following night; (d) bedtime routines are stable across time; and (e) negative affect is not associated with bedtime routines or sleep. The findings from the present study represent

a contribution to the field in what is known about the complex interplay between bedtime routines and sleep in young children.

DEDICATION

This dissertation is dedicated to my loving husband Richard, and all three of my children, Joe, Brittany, and Olivia. You each have made me the person I am today, and this would not have been possible without you. I love you.

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CHAPTER 1: INTRODUCTION

The present study is an examination of bedtime routines and sleep in early childhood. Sleep, in general as well as in early childhood, is the result of complex bio-psycho-social influences (Tikotzky, 2017). Brain maturation, melatonin secretion, and medical problems such as sleep-disordered breathing or chronic ear infections are all biological processes that influence child sleep, while the impact of parents' work schedules and children's school/childcare attendance on children's sleep schedules is an example of a social influence (El-Sheikh & Sadeh, 2015). Parent-child interactions during the bedtime routine are crucial psychological influences on children's sleep, and the focus of the current study.

There is a rich body of evidence that highlights the importance of adequate and high-quality nighttime sleep for children, linking sleep problems and deficits to a host of negative outcomes in the realms of social/emotional, behavioral, cognitive, and physical health (e.g.: Chen, Beydoun, & Wang, 2008; Geiger, Achermann, & Jenni, 2010; Gregory & Sadeh, 2012; Touchette et al., 2009). Bedtime routines, the set of predictable or consistent activities in which families engage in on a nightly basis in the hour or so before lights out (Mindell, Sadeh, Kwon, & Goh, 2015; Mindell & Williamson, 2017), and their relations to sleep outcomes in children have been examined less frequently in the literature. Of the few studies that have been conducted, bedtime routines have been found to relate to better sleep outcomes for children, including less time to fall asleep, fewer night wakings, and longer nighttime sleep duration (e.g. Jones & Ball, 2014; Mindell & Williamson, 2017). However, gaps still remain in our understanding of the complex interplay of how bedtime routines relate to nighttime sleep outcomes for toddlers, which is the aim of the current study.

Bedtime routines are an interesting context in which to study family processes because they involve not just utilitarian caretaking tasks such as giving a bath or brushing teeth, but also interactive stimulation for a child, such as reading or singing lullabies. Further, bedtime routines can be conceptualized as representing opportunities for reinforcement of the familial bond in order to calm children and make them feel safe enough to fall asleep. The Transactional Model of Development (Sameroff 1975; Sameroff & Chandler, 1975) is the organizing framework for the present study. This model asserts that development is the result of ongoing, bidirectional transactions between a child and their caregiving environment with special emphasis on parent-child interactions. As will be explored, bedtime routines are a transactional process wherein parents and children each contribute to the interaction. These routines are enacted with the goal of aiding the child in falling asleep and ensuring children have sufficient and high-quality sleep with few, if any, wakings.

Bedtime routines are practically universal: between 81% and 95% of parents of young children report enacting some sort of bedtime routine, yet bedtime routines can vary widely between families and even between nights within the same family (Mindell & Williamson, 2017). Despite their prevalence and their importance for contributing to positive sleep outcomes in young children, bedtime routines themselves are not frequently studied. Little work has been done examining the characteristics of bedtime routines themselves, individual differences in bedtime routines, and changes in bedtime routines with maturation. Using a longitudinal design examining toddler-aged children across a one-year age span, the current study aims to elucidate what is not yet known about bedtime routines and sleep: (a) how consistent bedtime routines are on a night to night basis; (b) if bedtime routines change across time as children mature; and (c) how child-level characteristics such as temperament influence bedtime routines and sleep outcomes. The knowledge gained from this research is important because it will provide researchers and practitioners practical information on how parents can use bedtime routines to foster positive sleep practices and improve sleep outcomes in toddlers.

CHAPTER 2: LITERATURE REVIEW

There is ample evidence that sufficient and high-quality sleep in early childhood is vitally important for optimal health, development, and well-being. However, it is important when interpreting this evidence to consider the variety of ways in which sleep has been defined and operationalized, how sleep has been measured, and how sleep has been reported as relating to social-emotional/behavioral, cognitive, and health related outcomes. This review will begin with an overview of different sleep measures and how they are defined, then a synopsis of average sleep quantity in early childhood focusing on the toddler period, followed by an examination of the prevalence of sleep problems and their consequences for children's development. Then, the review will highlight what is known about bedtime routines in young children – an important contributor to measures of children's sleep outcomes. Drawing upon the Transactional Model of Development (Sameroff 1975; Sameroff & Chandler, 1975) as its guiding framework, this review will examine how sleep outcomes, including timing, quantity, and quality, and bedtime routines are best studied and understood from a transactional perspective. Finally, this review will summarize what is known, and what still needs to be known, about sleep timing, quantity, and quality, and bedtime routines, as well as identify research questions to address these knowledge gaps to move the field forward.

Sleep in Early Childhood

Sleep measures. There are three broad domains of sleep measures in pediatric sleep research: sleep timing, sleep quantity, and sleep quality (Acebo, Sadeh, Seifer, Tzischinsky, Hafer, & Carskadon, 2005; Dewald, Meijer, Oort, Kerkhof, & Bogels, 2010; Iwata, Iwata, Iemura, Iwasaki, & Matsuishi, 2012; McDonald, Wardle, Llewellyn, van

Jaarsveld & Fisher, 2014; Taylor, Williams, Farmer, & Taylor, 2015). The first domain is *sleep timing* which is often measured by: (a) bedtime, which is the parent report of when the child was in bed for the night; (b) sleep onset time, which is the time child fell asleep and is based on parent report or objectively measured via actigraph; (c) wake time, which is the parent report of when the child awoke in the morning; and (d) sleep offset time, which is the actigraph record of when the child awoke. *Sleep quantity* is the second domain and is typically measured by either parent or actigraph report. Sleep quantity can be reported as nighttime sleep duration, which includes sleep occurring only at night, or for a 24-hour sleep duration, which includes nighttime sleep plus any daytime naps. The third domain, *sleep quality*, includes measures of sleep latency/difficulty falling asleep, night wakings, and sleep efficiency. Sleep latency is the time it takes for a child to fall asleep from the time the parent reported them in bed (bedtime) to the time the child actually fell asleep (sleep onset). Difficulty falling asleep is a subjective parental judgement of how difficult it is for their child to settle enough to fall asleep. Night wakings can either be reported as a frequency (i.e. number of times a child woke up during the night) or as a duration (i.e. total length of time spent in bed awake). Finally, sleep efficiency is the percentage of time spent in bed that a child is actually asleep.

Researchers typically measure children's sleep two ways: parent report (either via daily sleep diaries or global ratings as described above) and actigraphy. Actigraphy is a non-invasive method for monitoring periods of rest and activity that involves wearing a small portable device resembling a watch that records movement. Actigraphy has been established as a valid and reliable method for measuring children's sleep (Acebo, Sadeh, Seifer, Tzischinsky, Hafer, & Carskadon, 2005; Sadaka et al., 2014; Sadeh & Acebo, 2002; Sadeh, Lavie, Scher, Tirosh, & Epstein, 1991). When actigraphy is used, it is frequently accompanied by a daily sleep diary, which is used to aid in verifying and scoring the actigraph data to provide accurate estimates of children's sleep. Parental report of children's sleep typically overestimates when compared to actigraph records (Dayyat, Spruyt, Molfese, & Gozal, 2011; Molfese et al., 2015; Nelson et al., 2014). For example, in a study of 327 children ages three to ten years old, Dayyat et al. (2011) found that parents overestimate their children's sleep duration by over an hour each night, while Nelson et al. (2014) found that parents overestimate their children's nightly sleep duration by an average of 24 minutes each night, in a sample of 217 children aged four to nine years old. In a study of 64 toddler children aged 30 months, Molfese et al., (2015) found that parents overestimate their children's nightly sleep duration by over two hours a night.

Part of this overestimation can be attributed to parents being unaware of their child's night wakings, or of when their child actually falls asleep or wakes up in the morning. In contrast, actigraph recordings use an algorithm developed and validated for use with pediatric populations (Sadeh, Alster, Urbach, & Lavie, 1989) to determine accurate sleep onset and wake times, as well as subtracting out any night wakings, among other sleep measures. As such, actigraphy is often considered to be an "objective" measurement of children's sleep in comparison to parent report. Nevertheless, actigraphy is subject to drawbacks as well including device failure (actigraph unexpectedly breaks or quits collecting data), participant noncompliance (child refusing to wear actigraph), and wrongfully scoring active sleepers or car naps as wake periods (Sadeh & Acebo, 2002).

Average sleep quantity in early childhood. The National Sleep Foundation recommends that toddlers (ages one to two) get 11 to 14 hours of sleep at night and preschoolers (ages three to five) get 10 to 13 hours of sleep at night (Hirshkowitz et al., 2015). However, strong evidence reported in research studies suggests that there is variability in how much sleep young children actually get at night (sleep quantity). For example, in a meta-analysis of 34 studies from 18 different countries, parents reported that their children ages 2-3 years got on average 12 hours of sleep at night, while children ages 4-5 years old got 11.5 hours of sleep at night (Galland, Taylor, Elder, & Herbison, 2012). A large telephone poll of 1,473 parents of children ages 10 and younger found that parents of toddlers aged 12-35 months reported an average 9.8 hours of sleep at night (Mindell, Meltzer, Carskadon, & Chervin, 2009). In an online survey of over 5,000 parents of infants and toddlers in the US and Canada, parents reported that toddlers aged 18-23 months slept an average of 10.3 hours per night and children ages 24-36 months slept on average 10 hours per night (Sadeh, Mindell, Luedtke, & Wiegand, 2009). In their study of 2,041 toddlers, Hysing et al. (2016) reported the mean duration of sleep in toddlers was 12 hours 27 minutes per night. In contrast, in a cross-sectional study of 169 children ages 1 - 5 years old, Acebo, Sadeh, Seifer, Tzischinsky, Hafer, and Carskadon (2005) used parent report and actigraph records of children's sleep and found that actigraph estimates for children's sleep was 8.7 hours per night, while parent report of children's time in bed ranged from 10.4 to 11.4 hours per night. Some of these differences in reported sleep duration for young children can be attributed to age of the child. Sleep-wake patterns evolve rapidly during the first years of life (Sadeh, Mindell, Luedtke, & Wiegand, 2009) and may not be stable across early childhood. For example, Taylor et al. (2015) found that total sleep duration and nighttime sleep duration declined with age in early childhood. It is important to note, however, that differences in how individual studies demarcate the ages that include infants vs. toddlers vs. preschoolers can impact reports of average sleep duration for each age range.

Prevalence of sleep problems in children. Sleep problems as reflected by measures of sleep quality, such as sleep latency/difficulty falling asleep, night waking, and sleep efficiency, can be common in young children. Sleep problems are a main reason parents seek professional help regarding their child's sleep (Sadeh et al., 2009; Tikotzky, 2017). Several studies have reported on the prevalence of sleep problems in pediatric populations. For example, Hysing et al. (2016) reported in their study of over 2,000 Norwegian two-year-olds that 54% of mothers reported their toddlers experiencing 1-2 night wakings per night and 10% had a sleep latency longer than 30 minutes. Mindell et al. (2009) reported that 46.4% of American toddlers in their study had at least one waking per night and 10.5% had a sleep problem (other than night waking) as reported by their mothers. In their study of nearly 5,000 children 4- to 5-years old, Hiscock et al. (2006) reported that 12.8% of Australian mothers reported their child experiencing difficulty falling asleep, 18.1% of mothers reported at least one waking per night, 19.8% of mothers reported an unspecified mild sleep problem, and 13.8% of mothers reported an unspecified moderate or severe sleep problem in their children.

A few studies have examined demographic correlates of sleep problems in young children. Acebo et al. (2005) found that low socioeconomic status (SES) was associated with more actigraph recorded night wake minutes and episodes, and more night-to-night variability in the bedtime and sleep quantity. In another study of 1,702 children aged 14-

27 months, researchers found that lower maternal education, non-white background, being male, low birth weight, living in a home with >1 older child, and watching >1 hour of TV in the evenings were all independently associated with parent-reported shorter sleep duration, defined as less than 11 hours of sleep per night (McDonald et al., 2014). Taken together, these studies report that between 18% and 50% of children experience at least one waking per night and between 10% and 20% of children experience some other type of sleep problem. Given the prevalence of sleep problems in early childhood, it is important to understand how sleep problems can impact children's behavior and development.

Sleep and social-emotional/behavior problems. Sleep problems are associated with social-emotional and behavioral problems in young children. In a study of 2,041 Norwegian toddlers aged 2 years old, mothers reported on their child's sleep and social emotional adjustment (Hysing et al., 2016). They found that sleep problems, including short sleep duration, night wakings, and difficulties falling asleep were associated with social-emotional problems (such as hitting others or crying/tantrums) in a dose-dependent manner, such that the more sleep problems that were reported by mothers, the more social emotional problems were also reported (Hysing et al., 2016). Mindell, Leichman, DuMond, and Sadeh (2017) studied sleep and social-emotional development in 117 mother-child dyads. Infant sleep was assessed via maternal report at ages 6, 12, and 18 months, and social-emotional problems were assessed at 6, 12, and 18 months. Mindell et al., (2017) found that later bedtimes and less total sleep time across the 24-hour period predicted higher internalizing problem scores, including depression/withdrawal, general anxiety, separation distress, and inhibition.

In a population-based study of over 32,000 children in Norway, Sivertsen et al. (2015) examined relations between sleep problems in toddlers and later emotional and behavioral problems at preschool age. Sleep duration and night wakings were assessed via maternal report at 18 months, and internalizing and externalizing behavior problems were assessed via maternal report on the Child Behavior Checklist (Achenbach & Rescorla, 2001) at 18 months and 5 years old. Sivertsen et al. found that sleep duration of less than 13 hours in a 24-hour period was concurrently associated with an increased risk of internalizing and externalizing behavior problems at 18 months, while sleep duration of less than 12 hours at night was associated with increased risk of internalizing and externalizing behavior problems at 5 years old. In addition, more than three night wakings per night at 18 months old was associated with more internalizing and externalizing behavior problems at 5 years old. Touchette et al. (2009) investigated the developmental trajectories of nighttime sleep duration and hyperactivity from 1.5 to 5 years old in a sample of 2,057 mothers and their children, and found that the trajectories of nighttime sleep and hyperactivity were significantly associated, such that the children in the "low hyperactivity" trajectory were most likely to be in the "11 hr persistent sleepers" trajectory, while the "high hyperactivity" trajectory were most likely to be persistently short sleepers.

Williams, Berthelsen, Walker, and Nicholson (2017) examined relations between behavioral sleep problems and emotional and attention regulation in a longitudinal population-based study in Australia. Mothers reported on sleep problems, emotional dysregulation, and attentional regulation biennially from 0-1 years to 8-9 years of age on 4,109 children. Behavioral sleep problems included: difficulty falling asleep, not happy to sleep alone, night waking, and restless sleep. Emotional dysregulation included behaviors such as: child cries in spite of soothing, and irritable all day. Attention regulation included: goes back to same activity after interruption, stays with activity for long time. Williams et al. found that behavioral sleep problems predicted emotional dysregulation two years later, from infancy to 8-9 years old, while behavioral sleep problems did not have the expected negative effect on attention regulation until ages 6-7 years old. They also found stability in sleep problems across time, suggesting that early sleep problems persist into at least middle childhood. In sum, sleep problems have been consistently linked with social/emotional and behavioral problems, from infancy through middle childhood.

Sleep and cognitive/school performance. Sleep problems also impact cognitive functioning and school performance, although most research evidence comes from studies conducted on school-age children. For example, in a meta-analysis of 86 studies on 35,936 children aged 5-12 years old, Astill, Van der Heijden, Van Ijzendoorn, and Van Someren (2012) found that sleep duration was positively correlated with cognitive performance, executive functioning, and school performance, but was not correlated with sustained attention and memory. Geiger, Achermann, and Jenni (2010) examined relations between sleep duration and intelligence scores in 60 healthy German children aged 7-11 years old. Sleep duration was assessed via questionnaires, actigraphy, and sleep diaries, and intelligence was assessed via the German version of the Wechsler Intelligence Scale for Children (WISC-IV; Petermann & Petermann, 2007). Somewhat counterintuitively, regression analyses found a negative association between weekend sleep duration and IQ scores, with a predicted increase of 6.11 IQ points associated with each hour of shorter sleep duration, while sleep duration on weekdays was unrelated to IQ scores. Geiger et al. (2010) posited that children with higher daytime cognitive efficiency, reflected as higher IQ scores, also showed increased nighttime efficiency, reflected as shorter sleep duration, but offered no explanation as to why only weekend sleep was related to IQ. In another meta-analysis of 26 studies on children ages 8-18 years old, Dewald et al. (2010) found better sleep quality, longer sleep duration, and less daytime sleepiness were each independently associated with better school performance. In one study on preschool children, Molfese, Beswick, Molnar, and Jacobi-Vessels (2009) examined relations between parent reported sleep duration, problem behaviors, health status and letter knowledge in 60 pre-kindergarten children. They found that the children who slept more than 10 hours per night were more likely to make larger gains in letter knowledge across the school year. Taken together, sufficient and high-quality sleep has implications for children's cognitive and school performance.

Sleep and health. There is also some evidence that sleep problems relate to physical health and obesity in children. In a national population study of 4,983 children ages 4-5 years in Australia, Hiscock et al. (2006) found that children with a mother-reported sleep problem (either mild or moderate/severe) had lower health related quality of life, as indexed by physical, psychosocial, and total health measures. Chen, Beydoun, and Wang (2008) conducted a meta-analysis of 17 studies examining relations between sleep duration and obesity in children 0-18 years old, and found that children with shorter sleep duration had a 58% higher risk for overweight or obesity. In addition, there were no age-related differences in the relation between short sleep duration and higher risk for overweight or obesity. In sum, some evidence indicates that sleep in young children may have implications for their physical health as well.

Given the reports of the impacts of sleep problems on social-emotional/ behavioral, cognitive and health-related outcomes in young children, it is crucial to understand the factors that contribute to sufficient and high-quality sleep. One of those factors is the bedtime routine. A bedtime routine is defined as the predictable activities that occur in the hour or so before lights out, and before the child falls asleep (Mindell, Sadeh, Kwon, & Goh, 2015; Mindell & Williamson, 2017). The American Academy of Pediatrics recommends implementing regular bedtime routines and activities so that children associate the pre-bedtime period with sleep, and to help cue them for falling asleep (Cohen, 1999). The following section will review what is known about bedtime routines in young children.

Bedtime Routines

Consistency of the bedtime routine on a nightly basis. There is evidence that regular and consistent bedtime routines are associated with more positive sleep outcomes including shorter time to fall asleep, fewer night wakings, less bedtime resistance, and longer nighttime sleep duration (Jones & Ball, 2014; Mindell, Kuhn, Lewin, Meltzer, & Sadeh, 2006; Morgenthaler, Owens, Alessi et al., 2006; Staples, Bates, & Petersen, 2015). Underscoring the importance of a consistent bedtime routine, in a cross-sectional study of over 10,000 children aged 0-5 years from 14 different countries, Mindell et al. (2015) reported a dose-dependent association between the bedtime routine and sleep measures. Parents were asked, "In a typical week, how often does your child have a regular bedtime routine?" with answer choices including "never," "1-2 nights per week," "3-4 nights per week," "5-6 nights per week," and "every night." As the number of nights per week that a child followed the same bedtime routine increased, there were linear improvements in sleep outcomes, including earlier bedtimes, shorter sleep latency, fewer night wakings, and longer sleep duration.

Evidence from large-scale studies in the United States have estimated that between 81% and 95% of parents of young children (birth to five years old) report having a bedtime routine (Hale et al., 2009; Mindell et al., 2009). Despite the overwhelming majority of families with bedtime routines for their children, little is known about the extent to which bedtime routines are implemented on a nightly basis. In one study of 3,217 low-income families with preschool children, 81% of the sample reported having a bedtime routine, but only 71% reported using the bedtime routine on 4 of the last 5 weeknights (Hale et al., 2009). They also found socio-demographic differences in use of bedtime routines with Black, Hispanic, and socially disadvantaged families less likely to implement bedtime routines on a nightly basis. In a study of mostly low-income children aged 1-7 years, only 44% of caregivers reported that their child followed a bedtime routine on a nightly basis (Yoo, Slack, & Holl, 2010).

Thus, there are discrepancies between having a bedtime routine and implementing a bedtime routine on a consistent, nightly basis. In addition, the few studies that have examined the consistency of the bedtime routine in early childhood have relied on a global parent rating, typically assessed via a single question asking parents how consistently they implement their bedtime routine. For example, in the Hale et al. (2009) study, parents were asked to identify the bedtime routine that they had followed on 4 of the past 5 weeknights, and, in the Yoo et al. (2010) study, parents were asked how often they followed a bedtime routine on a six-point scale ranging from "every day" to "never". While global ratings can give researchers a general idea of how consistent bedtime routines are in a sample, these ratings may be more reflective of parents' "idealized" bedtime routine (or consistency thereof) because parents are being asked to retrospectively identify the bedtime routine from the past several nights or estimate how often the same routine is typically implemented. In contrast, obtaining daily reports on the bedtime routine via a daily sleep diary may help to ameliorate this drawback to global ratings because parents are asked nightly what they did that night, reducing recall bias, and are not asked to make judgment calls about how consistent the routine was for the past several days. In one notable example, Staples et al. (2015) asked parents of 87 toddlers to report daily on the bedtime routine activities completed each night in a sleep diary for 7 consecutive nights. The researchers defined those activities that were completed on all seven nights of the sleep diary as being a part of the "regular" routine, while any activities that were completed on some but not all of the nights as an "irregular" part of the routine. These researchers reported that greater adherence to a bedtime routine was concurrently associated with more nighttime sleep at 36 and 42 months old. Therefore, consistent bedtime routines may be associated with positive sleep outcomes, yet very little is known in terms of how consistent bedtime routines are actually implemented as reported on a nightly basis. In addition, it is unknown if nightly variations in the bedtime routine relate to sleep outcomes on that night.

Longitudinal stability of bedtime routines. As adults transition to parenthood, they begin reorganizing their lives to include the demands of child-rearing (Fiese, Tomcho, Douglas, Josephs, Poltrock, & Baker, 2002), part of which includes establishing new routines, including bedtime routines. As their child grows and develops throughout early childhood, such routines evolve and change over time (Fiese, 2006) to accommodate changes in child characteristics, be aligned with parental competencies, and reflect the family goals and values (Spagnola & Fiese, 2007). Some research has found evidence that family routines change across time, such that parents of infants reported fewer predictable routines compared to parents of preschoolers (Fiese et al., 2002; Spagnola & Fiese, 2007). Fiese and colleagues speculated that as children mature and become more active participants in family life, routines may become more regular and predictable, suggesting that routines change across time.

With bedtime routines specifically, some research has found that it is during the preschool and early school years when families begin to negotiate and make compromises around bedtime routines (Nucci & Smetana, 1996). Developmental shifts from infancy to early childhood potentially serve as perturbations to the family system, requiring reorganization (Peltz, Rogge, Sturge-Apple, O'Connor, & Pigeon, 2016). For example, Mindell and Williamson (2017) reported that feeding and bathing are among the most common bedtime routine activities for both infants and toddlers, but in comparison to infants, a much smaller number of toddlers are rocked at bedtime, and a much larger number of toddlers are engaged in more active behaviors, such as singing songs, reading books, or running around.

While meager, the cross-sectional evidence cited above on differences in bedtime routines between infants and toddlers suggests that bedtime routines change across time. However, to my knowledge, no studies have included longitudinal examinations of whether and how the bedtime routine changes across early childhood. A longitudinal study is needed in order to determine whether bedtime routines do in fact change across time as part of a normative developmental course, and if there are discrete events in family life that may lead to changes in the bedtime routine (e.g., addition of a sibling).

Bedtime routine activities and types. Some studies have examined the actual activities that comprise bedtime routines. Mindell and Williamson (2017) reported that the bedtime activities typically fall within the broader domains of nutrition (e.g. feeding, healthy snack), hygiene (e.g. bathing, oral care), communication (reading, singing lullabies), and physical contact (e.g. massage, cuddling/rocking). In contrast, Hale and colleagues (2009, 2011) examined the activities in the bedtime routine in over 3,000 children aged three to five as they related to socio-demographic characteristics and sleep, cognitive, and behavioral outcomes. In their 2009 study, parents were asked to report on which routine activities they engaged in at least four of the last five weeknights, and these reported activities were assigned to five non-mutually exclusive categories of bedtime routines: (a) interactive with parent (read/tell story, pray, talk, sing, play game, cuddle); (b) non-interactive with parent (give child toy, other); (c) watch television or a video; (d) eat a snack; and (e) hygiene-related (bathe, use toilet, brush teeth). Use of interactive and hygiene related routines were most common, with 60% and 58% respectively, followed by non-interactive routines (26%), eating (15%), and television/video watching (11%). These routine types were not mutually exclusive; a majority of families reported implementing only one (22%) or two (35%) types of routines, and the most common overlapping bedtime routine types were interactive and hygiene-related routines (Hale et al., 2009). Hale et al. (2009) reported that interactive and hygiene-related routines were associated with a number of socio-demographic factors. Interactive routines were associated with maternal age, race/ethnicity, education and vocabulary knowledge, and income-to-poverty status, while use of hygiene-related routines was associated with maternal education, maternal work, maternal first language, and income-to-poverty status.

Hale et al. (2011) were specifically interested in the use of language-based bedtime routines, which they defined as reading or telling a story, praying, talking, singing, and/or playing a game, and their relations with sleep duration, cognitive skills as measured by the Peabody Picture Vocabulary Test – Revised (PPVT-R; Dunn, Dunn Robertson, & Eisenberg, 1981), and internalizing and externalizing behavior problems, as measured by the Child Behavior Checklist (CBCL; Achenbach, 1992). They found that the use of language-based bedtime routines was associated with increased sleep duration and verbal ability, even after controlling for child, mother and household characteristics, but associations with the behavioral outcomes were non-significant after controlling for child, mother, and household characteristics. They also found that Black, less educated, single-mothers, and low-income families were significantly less likely to report use of language-based bedtime routines than parents from other socio-demographic groups.

Theoretical Framework

The development of sleep patterns in young children is a complex process that is influenced by both biological mechanisms and environmental influences (Tikotzky, 2017). The current study uses the transactional model of development (Sameroff, 1975; Sameroff & Chandler, 1975) as the guiding framework for understanding these complex processes as they specifically relate to sleep and bedtime routines. Following is an overview of the transactional model of development and a discussion of how the transactional model could be applied in understanding findings from studies of children's sleep and bedtime routines.

Transactional model of development. The transactional model of development was developed by Sameroff and colleagues within the context of biological risk and environmental trauma (Sameroff, 1975; Sameroff & Chandler, 1975). The transactional model was designed to examine why some children, due to biological risk factors (e.g., premature birth) or environmental risks (e.g., experiencing child abuse or neglect), develop normally with few residual effects of the risk or trauma, while others experience developmental challenges and delays. Indeed, there are reports in the "resilience" literature of children thriving despite growing up in the worst of environments, and conversely, children with no identifiable biological problems and raised in the best of environments exhibiting developmental deviations (Sameroff, 1975, 2009). Sameroff and colleagues posited that children are neither doomed nor protected by their own biological characteristics or environments alone, and that development, positive or negative, occurs within a series of ongoing transactions between the child and his/her environment such that each is altered by the other (Sameroff, 1975, 2009).

Sameroff (1975) proposed that there were three models for understanding development: a main effects model, an interactional model, and a transactional model. The nature vs. nurture debate most aptly embodies the main effects model: either biology or environment is considered to be the sole contributor to later developmental outcomes and these influences are completely independent of one another. In a main effects model, development is a linear chain of simple causes and invariant effects (Sameroff, 1975; Sameroff & Chandler, 1975). For instance, if one was interested in the relationship between abusive parenting and maladaptive child outcomes from a main effects paradigm, one would argue that abusive parenting is the only cause for maladaptive outcomes in children (efficient cause) and abusive parenting will always lead to maladaptive outcomes for all children (invariant effects).

In contrast, an interactional model takes both biology and environment into consideration, and development is impacted by interactions between the two (Sameroff, 1975). While the interactional model is an improvement over the main effects model because it considers the impacts of interactions between biology and environment, it falls short because it incorrectly assumes that good or bad biology or environments can be defined independently from one another, that these evaluations will persist over time (i.e., a "good" environment will always be a good environment, a "bad" biological trait will always be bad), and perhaps most importantly, the structure and influence of biology and environment will remain constant across time (Sameroff, 1975, 2009). In short, an interactional model assumes that neither the child's biology nor the environments will change as a result of their ongoing interactions (Sameroff, 1975, 2009).

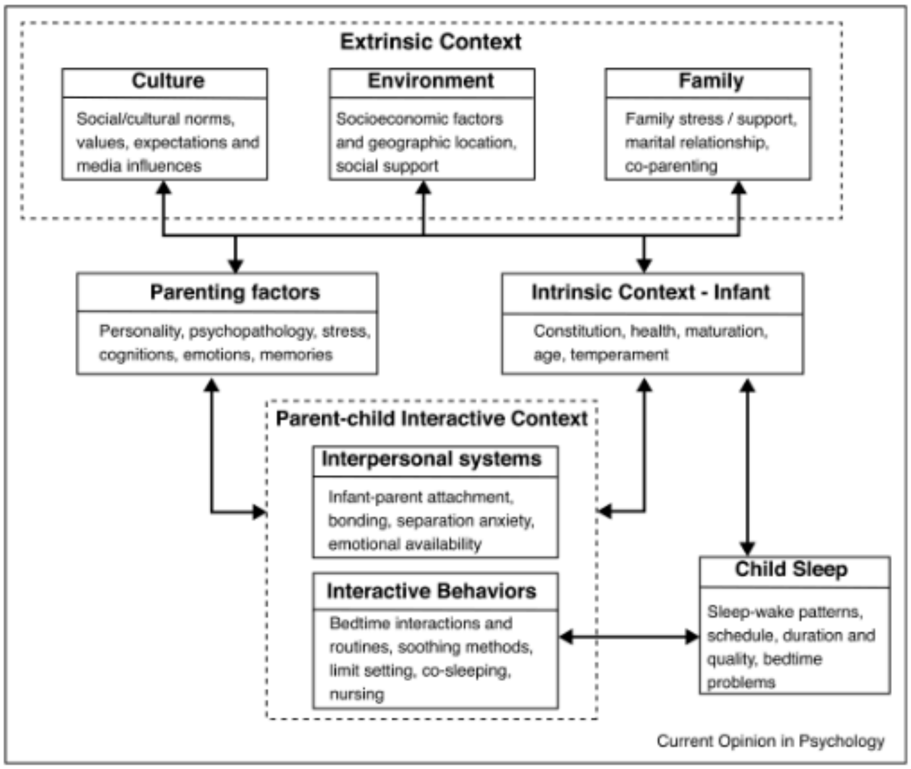
The transactional model moves from static interactions, in which biology and environment influence behavior the same way every time, to dynamic transactions, in which the activity of one changes the activity of the other. This could occur either quantitatively by increasing/decreasing the usual behavior or qualitatively by eliciting or initiating a new behavior (Sameroff, 2009, p. 24; Sameroff & Chandler, 1975). In other words, in a transactional model both biology and environment are interdependent and change as a result of their mutual influence on each other (Sameroff & Chandler, 1975).

Since it was first proposed, the transactional model of development has expanded beyond a biological risk/environmental trauma perspective to a more general theory of child development resulting from continuous dynamic interactions between the child's individual characteristics and their environment, with special emphasis on the experiences provided by a child's family and social context (Sameroff, 2009; Sameroff & Mackenzie, 2003). What is different about the transactional model of development from other theories is that equal emphasis is placed on bidirectional effects between children and their environments – children affect their environments and environments affect children (Sameroff, 2009; Sameroff & Mackenzie, 2003). A child's environment in the transactional model specifically refers to parent-child interactions. Moreover, these bidirectional effects are interdependent and dynamic and obey temporal precedence. For instance, a child's behavior changes the caregiver's expectations of their child, which in turn changes the caregiver's behavior towards the child, which then changes the child's behavior (Sameroff & Mackenzie, 2003). This is in contrast to the proximal processes as outlined in Bronfenbrenner's bioecological model (1994), which assumes that interactions between parent and child are static – the interaction between the two does not change across time as a result of their interactions.

A limitation to current developmental research is that a failure to find statistical links between two variables that should be linked theoretically is most often attributed to an inability to accurately identify the critical links in the chain of causation (Sameroff & Chandler, 1975). Due to constraints on research or sample size, critical covariates are not included or an unidentified third variable is not investigated. Alternatively, from a transactional perspective, predictive failures are instead attributed to a lack of adequate knowledge and appropriate temporal testing of the complex mutual influences between the child and environment (Sameroff & Chandler, 1975). Emphasis moves away from the domain of identifying and separating the biological and environmental causes, towards focusing on and understanding the integrative and organizing capacities of the whole organism – the adaptiveness of the relationship between the individual child and their environment (Mackenzie & McDonough, 2009; Sameroff & Chandler, 1975). Thus, the transactional model is multivariate, dynamic, endogenous, heterogeneous, and path-dependent, and involves multiple individuals (Gonzalez, 2009). For a model to be transactional, researchers need to include all levels at which behavior is organized and given meaning (Sameroff, 2009), including not just the child- or parent-level variables, but also the interactions between the two.

Sleep and the transactional model. Sadeh and Anders (1993) adapted the original transactional model and proposed that children's sleep itself is best understood using a transactional model (See Figure 2.1). The transactional model of child sleep proposes that the development of sleep, including timing, quantity, and quality, in infancy and early childhood stems from bidirectional and dynamic interactions between a child's intrinsic context (e.g., health, maturation, temperament) and the proximal extrinsic parental context, which includes interactive behaviors between parent and child such as the bedtime routine and soothing methods (El-Sheikh & Kelly, 2017; Sadeh & Anders, 1993; Tikotzky, 2017). From this perspective, children's sleep-wake behaviors are embedded within the family and, according to El-Sheikh and Kelly (2017), relationships within the family play a primary role in shaping children's sleep. The transactional model of children's sleep allows for multiple levels of assessment and intervention, including intrinsic contexts, such as the child, parent, and interactive behaviors between the two, and extrinsic contexts such as socioeconomic status and sociocultural norms surrounding sleep. The present study will focus specifically on those contexts that have direct links to child sleep according to the model: the constitutional status of the child,

Figure 2.1



Adapted from Sadeh and Anders, 1993 and Sadeh, Tikotzky and Scher, 2010
From: Tikotzky, 2017

including age and temperament, and the interactive behaviors between parent and child surrounding sleep, specifically the bedtime routine. These are described below.

Family routines as a transactional process. Family routines represent one area that is well-suited for the study of transactional processes because they represent the intersection between maternal and child characteristics, as well as family-level factors (Brody & Flor, 1997; Fiese et al., 2002). Family routines are specific, patterned interactions that are repeated regularly over time, involve two or more family members, and are recognized by continuity in behavior (Fiese et al., 2002; Sagnola & Fiese, 2007; Wolin & Bennett, 1984). Family routines are observable practices, are characterized by instrumental communication (e.g., "this is what needs to be done"), involve a momentary time commitment, and conveys little symbolic meaning to non-family members on what it means to be a member of the family. Family routines are instrumental, moving the family as a whole towards a shared short-term goal such as mealtime or bedtime (Fiese et al., 2002; Spagnola & Fiese, 2007). In contrast, family rituals transcend the "here and now" and convey a family identity (e.g., gathering with extended family for holidays or religious events).

Examining the enactment of family routines as part of a transactional process allows for investigation of how family life may affect individual adaptations in the child, while at the same time examining how individual characteristics of the child may affect the parent and ultimately whole family functioning (Fiese et al., 2002). In the successful execution of a family routine, a transaction occurs between parent and child in which child behavior is better regulated and in turn parents feel more competent (Fiese et al., 2002). For example, Sprunger, Boyce, and Gaines (1985) found that when there were regular routines in the household, mothers of young infants reported more satisfaction and feeling more competent in their parenting role. Fiese et al. (2002) found family routines were related to not only parenting competence, but also child adjustment and marital satisfaction. As children become more competent, they more actively engage in family routines, thus maintaining the transaction from child behavior to parental competence and back again.

Child characteristics and the capabilities and characteristics of the parent impact the determination of whether a family routine is successfully executed or not (Sameroff & Fiese, 2000). For instance, easygoing children may be more responsive to routines in general, while more competent parents may be more successful in creating and enacting satisfying family routines (Fiese et al., 2002). Family routines are a part of the predictable aspects of family life that support child development, and their regularity reflects an overall level of family organization (Spagnola & Fiese, 2007). Indeed, it is a hassle when routines are disrupted and indication of stress in the family is often first expressed by a disruption in family routines (Fiese et al., 2002; Spagnola & Fiese, 2007; Steinglass et al., 1987).

Application of transactional model to bedtime routines. The bedtime routine is one type of family routine and it appears to be nearly universally used by families with young children (Mindell & Williamson, 2017). Beyond the benefits of improved sleep outcomes in children, bedtime routines have also impacted child and family functioning in various domains. Mindell and Williamson (2017) reported on several studies of children ages 0 - 5 that have found bedtime routines to be associated with improved child mood and emotional-behavioral regulation. In two intervention studies, mothers who implemented a specific and consistent bedtime routine for two weeks consisting of a bath, a massage with a provided massage lotion, and quiet activities such as cuddling or singing a lullaby reported improvements in self-reported mood and maternal confidence in managing their child's sleep problems (Mindell et al., 2009; Mindell, DuMond, Sadeh, Telofski, Kulkarni, & Gunn, 2011). Additionally, families reported significant improvements in marital satisfaction after implementing a bedtime routine to reduce bedtime resistance in toddlers (Adams & Rickert, 1989). In a study with older children from first to fifth grade, bedtime routines were protective for children post-divorce, such that children in families with divorced parents with more regular bedtime routines had better academic performance, fewer school absences, and better overall health compared to children of divorce who did not have regular bedtime routines (Guidubaldi, Cleminshaw, Perry, Nastasi, & Lightel, 1986). Finally, Hale and colleagues found direct links between language-based bedtime routines (including reading/telling a story, praying, talking, singing, or playing a game) at age three and verbal test scores at age five in a large sample of low-income children (Hale et al., 2011).

Intrinsic child context – Temperament. Sadeh and Anders (1993) placed specific focus on the role of children's temperament as the intrinsic child context (or what Sameroff and colleagues refer to as "biology"; Sameroff, 1975, 2009; Sameroff & Chandler, 1975) that influences children's sleep. Temperament has been defined as constitutionally-based differences in reactivity and regulation in the domains of affect, activity, and attention (Rothbart & Bates, 2006). Reactivity refers to an individual's initial responses to environmental stimuli, while regulation refers to the modulating influence that operates on that reactivity. Temperament traits emerge early in life and are shaped by complex interactions between genetic, environmental, and maturational forces (Rothbart, 2011; Rothbart & Bates, 2006).

Research has consistently identified direct links between temperament and sleep. For instance, in a study of 35 healthy toddlers aged 11 – 27 months, mother-reported sleep measures were related to some temperament dimensions (Scher, Epstein, Sadeh, Tirosh, & Lavie, 1992) as rated by mothers on the Carey Toddler Temperament

Questionnaire (Carey & McDevitt, 1978). Specifically, higher rhythmicity patterns (i.e., regularity of eating, sleeping, etc.) were associated with shorter mother-reported sleep duration and fewer night wakings. Children higher in withdrawal, defined as exhibiting a fearful response to new object or person, fell asleep later, woke up later, and had more night wakings, whereas less adaptable (more rigid) and more distractible (unfocused) children had shorter mother-reported sleep duration. Scher et al. (1992) also found relations between mother-rated temperament and actigraph-recorded sleep measures with more withdrawn children falling asleep later and more persistent (continuing task despite obstacles) children having higher sleep efficiency. Withdrawn children are typically more fearful in general and have higher anxiety levels, which may inhibit their ability to fall asleep earlier.

In contrast, persistent children have higher overall attention skills, a cognitive component of executive functioning. It may be that children with higher attention or executive function skills display more efficient brain processing, which is also manifested in more efficient sleep. In another study of 63 sleep-disturbed toddlers ranging in age from 9 to 24 months, and compared to a control group of 35 toddlers ranging in age from 11 to 27 months, Sadeh, Lavie, and Scher (1994) found that the sleep-disturbed children (characterized by more night wakings) had lower sensory thresholds, were less adaptive, more distractible, and more demanding than the control group children. In their study of 64 toddlers aged 30 months, Molfese et al. (2015) reported that toddlers higher in activity had less actigraph-recorded nighttime sleep and toddlers higher in soothability (easy to calm down) had more actigraph-recorded total sleep (night plus daytime nap). In addition, they found that more fearful toddlers had more variable sleep onset times and more soothable toddlers had less variability in parent-reported nighttime sleep.

While these studies have been useful for laying the groundwork for testing the path from the intrinsic child context of temperament to child sleep, they have mainly been unidirectional in orientation (i.e., from temperament to sleep) or interactional, overlooking the possibility of bi-directional transactions (e.g., temperamentally resistant children get less sleep, less sleep amplifies the resistant behavior of the child). Indeed, in the original proposal of the transactional model (Sameroff, 1975; Sameroff & Chandler, 1975), temperament was consistently raised as one aspect that theoretically develops transactionally. Thomas and colleagues (Thomas, Chess, & Birch, 1968; Thomas & Chess, 1977) outlined how changes that occur in a child's temperament were a function of the transaction between the child and their family environment. A positive feedback loop is initiated when children with difficult temperaments elicit maladaptive parenting, which in turn leads to their own maladaptive behaviors (Bornstein, 2009). Thus, a mother who comes to identify her child as 'difficult' may treat her child as difficult, irrespective of their actual behavior (Sameroff, 1975). From this perspective, temperament is not just a set of traits inherent to the child, but also a relational construct, which cannot be separated from the caregiving context to which the child reacts and within which he/she self-regulates (Bornstein, 2009; Sameroff & Mackenzie, 2003). The implication of this for the transactional model of children's sleep is that in addition to temperament being directly linked to children's sleep, it is entirely possible for temperament to also relate transactionally to the bedtime routine.

Although not yet investigated, associations between temperament and bedtime routines has been posited. Spagnola and Fiese (2007) noted that even within the same family, an interactional pattern that works for one child may not work for another and may obligate the family to negotiate daily routines that fit with each individual child's temperament. In regards to bedtime routines specifically, different temperament traits would influence how long and which activities in a bedtime routine would be adaptive versus maladaptive for a particular child (Mindell & Williamson, 2017). For example, a child who is low in adaptability might require an extremely rigid bedtime routine, which consists of the same activities in the same order for the same length of time every night, because even small perturbations in the normal routine might cause the child distress to the point where they are unable to settle to sleep.

Knowledge Gap

To summarize, the literature on bedtime routines has reported relations between bedtime routines and benefits to children's sleep and other outcomes. However, very little work has been published that elucidates the characteristics of bedtime routines themselves, possible individual differences in routines, and possible changes in routines with maturation. More information is needed to determine: the extent to which bedtime routines are consistent or vary on a night-to-night basis, how bedtime routines develop and change over time in young children, what activities are included in bedtime routines, how temperament plays a role in bedtime routines, and the relations between bedtime routines and sleep.

The Present Study

The purpose of this study is to build on the groundwork that has already been laid on bedtime routines and sleep outcomes in the extant literature, focusing on four specific sleep outcome measures: actigraph-recorded sleep onset, actigraph-recorded sleep duration, actigraph-recorded sleep latency, and parent-reported sleep duration. The present study will move the field forward by first defining and quantifying variability in the nightly bedtime routine, and then by addressing three specific research aims and associated research questions:

1. Consistency of the Bedtime Routine on a Nightly Basis Within Age
    a. Is variability in the bedtime routine on individual nights related to sleep outcome measures on those same nights at 30, 36, and 42 months old?
    b. Is sleep on one night associated with variability in the bedtime routine on the following night, at 30, 36, and 42 months?
    c. Are the night-to-night relations between variability in bedtime routines and sleep outcome measures the same at 30, 36, and 42 months?
2. Longitudinal Stability of Bedtime Routines
    a. Does the length of bedtime routines change or remain the same from 30 to 36 to 42 months?
    b. Do the activities of the bedtime routine change or remain the same from 30 to 36 to 42 months?
3. Child-Level Characteristics that Impact the Types of Bedtime Routines and Sleep
    a. Is temperamental negative affect (a composite of the temperament traits of anger/frustration, fear, sadness, discomfort, and soothability) associated with

the consistency of the bedtime routine (both length and types of activities) on a nightly basis?

b. Is temperamental negative affect associated with the longitudinal stability of the bedtime routine (length or activities) across time from 30 to 36 to 42 months?

c. What are the transactional relations between negative affect and bedtime routines across time?

    i. Is negative affect at 30 months associated with bedtime routines at 36 months, which is associated with negative affect at 42 months?

    ii. Is the bedtime routine at 30 months associated with negative affect at 36 months, which is associated with the bedtime routine at 42 months?

Study hypotheses. The few studies that have examined the consistency of the bedtime routine on a nightly basis have relied on a global parent report of bedtime routine consistency (see Hale et al., 2009; Sadeh et al., 2009, for examples). Few published studies to date have examined the bedtime routine as reported on a nightly basis or how it may relate to sleep that night. Staples et al. (2015) used nightly reports of bedtime routines, but averaged across the reporting period to analyze overall relations between bedtime routines and sleep outcomes. Therefore, using nightly measures of variability in the bedtime routine will yield precise information on the extent to which bedtime routines vary on a night-to-night basis over a global parent report of bedtime routine consistency. Work by Prokasky, Fritz, Molfese, and Bates (2019) examining the effect of nightly variability in the bedtime routine on that night's sleep suggests that nightly deviations from the family's normal bedtime routine differentially relate to sleep outcomes on weeknights vs. weekends. That is, more deviation from the normal routine activities predicted more parent-reported sleep on weekends, but not weeknights, while more variable routine lengths were associated with less parent-reported sleep on weeknights, but not weekends. Therefore, it is hypothesized that night-to-night variability in the bedtime routine impacts sleep outcomes on a nightly basis (for Research Aim 1). However, because no previous literature has examined whether sleep on a particular night will impact bedtime routines the following night, no specific hypotheses are made about whether these relations exist or whether they are the same across time from 30 to 42 months of age.

Based on the literature that family routines differ between infancy and preschool (e.g., Fiese et al., 2002; Spagnola & Fiese, 2007), and that it is during the preschool years when families begin to negotiate and make compromises around bedtime routines (Nucci & Smetana, 1996), it is hypothesized that bedtime routines will change between 30 to 42 months, both in the types of activities completed during the bedtime routine and in the length of the bedtime routine (for Research Aim 2).

Finally, given the extensive literature linking temperament to sleep outcomes (e.g., Sher et al., 1992; Sher, Tirosh, & Lavie, 1998; Molfese et al., 2015), and taking a transactional perspective to understanding relations between bedtime routines and sleep outcomes in children, it was hypothesized that temperamental negative affect will impact the within-age consistency and longitudinal stability of the bedtime routine and that transactional relations between bedtime routines and negative affect would be identified (for Research Aim 3).

CHAPTER 3: METHODS

Participants

The data used in the present study are drawn from two sites that were a part of the same longitudinal, NIH-funded grant to study the relations between toddler sleep, temperament and self-regulation. The participant demographic information reported below is based on the sample from each site that began the study and had complete data at 30 months of age, but not all children were tested at all subsequent time points. This was due to two reasons: participant attrition across the one-year testing period and the grant funds being depleted before all children could be tested at all time points.

Sample 1. Participants from Site 1 were 184 typically developing toddlers aged 30 months (87 female) and their primary caregivers recruited from a mid-size city in the Midwest United States. The majority of toddlers were White (83.7%), followed by multiracial (8.2%), Hispanic (2.7%), Asian (2.7%), Black (1.6%), and Native American (1.1%). These characteristics are reflective of those of the larger community from which the sample was drawn. The majority of primary caregivers (96.2% mothers; herein referred to as parents) were married (84.0%) and ranged in age from 21 to 46 years old (M = 32.12, SD = 4.68); four parents did not report age. Parents' education levels ranged from college degree (83.2%) to some college (14.0%) to high school diploma (2.8%); five parents did not report education level. Family income was reported in $5,000 increment bands and ranged from less than $10,000 per year to more than $125,000 per year, with a mean of $70,000 - $75,000 per year, and 12.3% of families reporting family income of more than $125,000 per year; five families did not report income.
Hollingshead Four-Factor Index of Socioeconomic Status (SES; Hollingshead, 1975) was

computed based on parents' educational attainment and occupational prestige. Hollingshead SES codes ranged from 20 to 66, with higher scores indicating higher SES. The mean SES for this sample was 48.90 (*SD* = 11.67). Of the 184 toddlers who participated at 30 months, 157 toddlers (74 female) participated at 36 months old, and 147 toddlers (70 female) participated at 42 months old.

Sample 2. Participants from Site 2 were 215 typically developing toddlers aged 30 months (101 female) and their primary caregivers, recruited from a mid-size city in the Midwest United States. Toddler race/ethnicity data were not collected in sample 2, but 89.3% of primary caregivers were White, followed by 4.4% Hispanic, 3.4% Black, 1.5% Asian, 1.0% multiracial, and 0.5% Native American; nine primary caregivers did not report race/ethnicity. The majority of primary caregivers (97.7% mothers; herein referred to as parents) were married (86.9%), and ranged in age from 21 to 53 years old (*M* = 32.79, *SD* = 4.92). Parents' education level ranged from college degree (81.5%), some college (13.7%), high school diploma (1.9%), GED (1.4%), to some high school (1.4%). Annual family income was not collected in sample 2; however, Hollingshead SES codes ranged from 8 to 66, and the mean SES for this sample was 47.76 (*SD* = 13.81). Of the 215 toddlers who participated at 30 months, 169 toddlers participated at 36 months (78 female), and 155 toddlers participated at 42 months (69 female).

Measures

Demographics.

Sample 1. Parents reported demographic information on a questionnaire that asked parents to identify sex and race/ethnicity of their toddlers. The demographic form also asked parents to report their and their parenting partners' race/ethnicity, education level, relation to child, occupation, marital status, annual family income, numbers and ages of siblings, and who resided in the same home as the toddler.

Sample 2. Parents reported identical demographic information on a questionnaire as in sample 1, except toddler race/ethnicity was not collected in sample 2.

Sleep.

Actigraphy. Toddlers' sleep was measured continuously for approximately two weeks using a Micro-Mini Motion Logger actigraph (Ambulatory Monitoring, Inc., Ardsley, New York), which is a small wristwatch-like device that records motion and activity levels from an accelerometer. Actigraphy is a non-invasive method for tracking rest and activity periods that has been established as a valid and reliable method for measuring children's sleep (Acebo et al., 2005; Sadaka et al., 2014; Sadeh & Acebo, 2002; Sadeh, et al., 1991). Using the ActionW 2.7 software (Ambulatory Monitoring Inc., Ardsley, New York), actigraph data were scored using the Sadeh algorithm (Sadeh et al., 1989), which has been validated against polysomnography in toddler populations (Sadeh et al., 1991). Three variables relating to nighttime sleep available from actigraphy were used in the present study: *actigraph recorded sleep onset time* (the time the actigraph records determined the child fell asleep), *actigraph recorded nighttime sleep duration* (total amount of nighttime sleep minus any night wakings), and *actigraph recorded sleep latency* (amount of time between when the parent reported the child was in bed and the actigraph recorded sleep onset). Pre-processing of the actigraph data, which included examining the nightly sleep diaries to mark toddler's bedtimes, wake times, and times when the actigraph was not worn, was done to obtain daily values of these variables. Actigraph-recorded sleep onset time was recorded as military time in the ActionW 2.7

software used to process the actigraph data (e.g., 21:30, which corresponds to a clock time of 9:30 pm). To accommodate analyses using this specific variable, sleep onset times were converted to a decimal by taking the minutes and dividing by 60. Therefore, an actigraph recorded sleep onset time of 21:30, for example, was converted to 21.50 and this number was entered into analyses.

Sleep diary. Parents recorded their toddlers' bedtime each night for two weeks, as well as the time their toddler woke up the next morning. This information was used to aid in scoring the actigraph data and to compute a parent-reported measure of nighttime sleep duration reported in hours, which was defined as the length of time from when the parent reported the toddler in bed to the time the parent reported the toddler awake. Parents also recorded each night in the sleep diary whether the actigraph was worn, when or if it was temporarily removed (e.g., for bath), and any naps or night wakings the toddler experienced during the testing period.

Bedtime routines. Parents reported on the bedtime routine each night in the sleep diary, including routine start time and the specific activities included in the routine. Parents were provided with six common bedtime routine activities to check off if completed: shower/bath, pajamas, story, water, TV, and brush teeth. Four additional spaces were provided for parents to write in their own activities (e.g., pray). The write-ins resulted in a total of 24 additional activities engaged in by families during the bedtime routine. These additional activities were grouped into 11 additional categories: pray/read scripture, potty/diaper change, snack/treat/meal, cuddle/rocking, play, music/singing, special object (including blanket, stuffed animal or pacifier), talking, giving medicine, pickup toys, and other (mostly family specific, such as trim nails, phone calls to family, night walks, or stretching). Providing drinks of juice, milk or a bottle were combined with the original "water" category to form a "drink" category; reading was combined with the "story" category; and use of a tablet or phone, watching videos on YouTube, and watching movies were combined with the original "TV" category to form a new "technology use" category. This data reduction resulted in 17 categories of bedtime routine activities that parents reported in the sleep diaries: bath, pajamas, read, drink, technology use, brush teeth, pray, potty, snack, cuddle, play, music, object, talk, medicine, pickup, and other.

Temperament. Child temperament was measured from parent report on the Children's Behavior Questionnaire- Short Form (CBQ-SF; Putnam & Rothbart, 2006). The CBQ-SF is a 94-item assessment of children's temperament in which parents rate their children's behavior (e.g. "has temper tantrums when s/he doesn't get what s/he wants") on a 7-point scale ranging from 1 = 'extremely untrue of your child' to 7 = 'extremely true of your child'. The CBQ-SF provides scores for 15 fine-grained temperament traits: activity, high-intensity pleasure, approach, impulsivity, shyness, falling reactivity, fear, frustration, sadness, discomfort, attentional focusing, low-intensity pleasure, inhibitory control, perceptual sensitivity, and smiling and laughter. These temperament traits load onto three dimensions: Surgency/Extraversion, Negative Affectivity, and Effortful Control. The CBQ-SF has demonstrated adequate to good internal consistency on each of the 15 subscales (alphas ranging from .58 to .82), and is a widely used measure of temperament in children ages 3 to 8 years old (Putnam & Rothbart, 2006). The temperament dimension examined in the present study was

Negative Affectivity, which is a composite of the anger, discomfort, soothability, fear, and sadness subscales.

Procedures

Sample 1. Participants were recruited from local child care centers and pediatrician's offices, through personal contacts, and the distribution of flyers at child-friendly events and locations. Families with toddlers who were within the required age range (not yet 30 months old) and lived within one hour of the testing site were invited to participate. Data were collected when toddlers were 30, 36, and 42 months old.

When toddlers turned 30 months old, project staff contacted interested families and an initial home visit was scheduled. At the initial home visit, the parents were given study materials including questionnaires (demographic, CBQ-SF, and CAQ) and a daily sleep diary to be completed about their toddler. Toddlers were given a sweatband to wear containing an actigraph to record sleep measures. Parents were instructed to have their toddler wear the actigraph on their non-dominant wrist continuously through the day and night, except when the actigraph could get wet (e.g., bath or swimming). If the toddler resisted wearing the actigraph on their wrist, parents were instructed that the actigraph could be placed on the upper arm or ankle. Approximately one week after the initial home visit, a lab visit was scheduled where the parent and toddler completed a series of tasks designed to measure self-regulation. At the lab visit, data from the actigraph were downloaded, and compliance with the sleep diary was checked. Approximately one week after the lab visit, a second home visit was conducted wherein project staff observed the bedtime routine for the one- to two-hour period leading up to the toddlers' bedtime (until lights out). After the toddler was placed in bed for the night, project staff collected the actigraph, daily sleep diaries, and questionnaires from the parent and concluded the visit. This resulted in approximately two weeks' worth of actigraph and sleep diary data for each child. The same procedure was repeated when toddlers were 36 and 42 months old. All procedures were approved by the institutional review board.

Sample 2. Participants in sample 2 were primarily recruited through a database using county birth records and community outreach efforts, such as through the local Head Start agency and the Housing Authority in a mid-size city in the Midwest United States. Families were recruited when toddlers were not yet 30 months old, and contacted for participation when the toddler turned 30 months old. The sequence of data collection was slightly different in sample 2 than in sample 1. An initial home visit was scheduled, during which project staff gave questionnaires, sleep diaries, and the actigraph to families. A few days after the first home visit, the second home visit was scheduled, and project staff observed the bedtime routine. One week after the first home visit, the lab visit was scheduled, and toddlers and their parents came in and completed a series of tasks designed to measure self-regulation, using mostly the same methods as participants in sample 1. At the lab visit, actigraph data were downloaded, and compliance with the sleep diary was checked. One week after the lab visit, a second lab visit was scheduled in which the second week of actigraph and sleep diary data were collected. This process was repeated when toddlers were 36 and 42 months old. All procedures were approved by the institutional review board.

Combined sample. Despite differences in the sequence of data collection across the two sites, identical actigraph and sleep diary data were collected (two weeks' worth per child), which are the two main data sources of the present study. In addition, the same measure of children's temperament (CBQ-SF) was used at both sites, and nearly identical demographic information was collected. Therefore, data were combined from both samples and analyses were conducted on the combined dataset.

In regards to the daily actigraph and sleep diary data collected, the main goal at both sites was to collect at least two weeks' worth (14 days and nights) of data on each child in order to maximize the reliability of the sleep parameter estimates available from the actigraph. However, for some children in both samples, unforeseen incidents resulted in less than 14 nights of actigraph data being collected, such as device failure (actigraph stopped collecting data for unknown reasons), loss of actigraph by the participants, or the toddler refusing to wear the actigraph. In other cases, for some children in both samples, more than 14 days of actigraph or sleep diary data were collected, such as when visits needed to be rescheduled due to child illness or a family scheduling conflict. In addition, for some children in both samples, there are instances in which actigraph data were collected, but there was no corresponding sleep diary data that matched the night(s) on which there were actigraph data recorded (parent forgot to fill out sleep diary), or vice versa (parent filled out sleep diary but child didn't wear actigraph). Because the bedtime routine variables were the main focus of the study and served as the predictor variables in the research questions, the number of nights of data available in the sleep diaries (source of the bedtime routine variables) was investigated. Only one quarter of the combined sample had sleep diary data available after the 14th night, therefore only data collected on the first 14 nights of the data collection period were used in analyses. It is unknown what percentage did not fill out the sleep diary on the same night as the home visit. Full information maximum likelihood was used to account for missing data on the sleep outcome variables sourced from the actigraph records, including actigraph recorded sleep duration, actigraph recorded sleep onset, and actigraph recorded sleep latency.

Data Analysis

A variety of statistical methods were employed to answer research questions. The following sections are organized by research aim and their corresponding questions.

Consistency of the bedtime routine on a nightly basis within age. Because consistent bedtime routines are associated with better sleep outcomes for children, yet few research studies have examined how consistent the bedtime routine is on a nightly basis, the first aim addressed this gap by investigating the following three research questions. Using information about the bedtime routine from the parent reported nightly sleep diaries and actigraph recorded sleep measures, comparisons were made of the consistency of the bedtime routine and relations to sleep outcomes at 30, 36, and 42 months of age.

Prior to addressing the specific research questions, two measures of bedtime routine variability were computed: *routine length variability* (RLV) and *deviation from the normal routine (DNR)*. Using the method developed by Prokasky et al. (2019), routine length variability was computed for each child as the absolute difference between the average routine length across the data collection period at each age and the routine length for each individual night at each age. First, routine length for each night was computed as the difference between the time the parent reported the bedtime routine started, and the time the parent reported that the child went to bed. Then, an average routine length was calculated by computing the mean length of routine for each night across the data collection period available for each toddler at each age. Finally, the difference between the average routine length and the routine length for each night were calculated, so that there was an RLV value for each individual night for each toddler.

To calculate deviation from the normal routine for each night, first a "normal" routine for each individual child was identified. The normal routine consisted of the individual activities (e.g., bath, brush teeth, read, etc.) that occurred on at least 10 of the 14 nights during the data collection period (i.e., at least 5 nights a week). Then, for each individual night, the number of non-normal bedtime routine activities that occurred and the number of normal bedtime routine activities that did not occur were summed to create a total deviation score with higher scores indicating more deviation from the normal routine for a particular night and lower scores indicating more consistent bedtime routines. For example, if a participant's normal routine consisted of bath, pajamas, and reading, (meaning that these three activities happened on at least 10 of 14 nights), and for a particular night, the bedtime routine consisted of bath, watching TV, and singing a song, this participants' deviation score would be equal to 4: 2 points for not doing pajamas and reading (part of normal routine), and 2 points for watching TV and singing (not part of normal routine). This process was repeated at 30, 36, and 42 months old, with higher deviation scores indicating more variable, or less consistent bedtime routines from night to night.

1a. Is variability in the bedtime routine on individual nights related to sleep outcome measures on those same nights at 30, 36, and 42 months old? To answer this question, multilevel modeling was used to examine associations between the nightly variability in the bedtime routine and sleep on that same night. Multilevel modeling was appropriate because daily measures of bedtime routine variability and sleep are nested within individuals, and was measured separately at 30, 36 and 42 months. Two bedtime routine predictors were examined in separate models: RLV, which was the difference between the average length in minutes of the bedtime routine across the data collection period and the length of the bedtime routine on any individual night, and DNR which represents how different the activities in an individual night's bedtime routine were from the normal routine, across the data collection period and the length of the bedtime routine on any individual night. Whether the night was a weeknight or weekend night was included as a Level 1 covariate along with the bedtime routine predictor in both models because of prior work reporting differences in children's sleep between weeknights and weekends (e.g., Iwata et al., 2012; Prokasky et al., 2019; Randler et al., 2012). Child gender was included as a time-invariant Level-2 covariate. The sleep outcome measures were actigraph-recorded nighttime sleep duration, actigraph-recorded sleep onset time, actigraph-recorded sleep latency, and parent-reported nighttime sleep duration. Equation 1 is the general form of the multilevel models that were computed.

Level 1:
(1)

$$\text{Sleep outcome} = b_{ij} + b_{1j}\,(\text{bedtime routine predictor}) + b_{2j}\,(\text{weeknight}) + e_{ij}$$

Level 2:

$$b_{0j}\,(\text{sleep outcome average}) = c_{00} + c_{01}\,(\text{gender}) + u_{0j}$$
$$b_{1j}\,(\text{bedtime routine predictor}) = c_{10} + c_{11}\,(\text{gender}) + u_{1j}$$
$$b_{2j}\,(\text{weeknight}) = c_{20} + u_{2j}$$

1b. Is sleep on one night associated with variability in the bedtime routine the following night at 30, 36, and 42 months? To address this question, autoregressive cross-lagged path models were run, regressing each night's bedtime routine predictor and sleep outcome measure on the previous night's bedtime routine and sleep outcome measure. Separate models were run for each pair of bedtime routine predictor (RLV and

DNR) and sleep outcome measure, for a total of eight models run at each age. Figure 3.1 graphically shows all paths tested in the fully cross-lagged autoregressive path model. Identical sets of models were run at 30, 36 and 42 months.

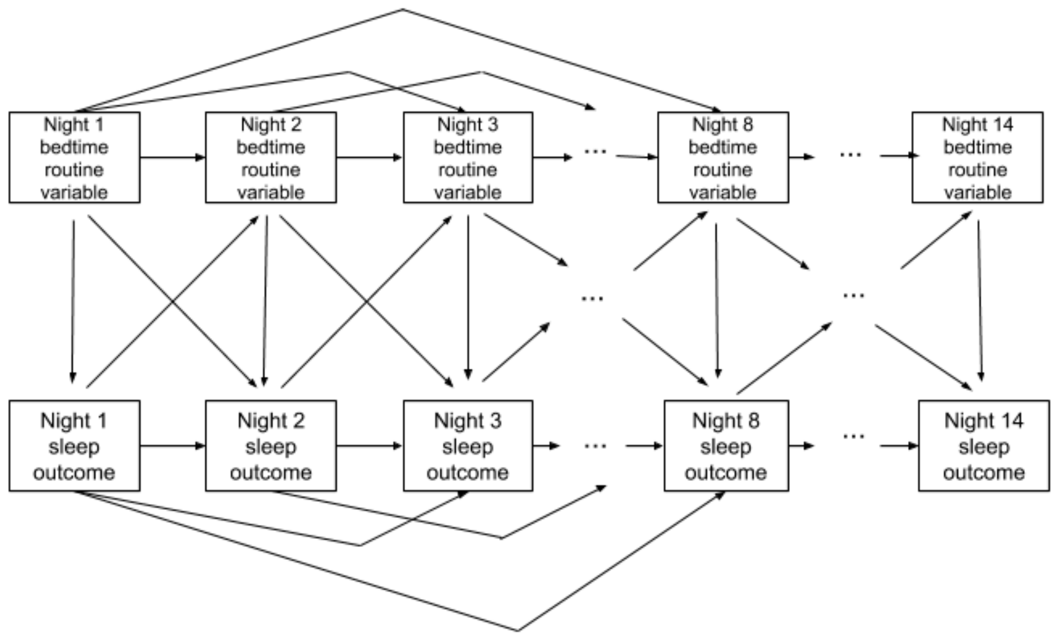


Figure 3.1. Full cross-lagged path model tested at 30, 36, and 42 months. Separate models were tested for each bedtime routine (routine length variability and deviation from normal routine) and sleep outcome (actigraph recorded sleep duration, parent reported sleep duration, sleep onset, and sleep latency) pair.

1c. Are the night-to-night relations between variability in bedtime routines and sleep outcomes the same at 30, 36, and 42 months? To address the final question, results from the autoregressive cross-lagged path models in question 1b were compared to determine whether the same paths between the bedtime routine and sleep outcome variables were significant across ages. If so, coefficients were examined to determine if they were of the same size and direction across all three ages.

Longitudinal stability of bedtime routines. Because no research has explicitly examined the longitudinal stability of bedtime routines across time, the second research aim addressed this gap by answering the following three research questions.

2a. Does the length of bedtime routines change or remain the same from 30 to 36 to 42 months? To answer this question, the average routine length for each child at each age was computed and ANOVAs were computed to determine whether the length of the bedtime routine was significantly different between ages.

2b. Do the activities of the bedtime routine change or remain the same from 30 to 36 to 42 months? To answer this question, bedtime routine activity data were aggregated across the data collection period at each age by creating proportion scores for each of the bedtime routine activities. Specifically, for each routine activity (e.g., bath, reading, etc.), the number of times it occurred during the testing period at each age was divided by 14 – the number of days in the data collection period at each age. This resulted in a proportion score of how often a particular bedtime routine activity occurred across the two weeks, with higher scores indicating the particular activity was more common. Proportion scores were calculated for all children at each age, and for each routine activity. Then, paired samples t-tests were computed on these proportion scores for each activity to determine if there were significant differences in how often each routine activity occurred at each age. Paired samples t-tests were used because it is inappropriate to run ANOVA on proportion scores. Scores at 30 months were compared to scores at 36 and 42 months, and scores were at 36 months were compared to scores at 42 months. Significant differences indicated which bedtime routine activities change in frequency across time, a proxy for changes in the bedtime routine across time.

Child-level characteristics that impact the types of bedtime routines and sleep. The final research aim addressed whether there are child-level characteristics, specifically child temperament, that relate to bedtime routines. While previous research has identified links between temperament and sleep outcomes in children, no previous research has examined whether temperament relates to bedtime routines specifically. This research aim examined this gap by addressing the following three research questions.

3a. Is temperamental negative affect associated with the consistency of the bedtime routine (both length and types of activities) on a nightly basis? In order to determine whether children high in negative affect had more consistent or more variable bedtime routines than children low in negative affect at 30, 36 and 42 months, correlations were computed between negative affect, average RLV, and average DNR at all three ages.

3b. Is temperamental negative affect associated with the longitudinal stability of the bedtime routine (length or activities) across time from 30 to 36 to 42 months? To determine whether children high in negative affect had more or less stable bedtime routines across time from 30 to 36 to 42 months, correlations were computed between negative affect at each age, and change in the routine length and change in the proportion scores of activities completed at each age for each child, from 30 to 36 to 42 months. To calculate change scores, differences between routine length and activity proportion scores were calculated between 30 and 36 months, and 36 and 42 months.

3c. What are the transactional relations between negative affect and bedtime routines across time? Does negative affect at 30 months relate to bedtime routines at

36 months, which in turn relates to negative affect at 42 months, or, do bedtime routines at 30 months relate to negative affect at 36 months, which in turn relates to bedtime routines at 42 months ? To address this question, cross-lagged path models were run between negative affect at each age and the bedtime routine variability indices (RLV and DNR) at each age.

CHAPTER 4: RESULTS

Several analytic techniques were used to address the three research aims and associated hypotheses of this study. This study is the first to define, quantify, and analyze consistency versus variability in bedtime routines and its associations with sleep measures. Therefore, prior to hypothesis testing, preliminary analyses were conducted to describe key features of the data and to define and summarize the study variables used in subsequent analyses. The preliminary analyses, which include descriptions of the two bedtime routine variability measures, and descriptive statistics and correlational analyses on all study variables are presented first. Then, results from testing the hypotheses of this study are presented, organized by their associated research aim.

Preliminary Analyses

Defining variability in the bedtime routine. Two descriptive measures, RLV = routine length variability, and DNR = deviation from the normal routine, were computed and used to characterize night-to-night variability in the bedtime routines of toddlers at 30, 36, and 42 months of age. RLV was calculated as the difference between the length of the bedtime routine in minutes on an individual night and the average length of the bedtime routine in minutes across the two-week reporting period for each child at each age. Higher scores indicate a more variable routine length on an individual night compared to a child's average routine length. DNR was calculated as the total deviation from the normal routine activities for an individual night from the average deviation from the normal routine activities across the two-week reporting period for each child at each age. Higher scores indicate more deviation from the normal bedtime routine activities on an individual night compared to a child's average deviation from the normal routine activities. Because these two measures of variability in the bedtime routine serve as the basis for subsequent analyses, descriptive information on these two indices of bedtime routine variability are presented below.

Bedtime Routine Length Variability. Table 4.1 presents the mean bedtime routine length variability computed for all children for each night during the two-week reporting period at 30, 36, and 42 months, while Figure 4.1 displays this information graphically. It is important to note that there was an uptick in routine length variability on night 14, which, at least for sample 1, was the night that research assistants observed the bedtime routine in participants' homes.

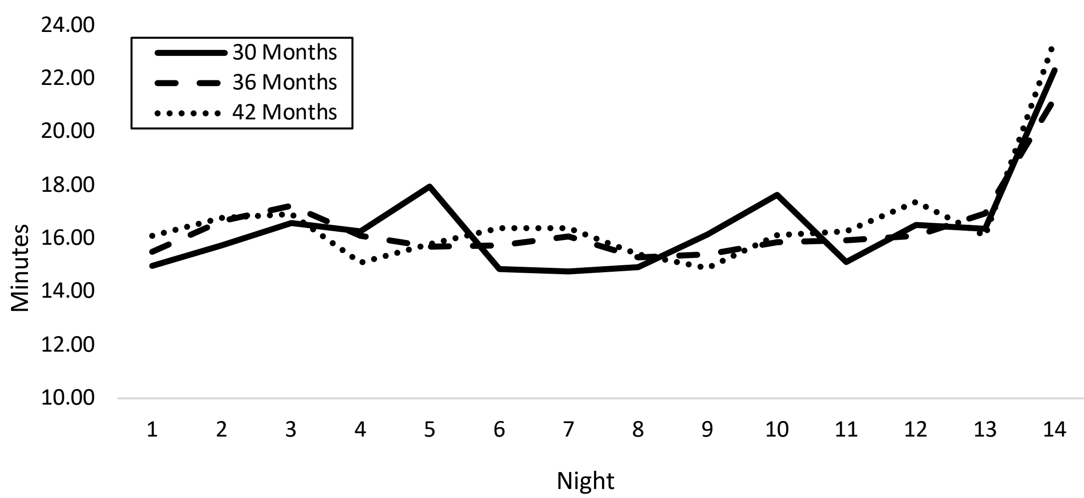


Figure 4.1. Nightly routine length variability across the two week data collection period at 30, 36, and 42 months.

Table 4.1
Nightly Bedtime Routine Length Variability in Minutes at 30, 36 and 42 Months

	30			36			42		
	Mean (SD)	Range	*N*	Mean (SD)	Range	*N*	Mean (SD)	Range	*N*
day 1	14.96 (15.17)	0-117.6	373	15.51 (15.06)	0-103.8	304	16.11 (17.59)	0-97.2	264
day 2	15.73 (15.22)	0-94.8	362	16.66 (16.88)	0-108.6	299	16.76 (24.54)	0-292.2	264
day 3	16.58 (17.35)	0-137.4	362	17.24 (24.65)	0-289.2	296	16.93 (18.57)	0-142.2	261
day 4	16.26 (16.79)	0-115.8	359	16.11 (14.80)	0-93.6	287	15.10 (15.80)	0-131.4	256
day 5	17.96 (20.68)	0-187.8	359	15.70 (16.04)	0-126.6	292	15.79 (16.25)	0-99	256
day 6	14.84 (14.62)	0-95.4	340	15.75 (15.28)	0-93	290	16.38 (15.68)	0-106.8	259
day 7	14.77 (14.93)	0-99	338	16.07 (16.30)	0-126	295	16.40 (19.71)	0-198.6	256
day 8	14.93 (18.07)	0-152.4	291	15.29 (16.10)	0-124.2	239	15.41 (16.44)	0-109.2	227
day 9	16.16 (19.81)	0-203.4	294	15.41 (17.99)	0.01-175.8	244	14.89 (15.78)	0-118.2	227
day 10	17.64 (18.55)	0-135.6	291	15.86 (16.86)	0-112.8	234	16.13 (17.44)	0-158.4	221
day 11	15.11 (15.49)	0-131.4	287	15.93 (16.06)	0-145.2	234	16.26 (17.92)	0-124.8	216
day 12	16.51 (18.00)	0-155.4	282	16.09 (16.47)	0-103.2	238	17.39 (18.01)	0-176.4	223
day 13	16.36 (17.68)	0-127.2	269	16.94 (23.38)	0-228	221	16.11 (14.67)	0.6-76.8	221
day 14	22.32 (29.48)	0-202.2	194	21.26 (34.77)	0.01-307.2	162	23.45 (28.60)	0-167.4	163

At 30 months, nightly bedtime routine length variability ranged from 14.77 minutes to 22.32 minutes across the two weeks. This means that across all children the length of the bedtime routine varied each night from each child's average by 14.77 to 22.32 minutes.

Figure 4.2 shows the nightly routine length variability at 30 months with standard deviation error bars. The variability in the length of the bedtime routine on a nightly basis ranged widely between children, indicating that while some children had very little variability in the length of their bedtime routine on a night-to-night basis, other children experienced large variability in the length of the bedtime routine from night to night.

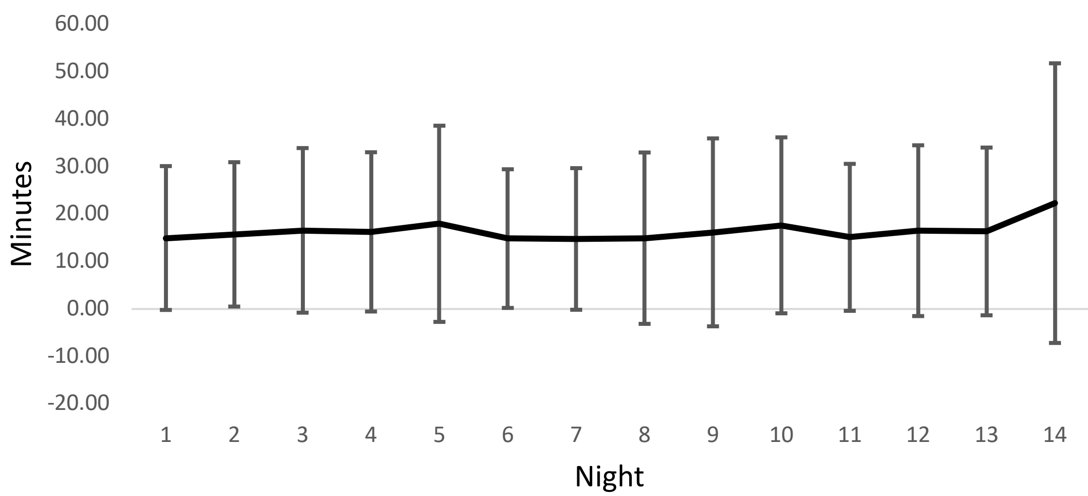


Figure 4.2. Nightly routine length variability at 30 months. Error bars represent standard deviations.

At 36 months, nightly variability in the length of the bedtime routine ranged from 15.29 minutes to 21.26 minutes, but again variability in bedtime routine length varied widely between children, as shown in Figure 4.3.

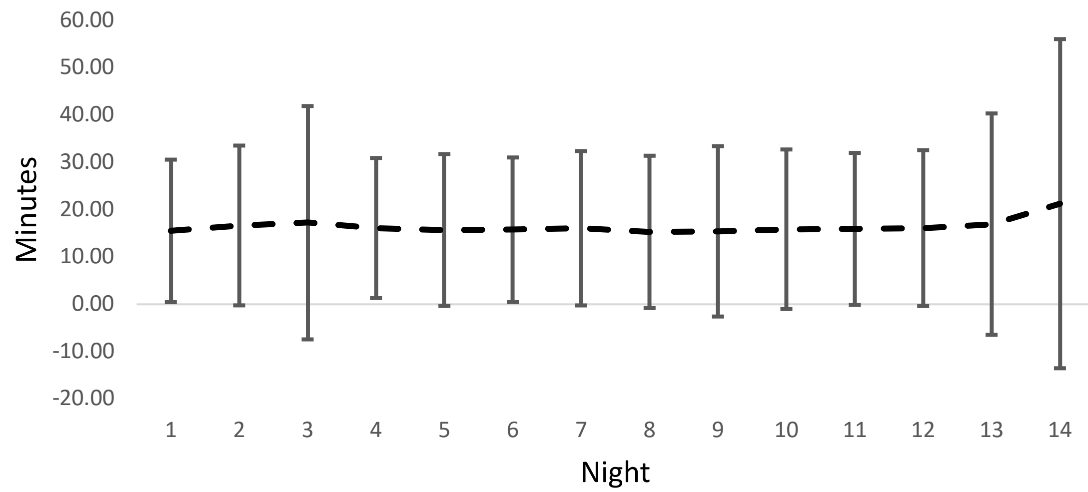


Figure 4.3. Nightly routine length variability at 36 months. Error bars represent standard deviations.

At 42 months, nightly variability in bedtime routine length ranged from 14.89 minutes to 23.45 minutes, but variability in bedtime routine length differed widely between children, as shown in Figure 4.4.

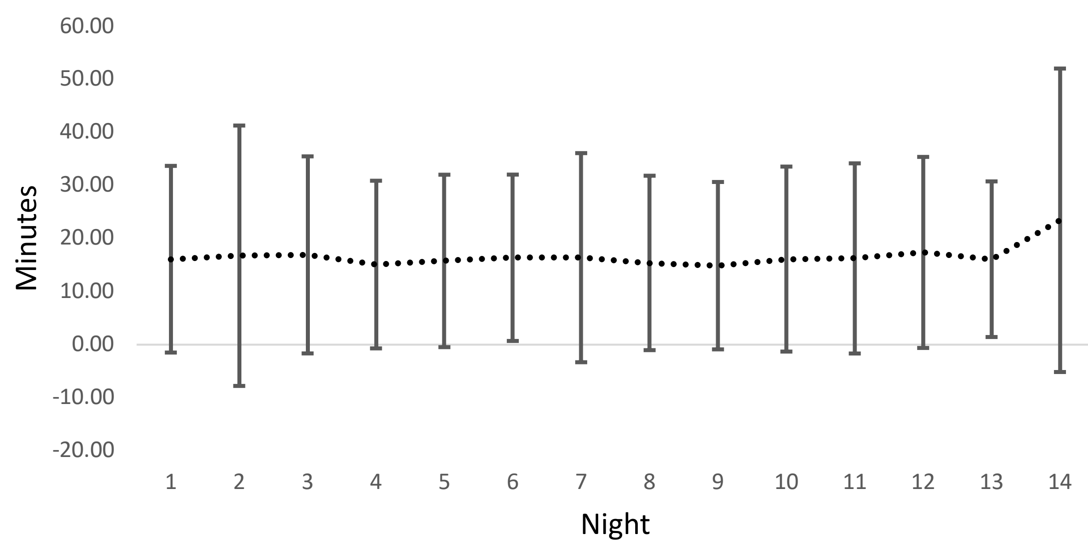


Figure 4.4. Nightly routine length variability at 42 months. Error bars represent standard deviations.

Deviation from Normal Routine. In regards to the second measure of variability, deviation from the normal routine, Table 4.2 presents the mean deviation from the normal routine computed for all children for each night during the two-week reporting period at 30, 36, and 42 months, and Figure 4.5 displays this same information graphically. Examination of Figure 4.5 indicates three potential patterns within the data. First, at least from days one to seven, the activities in a bedtime routine deviated more from the normal routine at 30 months than at 36 or 42 months. Second, there was a clear drop off in deviation from the normal routine after day seven at all three ages. Third, similar to the findings for routine length variability, there was an uptick in the deviation from the normal routine on day 14, the same day research assistants in sample 1 observed the bedtime routine.

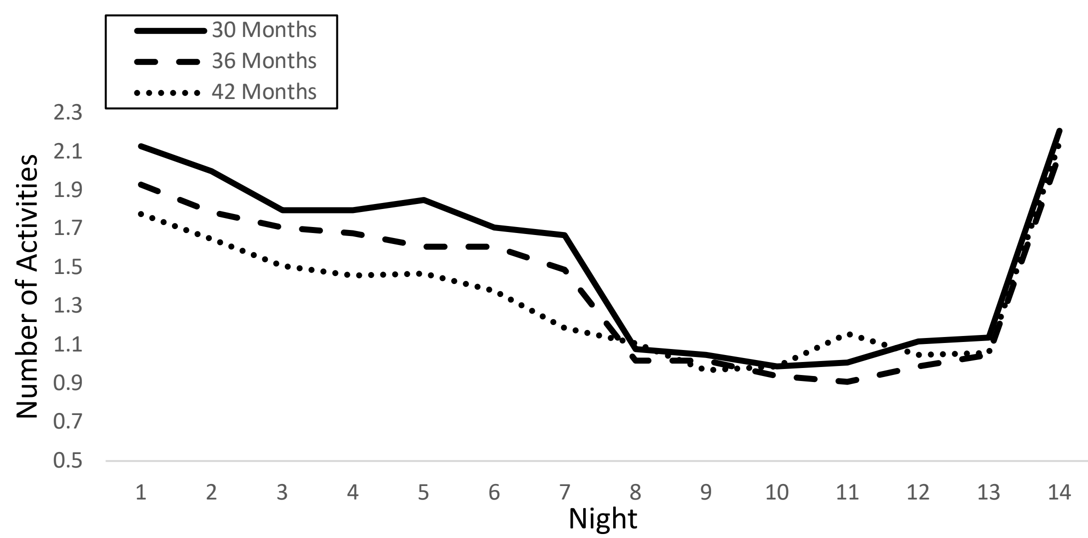


Figure 4.5. Nightly deviation from the normal routine across the data collection period at 30, 36, and 42 months.

Table 4.2
Nightly Deviation from the Normal Routine at 30, 36, and 42 Months

	30			36			42		
	Mean (SD)	Range	N	Mean (SD)	Range	N	Mean (SD)	Range	N
day 1	2.13 (1.78)	0-8	394	1.93 (1.64)	0-8	323	1.78 (1.65)	0-8	288
day 2	2.0 (1.68)	0-8	395	1.79 (1.74)	0-7	324	1.65 (1.71)	0-9	289
day 3	1.8 (1.71)	0-8	394	1.71 (1.72)	0-9	324	1.51 (1.57)	0-8	289
day 4	1.8 (1.76)	0-9	392	1.68 (1.68)	0-7	324	1.46 (1.54)	0-7	289
day 5	1.85 (1.70)	0-8	392	1.61 (1.67)	0-8	323	1.47 (1.57)	0-8	287
day 6	1.71 (1.73)	0-8	392	1.61 (1.67)	0-8	323	1.38 (1.50)	0-7	287
day 7	1.67 (1.74)	0-7	391	1.49 (1.58)	0-8	324	1.19 (1.39)	0-7	286
day 8	1.08 (1.35)	0-7	389	1.02 (1.30)	0-6	322	1.11 (1.28)	0-8	283
day 9	1.05 (1.28)	0-7	389	1.02 (1.26)	0-7	322	0.97 (1.15)	0-5	281
day 10	0.99 (1.16)	0-6	388	0.94 (1.21)	0-6	322	0.99 (1.16)	0-6	280
day 11	1.01 (1.22)	0-7	386	0.91 (1.19)	0-6	322	1.16 (1.31)	0-6	280
day 12	1.12 (1.31)	0-7	383	0.99 (1.22)	0-6	320	1.05 (1.17)	0-5	279
day 13	1.14 (1.30)	0-7	383	1.05 (1.26)	0-6	320	1.06 (1.14)	0-5	278
day 14	2.21 (1.86)	0-8	374	2.09 (1.81)	0-8	320	2.15 (1.80)	0-7	282

At 30 months, deviation from the normal routine ranged from 0.99 to 2.21 activities. This means that across the two-week reporting period, the number of routine activities that were different from the normal routine ranged from almost 1 to over 2 per night. However, as displayed in Figure 4.6, large variability exists between children on how much the bedtime routine activities deviated from the norm, indicating that some children had less variability in how much the bedtime routine on an individual night deviated from the normal routine, while other children had more variability in how much the bedtime routine on an individual night deviated from the normal routine.

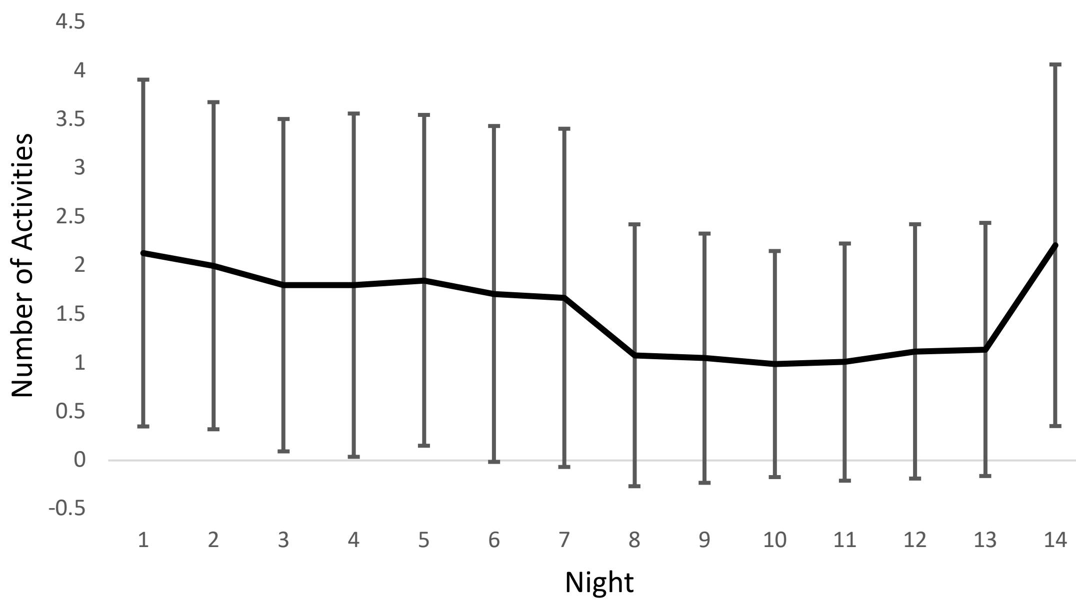


Figure 4.6. Nightly deviation from the normal bedtime routine activities at 30 months. Error bars represent standard deviations.

At 36 months, deviation from the normal routine ranged from 0.91 to 2.09, but again as shown in Figure 4.7, children varied widely from each other in how much the bedtime routine activities deviated from their normal routines on individual nights, with some having no deviation from their normal routine, and others deviating from their normal routine by almost four activities a night.

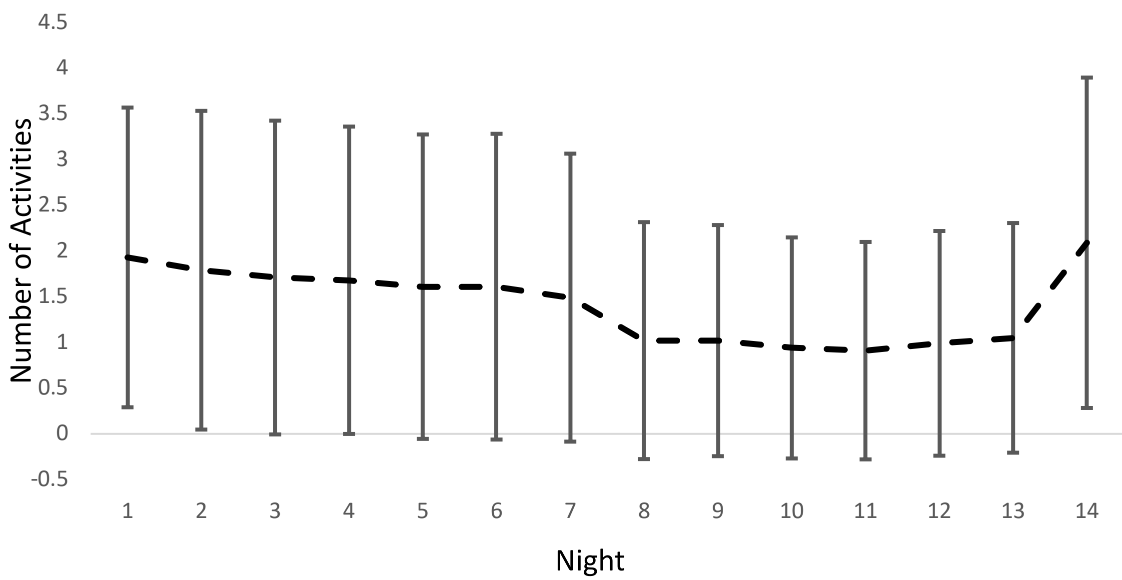


Figure 4.7. Nightly deviation from the normal bedtime routine activities at 36 months. Error bars represent standard deviations.

At 42 months, deviation from the normal routine ranged from 1.14 to 1.80, but deviation from the normal routine varied widely between children, as indicated by the large standard deviation bars shown in Figure 4.8. In other words, some children have no deviations from their normal routine activities, while others deviated by over 3 activities per night.

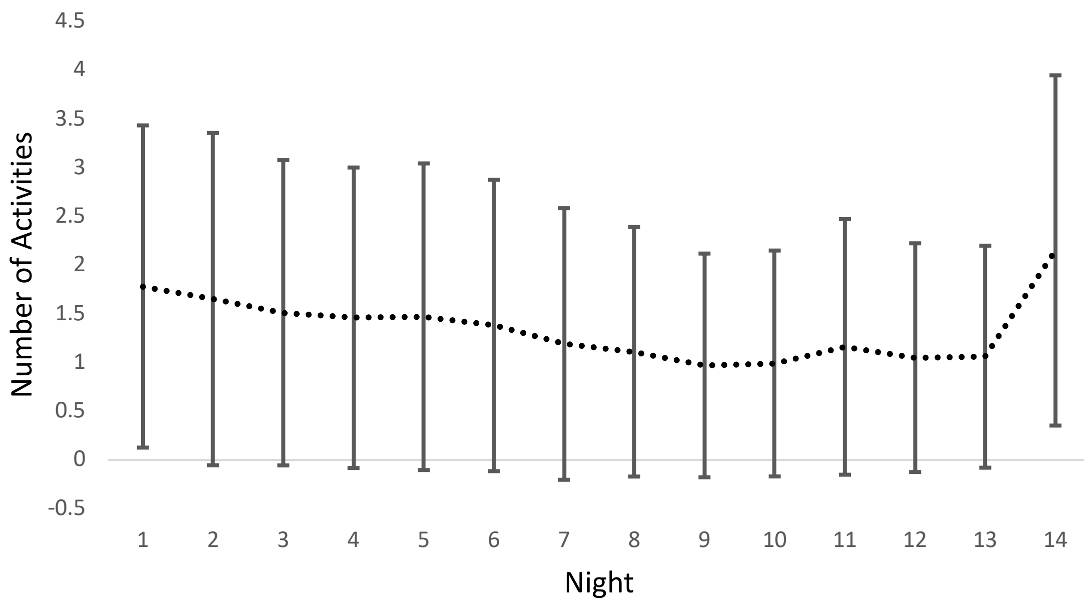


Figure 4.8. Nightly deviation from the normal bedtime routine activities at 42 months. Error bars represent standard deviations.

Descriptive statistics for study variables. Descriptive statistics for the bedtime routine variables, the sleep outcome variables and the negative affect temperament variable at 30, 36, and 42 months are found in Table 4.3. Regarding the bedtime routine variables, average routine length ranged from 44.38 to 44.94 minutes across ages, while average bedtime routine length variability ranged from 16.15 to 16.47 minutes across ages. Average deviation from the normal routine ranged from 1.38 to 1.57 activities across ages.

Regarding the sleep outcome variables, average parent-reported sleep duration ranged from 10.55 to 10.64 hours across ages, and average actigraph-recorded sleep duration ranged from 8.30 to 8.59 hours across ages. Average actigraph-recorded sleep onset time ranged from 9:24 pm to 9:26 pm across ages, and average sleep latency ranged from 35.13 to 38.11 minutes across ages. Average parent-reported negative affect across ages ranged from 3.60 to 3.87.

Table 4.3
Descriptive Statistics for All Study Variables

	30 months		36 months		42 months	
	M (SD)	N	M (SD)	N	M (SD)	N
Routine Length (minutes)	44.94 (21.41)	393	44.38 (19.55)	323	44.40 (18.81)	289
Routine Length Variability (minutes)	16.15 (10.04)	393	16.29 (9.89)	323	16.47 (10.30)	289
Deviation from Normal Routine (activities)	1.57 (0.84)	395	1.42 (0.74)	324	1.38 (0.78)	289
Parent Reported Sleep Duration (hours)	10.64 (0.84)	393	10.58 (0.67)	323	10.55 (0.64)	289
Actigraph Recorded Sleep Duration (hours)	8.30 (1.09)	380	8.48 (0.95)	294	8.59 (1.02)	279
Actigraph Recorded Sleep Onset Time	9:25 pm (50.4 min)	380	9:26 pm (48.6 min)	294	9:24 pm (52.2 min)	279
Actigraph Recorded Sleep Latency (minutes)	38.11 (24.42)	376	37.13 (20.57)	294	35.13 (21.36)	278
Negative Affect (possible range 0-7)	3.60 (0.58)	394	3.83 (0.60)	325	3.87 (0.63)	304

Within-age correlational analyses. To examine overall relations among study variables, nightly values for each variable were averaged across the two-week reporting period at each age, and correlations can be found in Tables 4.4 – 4.6. The pattern of significant correlations across ages was compared to determine if the bedtime routine and sleep measures were similarly related at each age. Bedtime routine length and routine length variability were significantly and negatively associated with both parent-reported and actigraph-recorded sleep duration at 30 and 36 months. Routine length and routine length variability were negatively associated with both parent-reported and actigraph-reported sleep duration at 42 months, however, only the correlations with parent-reported sleep were statistically significant. In other words, at 30 and 36 months, children got less sleep when their bedtime routine was longer and there was more variability in the length of the routine, according to both parent and actigraph report. At 42 months, however, children got less sleep when their bedtime routine was longer and more variable in length, according to parent report only. Longer bedtime routines and more variable routine lengths were positively associated with actigraph-recorded sleep onset at all three ages, such that children fell asleep later when they had longer or more variable routine lengths.

Table 4.4

Correlations Between All Study Variables at 30 Months

	Gender	Routine length	Routine length variability	Deviation from normal routine	PR sleep duration	AR sleep duration	AR sleep onset	AR sleep latency	Negative Affect
Gender	1								
Routine length	.157**	1							
Routine length variability	.130*	.673**	1						
Deviation from normal routine	.043	.167**	.163**	1					
PR sleep duration	.045	-.184**	-.216**	-.114*	1				
AR sleep duration	.033	-.147**	-.140**	-.146**	.371**	1			
AR sleep onset	.047	.206**	.231**	.170**	-.367**	-.350**	1		
AR sleep latency	.022	-.008	.017	.041	.322**	-.273**	.333**	1	
Negative affect	.098	.082	.101	.109*	-.070	-.032	.072	-.036	1

Note. PR = parent reported, AR = actigraph recorded.
* $p < .05$, ** $p < .01$, *** $p < .001$

Table 4.5
Correlations Between All Study Variables at 36 Months

	Gender	Routine length	Routine length variability	Deviation from normal routine	PR sleep duration	AR sleep duration	AR sleep onset	AR sleep latency	Negative Affect
Gender	1								
Routine length	0.105	1							
Routine length variability	0.022	.624**	1						
Deviation from normal routine	0.052	.191**	.175**	1					
PR sleep duration	0.092	-.203**	-.264**	0.023	1				
AR sleep duration	.144*	-.139*	-.154*	0.032	.495**	1			
AR sleep onset	-0.013	.207**	.188**	0.071	-.379**	-.395**	1		
AR sleep latency	-0.019	0.020	-0.093	-0.004	.203**	-.246**	.264**	1	
Negative affect	.154**	0.090	0.072	0.046	0.022	0.105	-0.055	0.029	1

Note. PR = parent reported, AR = actigraph recorded.
* $p < .05$, ** $p < .01$, *** $p < .001$

Table 4.6

Correlations Between All Study Variables at 42 Months

	Gender	Routine length	Routine length variability	Deviation from normal routine	PR sleep duration	AR sleep duration	AR sleep onset	AR sleep latency	Negative Affect
Gender	1								
Routine length	0.063	1							
Routine length variability	0.082	.563**	1						
Deviation from normal routine	0.076	0.097	.124*	1					
PR sleep duration	0.100	-.128*	-.170**	0.030	1				
AR sleep duration	.143*	-0.053	-0.029	0.056	.359**	1			
AR sleep onset	-0.005	.198**	.198**	0.059	-.323**	-.338**	1		
AR sleep latency	-0.010	-0.001	-0.073	-0.087	.220**	-.235**	.324**	1	
Negative affect	.141*	0.066	-0.071	0.080	0.091	0.093	-0.062	-0.005	1

Note. PR = parent reported, AR = actigraph recorded

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

Deviation from the normal routine was significantly and negatively associated with parent-reported sleep duration and actigraph-recorded sleep duration, and significantly and positively associated with sleep onset at 30 months. In other words, the more the bedtime routine activities deviated from the normal routine activities, the later children fell asleep, and the less sleep children got according to both parent and actigraph report. However, deviation from the normal routine activities was not associated with any sleep variables at 36 or 42 months.

Research Aim 1: Consistency of the Bedtime Routine on a Nightly Basis Within Age

The goal of the first research aim was to determine: (a) whether consistency or variability in the bedtime routine (i.e., length and activities) on an individual night would be associated with sleep measures (i.e., parent and actigraph recorded sleep duration, sleep onset, and sleep latency) on that same night; (b) whether sleep measures on a particular night would be associated with the bedtime routine on the following night; and (c) whether associations between nightly bedtime routines and nightly sleep measures were the same at 30, 36 and 42 months of age. This research aim was accomplished by testing several hypotheses:

1a. Variability in the bedtime routine on an individual night is associated with sleep measures on that same night at 30, 36, and 42 months.

1a1. More variability in the bedtime routine (both length and activities) will be associated with less parent-reported sleep duration.

1a2. More variability in the bedtime routine (both length and activities) will be associated with less actigraph-recorded sleep duration.

1a3. More variability in the bedtime routine (both length and activities) will be associated with later sleep onset.

1a4. More variability in the bedtime routine (both length and activities) will be associated with longer sleep latency.

1b. Sleep measures on a particular night will be associated with variability in the bedtime routine on the following night,

1c. Associations between bedtime routines and sleep measures will be the same at 30, 36, and 42 months.

Because no prior research has examined associations between sleep on one night and the bedtime routine on the following night, nor examined associations between bedtime routine and sleep measures longitudinally across time, no specific hypotheses are made regarding direction of effects for individual sleep measures. Thus, hypotheses 1b and 1c were exploratory.

Within-night associations between bedtime routines and sleep measures. To test hypothesis 1a (variability in the bedtime routine on a specific night is associated with sleep on that same night), multilevel models were run with the two measures of bedtime routine variability (routine length variability and deviation from the normal routine) as predictors. The four sleep variables (actigraph-recorded sleep duration, parent-reported sleep duration, actigraph-recorded sleep onset, and actigraph-recorded sleep latency) were the outcome measures. Each predictor and outcome pair were examined in separate models at each age (30, 36, and 42 months), resulting in 24 models. Gender and weeknight were dichotomous variables and included as covariates in each model. All Level 1 effects were modeled as random effects (see Equation 1).

Level 1: (1)

$$\text{Sleep outcome} = b_{ij} + b_{1j}\,(\text{bedtime routine predictor}) + b_{2j}\,(\text{weeknight}) + e_{ij}$$

Level 2:

$$b_{0j}\,(\text{sleep outcome average}) = c_{00} + c_{01}\,(\text{gender}) + u_{0j}$$
$$b_{1j}\,(\text{bedtime routine predictor}) = c_{10} + c_{11}\,(\text{gender}) + u_{1j}$$
$$b_{2j}\,(\text{weeknight}) = c_{20} + u_{2j}$$

Table 4.7 contains the results from the multilevel models for routine length variability (RLV) at 30 months. Bedtime routine length variability significantly predicted all four sleep outcome variables. Specifically, on nights with more variable routine lengths, children had shorter actigraph-recorded and parent-reported sleep duration, and had shorter sleep latency. Weeknight predicted only sleep onset, such that more variability in routine length predicted later sleep onset but only on weekends.

Table 4.7
Results from Multilevel Models Predicting Sleep Measures from Routine Length Variability (RLV) at 30 months

	Sleep Outcomes B (SE)			
	Parent Reported Sleep Duration	Actigraph Recorded Sleep Duration	Actigraph Recorded Sleep Onset	Actigraph Recorded Sleep Latency
Intercept	10.73 (0.06)*	8.31 (0.09)*	21.51 (0.07)*	40.64 (2.07)*
RLV	-0.01 (0.001)*	-0.004 (.002)*	0.003 (0.002)*	-0.14 (0.05)*
Weeknight	-0.03 (0.03)	0.01 (0.04)	-0.22 (0.03)*	0.86 (1.20)
Gender	0.11 (0.08)	0.14 (0.12)	-0.03 (0.09)	-0.75 (2.77)
RLV*gender	-0.001 (0.002)	-0.00 (0.003)	0.002 (0.002)	0.02 (0.07)
Residual Variance				
Level 1	0.51 (0.01)*	65.68 (0.002)*	0.52 (0.01)*	971.87 (26.91)*
Level 2				
Sleep Outcome	0.62 (0.06)*	57.77 (7.20)*	0.69 (0.07)*	458.76 (82.99)*
RLV	0.00 (0.00)*	0.00 (0.00)	0.00 (0.00)*	0.03 (0.04)
Weeknight	0.18 (0.03)*	0.02 (2.48)	0.06 (0.03)*	1.01 (48.29)

*$p < .05$

Table 4.8 presents the results from the multilevel models for deviation from the normal routine (DNR) at 30 months. DNR was not a significant predictor of any of the sleep outcome variables, however, children fell asleep later on weekends.

Table 4.8

Results from Multilevel Models Predicting Sleep Measures from Deviation from Normal Routine (DNR) at 30 months

	Sleep Outcomes B (SE)			
	Parent Reported Sleep Duration	Actigraph Recorded Sleep Duration	Actigraph Recorded Sleep Onset	Actigraph Recorded Sleep Latency
Intercept	10.60 (0.07)*	8.26 (0.09)*	21.52 (0.07)*	37.69 (1.94)*
DNR	-0.002 (0.02)	-0.03 (0.02)	0.01 (0.02)	-0.34 (0.60)
Weeknight	-0.004 (0.03)	0.07 (0.04)	-0.22 (0.03)*	1.43 (1.17)
Gender	0.08 (0.09)	0.08 (0.13)	0.04 (0.09)	-3.02 (2.62)
DNR*Gender	-0.001 (0.03)	0.02 (0.03)	-0.01 (0.03)	1.23 (0.88)*
Residual Variance				
Level 1	0.55 (0.01)*	65.99 (1.73)*	0.61 (0.02)*	1024.72 (26.32)*
Level 2				
Sleep Outcome	0.67 (0.07)*	63.64 (7.56)*	0.64 (0.07)*	307.48 (77.80)*
DNR	0.02 (0.004)*	0.64 (0.37)	0.01 (0.003)*	1.00 (5.65)
Weeknight	0.15 (0.03)*	2.93 (2.66)	0.05 (0.03)*	0.97 (46.80)

*$p < .05$

Table 4.9 presents the results from the multilevel models for RLV at 36 months. Similar to the results at 30 months, more variable bedtime routine length significantly predicted later sleep onset, shorter actigraph-recorded and shorter parent-reported sleep durations on those same nights. However, variability in the routine length was not related to sleep latency. Gender was a significant predictor only for actigraph-recorded sleep duration, with boys sleeping longer than girls. Again, more variable routine lengths were associated with later sleep onset on weekends.

Table 4.9
Results from Multilevel Models Predicting Sleep Measures from Routine Length Variability (RLV) at 36 months

	Sleep Outcomes B (SE)			
	Parent Reported Sleep Duration	Actigraph Recorded Sleep Duration	Actigraph Recorded Sleep Onset	Actigraph Recorded Sleep Latency
Intercept	10.69 (0.06)*	8.42 (0.09)*	21.52 (0.08)*	38.86 (2.31)*
RLV	-0.01 (0.001)*	-0.004 (0.002)*	0.01 (0.002)*	-0.07 (0.05)
Weeknight	-0.02 (0.03)	0.003 (0.05)	-0.25 (0.04)*	1.41 (1.53)
Gender	0.07 (0.08)	0.27 (0.13)*	-0.02 (0.10)	1.40 (2.92)
RLV*Gender	0.001 (0.002)	-0.002 (0.00)	-0.001 (0.003)	-0.06 (0.08)
Residual Variance				
Level 1	0.48 (0.01)*	60.01 (1.93)*	0.50 (0.02)*	850.81 (27.45)*
Level 2				
Sleep Outcome	0.43 (0.05)*	51.47 (6.77)*	0.75 (0.09)*	446.39 (83.23)*
RLV	0.00 (0.00)*	0.001 (0.00)	0.00 (0.00)*	0.02 (0.02)
Weeknight	0.10 (0.03)*	0.02 (2.63)	0.10 (0.03)*	140.07 (55.25)*

$^*p < .05$

Table 4.10 contains the results from the multilevel models for DNR at 36 months. Deviation from the normal routine did not predict any of the sleep outcome variables, but weeknight predicted sleep onset such that children fell asleep later on weekends.

Table 4.10
Results from Multilevel Models Predicting Sleep Measures Deviation from Normal Routine (DNR) at 36 months

	Sleep Outcomes B (SE)			
	Parent Reported Sleep Duration	Actigraph Recorded Sleep Duration	Actigraph Recorded Sleep Onset	Actigraph Recorded Sleep Latency
Intercept	10.58 (0.06)*	8.31 (0.10)*	21.63 (0.08)*	37.91 (2.19)*
DNR	-0.03 (0.02)	0.003 (0.03)	0.02 (0.02)	-0.41 (0.68)
Weeknight	0.002 (0.03)	0.05 (0.05)	-0.28 (0.04)*	0.84 (1.29)
Gender	0.04 (0.09)	0.22 (0.13)	-0.02 (0.11)	-0.43 (2.91)
DNR*Gender	0.03 (0.03)	0.01 (0.04)	-0.02 (0.03)	0.42 (0.98)
Residual Variance				
Level 1	0.53 (0.01)*	61.17 (1.87)*	0.59 (0.02)*	9140.67 (29.06)*
Level 2				
Sleep Outcome	0.42 (0.05)*	57.63 (7.71)*	0.87 (0.10)*	312.03 (70.14)*
DNR	0.02 (0.01)*	0.98 (0.45)*	0.01 (0.004)	0.47 (8.25)
Weeknight	0.12 (0.03)*	3.16 (2.89)	0.10 (0.03)*	1.28 (33.91)

*$p < .05$

Results at 42 months for routine length variability were nearly identical to results at 30 and 36 months, and are presented in Table 4.11. More variable routine lengths on individual nights predicted shorter actigraph-recorded and parent-reported sleep duration on those same nights, and more variable routine lengths were associated with later sleep onset on the weekends. Variability in the routine length was not associated with sleep latency.

Table 4.11
Results from Multilevel Models Predicting Sleep Measures from Routine Length Variability (RLV) at 42 months

	Sleep Outcomes B (SE)			
	Parent Reported Sleep Duration	Actigraph Recorded Sleep Duration	Actigraph Recorded Sleep Onset	Actigraph Recorded Sleep Latency
Intercept	10.64 (0.06)*	8.59 (0.10)*	21.45 (0.08)*	37.78 (2.35)*
RLV	-0.01 (0.001)*	-0.005 (0.002)*	0.01 (0.002)*	-0.10 (0.06)
Weeknight	0.01 (0.04)	-0.003 (0.05)	-0.21 (0.05)*	2.27 (1.43)
Gender	0.12 (0.08)	0.24 (0.14)	-0.06 (0.11)	-0.23 (3.17)
RLV*gender	0.001 (0.002)	0.001 (0.003)	-0.001 (0.002)	-0.02 (0.08)
Residual Variance				
Level 1	0.48 (0.01)*	65.61 (2.30)*	0.57 (0.02)*	928.68 (33.87)*
Level 2				
Sleep Outcome	0.46 (0.06)*	49.04 (7.79)*	0.75 (0.10)*	358.38 (71.36)*
RLV	0.00 (0.00)	0.001 (0.002)	0.00 (0.00)	0.02 (0.04)
Weeknight	0.14 (0.03)*	0.02 (2.53)	0.22 (0.05)*	2.84 (39.32)

**p < .05, **p < .01, ***p < .001*

Results for the multilevel models testing deviation from the normal routine are in Table 4.12. Once again, deviation from the normal routine was not associated with any of the sleep outcome variables, but weeknight predicted sleep onset such that children fell asleep later on the weekends.

Table 4.12
Results from Multilevel Models Predicting Sleep Measures from Deviation from Normal Routine (DNR) at 42 months

	Sleep Outcome B (SE)			
	Parent Reported Sleep Duration	Actigraph Recorded Sleep Duration	Actigraph Recorded Sleep Onset	Actigraph Recorded Sleep Latency
Intercept	10.45 (0.07)*	8.41 (0.10)*	21.62 (0.09)*	35.87 (2.40)*
DNR	0.01 (0.02)	0.03 (0.03)	-0.01 (0.02)	-1.03 (0.82)
Weeknight	0.04 (0.04)	0.04 (0.07)	-0.28 (0.05)*	2.64 (1.37)
Gender	0.14 (0.09)	0.27 (0.14)	0.00 (0.11)	-1.28 (3.34)
DNR*gender	-0.003 (0.03)	0.001 (0.04)	-0.04 (0.03)	0.57 (1.09)
Residual Variance				
Level 1	0.52 (0.02)	63.72 (2.05)*	0.64 (0.02)	924.88 (30.82)*
Level 2				
Sleep Outcome	0.49 (0.06)*	56.53 (8.29)*	0.96 (0.12)*	379.44 (72.59)*
DNR	0.01 (0.004)*	0.84 (0.47)	0.01 (0.01)	5.61 (6.31)
Weeknight	0.14 (0.03)*	13.86 (4.49)*	0.21 (0.05)*	4.40 (38.28)

*$p < .05$

Taken together, results partially supported hypothesis 1a. More variability in the routine length was associated with shorter parent-reported and actigraph-recorded sleep duration and later sleep onset at all three ages. However, contrary to the hypothesized direction of associations, more variable routine lengths were associated with shorter, not longer, sleep latency; and associations were only significant at 30 months. In addition, there were no significant associations between deviation from the normal routine activities and the sleep measures at any age.

Night-to-night associations between sleep measures and bedtime routines. While the multilevel models reported above were used to examine associations within the same night between variability in the bedtime routine and sleep measures, due to the structure of the data and patterns of missingness within the data, multilevel modeling was not appropriate to address across-night associations. Therefore, autoregressive cross-lagged path models were run at each age and for each bedtime routine predictor and sleep outcome pair, in order to address exploratory hypothesis 1b (sleep measures on one night would be associated with the bedtime routine on the following night). Note that no specific hypotheses were made regarding direction of the effects for the individual measures.

A model building approach was undertaken in order to arrive at the best-fitting, yet most parsimonious model. The first model tested the lag 1 within-variable paths. In other words, bedtime routine on night *t* predicting bedtime routine on night *t+1*, and sleep on night *t* predicting sleep on night *t+1*, across the 14 nights. Second, the lag 2 within-variable paths were added, such that the bedtime routine on night *t* predicted the bedtime routine on nights *t+1* and *t+2*, and sleep on night *t* predicted sleep on nights *t+1* and *t+2*. Third, the within-night, cross-variable paths were added, such that the bedtime routine on night *t* predicted sleep on that same night *t*. The fourth model tested added the paths from sleep on night *t* to bedtime routine on the following night, *t+1*. For example, sleep on night 1 predicted the bedtime routine on night 2, sleep on night 2 predicted the bedtime routine on night 3, and so on. The fifth model added the cross-lags, from bedtime routine on night *t* to sleep on night *t+1*. The final model (Model 6) added within-variable lag 7s, such that bedtime routine on night *t* predicted the bedtime routine on night *t+7*, and sleep on night *t* predicted sleep on night *t+7*. These lag 7's were included to account for week-to-week similarities in the bedtime routine (i.e., families doing the same things in the evening on Mondays vs. Tuesdays, etc.). Figure 4.9 graphically shows all paths included in the fully cross-lagged autoregressive path model, Model 6. The bolded arrows represent the paths that were the focus of exploratory hypothesis 1b: that sleep on one night would be associated with variability in the bedtime routine the following night. All other paths (greyed arrows) resulted from the model building process described above, and were included primarily as control variables.

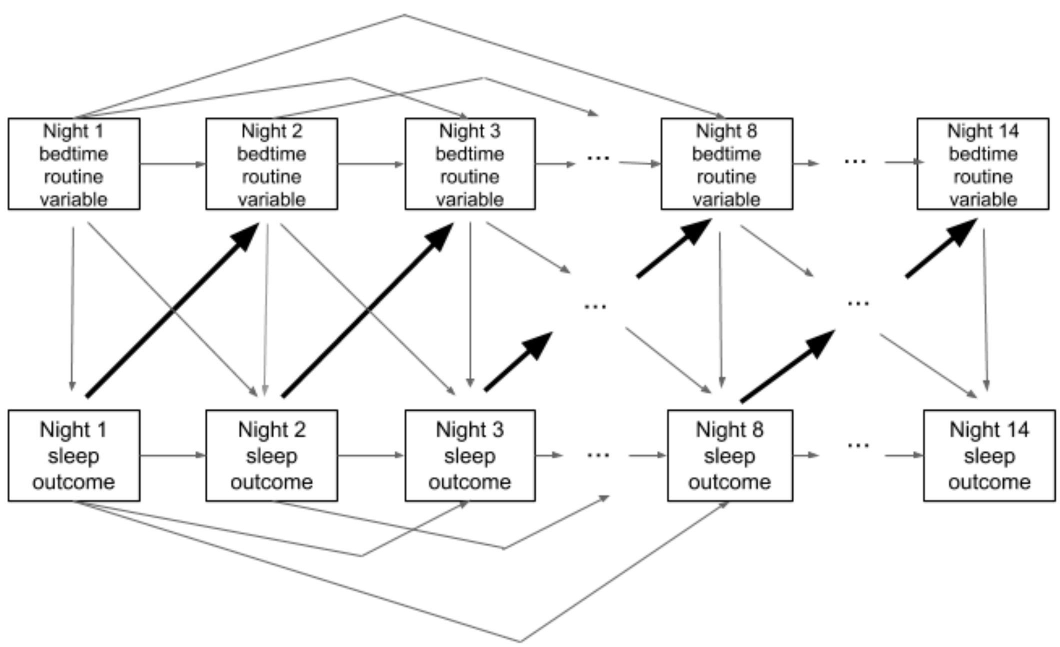


Figure 4.9. Example of Model 6: full cross-lagged path model tested at 30, 36, and 42 months. Bolded paths represent the paths of interest- from sleep on one night to bedtime routine variability the following night. Greyed out paths represent paths that were included as part of the model building process described above, and were included primarily as control variables.

To determine the best fitting model of the six tested for each bedtime routine and sleep outcome pair at each age, several fit indices were examined and considered. Model chi-square is a test of exact fit and a non-significant chi-square value indicates that the model fits the data perfectly (Kline, 2016). The Root Mean Square Error of Approximation (RMSEA) is a "badness-of-fit" index, with higher values indicating poorer fit. RMSEA values less than 0.06 indicate good fit of a model (Hu & Bentler, 1999). The Comparative Fit Index (CFI; Bentler, 1988) is a "goodness-of-fit" index, with higher values indicating better fit. CFI values greater than 0.95 indicate acceptable fit (Hu & Bentler, 1999). Finally, the Standardized Root Mean Square Residual (SRMR) is a "badness-of-fit" index, with values less than 0.08 indicating acceptable fit (Hu & Bentler, 1999; Kline, 2016).

Table 4.13 has model fit statistics for the fully cross-lagged autoregressive path model (Model 6) for every bedtime routine and sleep outcome pair at each age (eight models at each age, for a total of 24 models). Despite Model 6 being the best fitting model for each bedtime routine and sleep outcome pair from the model building process as described above, overall model fit statistics for each model run were not within the suggested ranges to be considered a good fitting model (Hu & Bentler, 1999; Kline, 2016). While overall model fit could have been improved by making non-hypothesized modifications suggested by the software used to run analyses (Mplus version 8.1), many of these modifications violated temporal precedence (such as regressing an earlier night's bedtime routine on a later night's bedtime routine). In addition, the primary purpose of this hypothesis was to explore whether sleep measures on a particular night would be associated with variability in the bedtime routine the following night, and not to identify a perfectly fitting model. Because Model 6 included all hypothesized night-to-night relations of interest between sleep measures and bedtime routines while controlling for within-variable autoregressive effects, results from Model 6 at each age are reported below for each sleep measure and bedtime routine variability pair, despite less than optimal overall model fit as indicated by the fit indices.

Table 4.13

Model Fit Statistics for Each Autoregressive Cross-Lagged Path Model Tested (Model 6), Predicting Measures of Routine Variability from Sleep Measures at 30, 36, and 42 Months (24 Total Models)

	30 months				36 months				42 months			
	X2	RMSEA	CFI	SRMR	X2	RMSEA	CFI	SRMR	X2	RMSEA	CFI	SRMR
Routine Length Variability												
PR Sleep Duration	754.80*	.07	.81	.12	677.93*	.07	.79	.11	711.53*	.08	.73	.11
AR Sleep Duration	724.15*	.07	.80	.10	473.51*	.05	.87	.09	579.20*	.07	.76	.11
AR Sleep Onset	795.45*	.07	.81	.15	616.71*	.06	.83	.15	712.37*	.08	.73	.17
AR Sleep Latency	694.73*	.06	.72	.10	535.79*	.06	.72	.11	581.52*	.07	.62	.11
Deviation from Normal Routine												
PR Sleep Duration	643.31*	.06	.90	.12	689.88*	.07	.86	.11	583.29*	.06	.87	.11
AR Sleep Duration	616.55*	.06	.91	.08	535.98*	.05	.90	.10	538.96*	.06	.88	.09
AR Sleep Onset	727.39*	.07	.89	.13	597.60*	.06	.89	.17	622.49*	.07	.85	.13
AR Sleep Latency	543.54*	.05	.91	.08	583.32*	.06	.85	.10	537.00*	.07	.84	.09

Note. AR = actigraph-recorded, PR = parent-reported. *df* = 274.
* $p < .05$

Overall, across all models tested that included each bedtime routine variable and sleep outcome pair at all three ages (24 models total), the majority of the within-variable autoregressive effects were significant, indicating that bedtime routine variability on one night was associated with bedtime routine variability on subsequent nights; likewise sleep measures on one night were associated with sleep measures on subsequent nights. There were also several within-night associations between bedtime routine variability and sleep outcomes on the same night, consistent with the findings from the multilevel models (research question 1a). Regarding the cross-lagged associations between bedtime routine variability on one night and sleep measures the following night, across all models the number of statistically significant paths varied from zero to two out of a possible 13, likely no more than expected by chance alone. However, these paths were not hypothesized, nor the target for investigation, and were only included as control variables as part of the model building process; thus, further interpretation was not pursued. Finally, for the hypothesized associations of interest, from sleep measures on one night to variability in the bedtime routine the following night, across all models tested at each age, again only a handful of paths (out of a possible 13) were significant. In fact, no model between any bedtime routine and sleep measure pair at any age had more than two significant paths out of a possible 13 (see Table 4.14 for the number of significant paths of interest for each model). For completeness, all path coefficients for each model tested are reported in Appendix A.

Table 4.14
Number of Significant Paths Across Two Week Reporting Period Between Sleep Measures and Measures of Routine Variability at 30, 36, and 42 Months

			30 months	36 months	42 months
<u>Sleep Measures on one night to Routine Length Variability (RLV) the Following Night</u>					
Parent-reported Sleep Duration	→	RLV	2	1	--
Actigraph-recorded Sleep Duration	→	RLV	--	1	2
Sleep Onset	→	RLV	1	--	2
Sleep Latency	→	RLV	--	2	--
<u>Sleep Measures on one night to Deviation from Normal Routine (DNR) the Following Night</u>					
Parent-reported Sleep Duration	→	DNR	--	1	1
Actigraph-recorded sleep duration	→	DNR	--	1	1
Sleep Onset	→	DNR	1	--	--
Sleep Latency	→	DNR	1	--	1

Note. There are 13 possible paths between sleep measures on one night and measures of routine variability the following night, thus all numbers reported above are out of a possible 13.

For illustrative purposes, Figure 4.10 shows the autoregressive cross-lagged path model for one bedtime routine/sleep measure pair: between routine length variability and parent-reported sleep duration at 30 months. Only significant paths are depicted with arrows, along with their coefficients. The two bolded arrows indicate the significant paths of interest: parent-reported sleep duration on night 4 to routine length variability on night 5, and parent-reported sleep duration on night 11 to routine length variability on night 12.

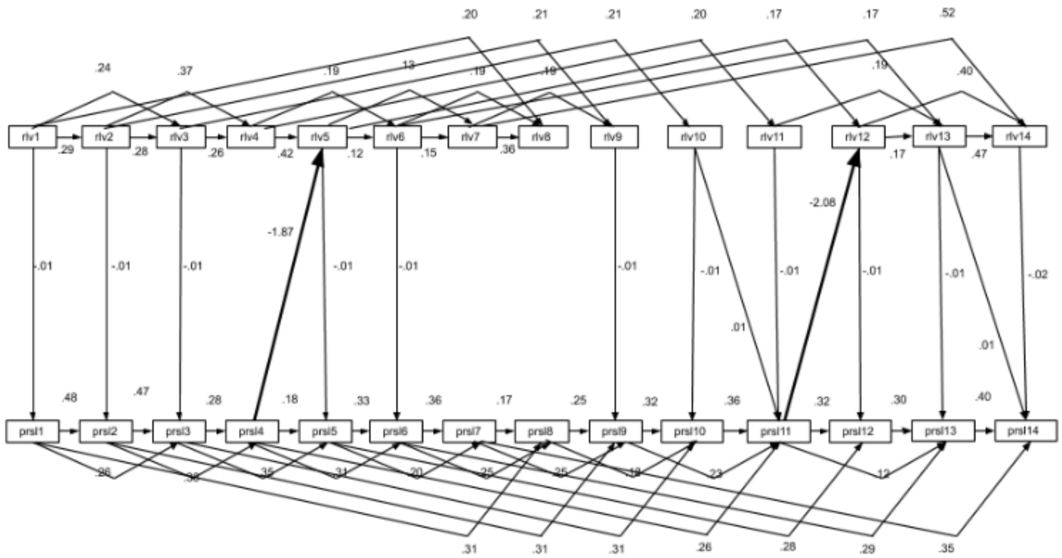


Figure 4.10. Autoregressive cross-lagged path model between routine length variability (rlv) and parent-reported sleep duration (prsl) on each night across two-week reporting period at 30 months. Only significant paths are included. Bolded arrows indicate hypothesized paths of interest.

In sum, there were only a few significant associations between sleep measures on an individual night and variability in the bedtime routine the following night, and significant associations were likely no greater than chance. Thus, hypothesis 1b, that sleep measures on a particular night are associated with bedtime routine variability the following night, was unsupported.

Similarities in associations between sleep measures and bedtime routine variability at 30, 36 and 42 months. Hypothesis 1c, that associations between sleep measures and bedtime routine variability are the same at 30, 36, and 42 months, is dependent upon evidence supporting hypothesis 1b. Because there were only a few significant associations between sleep measures on a particular night and bedtime routine variability the following night, and those associations were not consistent across ages, hypothesis 1c was not tested.

Research Aim 2: Longitudinal Stability of Bedtime Routines

The goal of the second research aim was to investigate the longitudinal stability of bedtime routines from 30 to 36 to 42 months. Two hypotheses were tested in this research aim:

2a. The length of the bedtime routine will change from 30 to 36 to 42 months, although it was not hypothesized if the length of the bedtime routine will get shorter or longer across time.

2b. The proportion of the bedtime routine activities completed at each age will change from 30 to 36 to 42 months, although it was not hypothesized which particular activities might change across time, nor whether the routine activities would increase or decrease in frequency across time.

Longitudinal stability of the bedtime routine length. To test hypothesis 2a (the length of the bedtime routine will change across time), first, bedtime routine lengths for each child were averaged across the two-week reporting period at each age to calculate an average routine length at 30, 36, and 42 months. Next, correlations were computed between average routine length at each age to determine if routine length was associated across time. Average routine length at 30 months was significantly positively correlated with average routine length at 36 months (r = .62), and significantly positively correlated with average routine length at 42 months (r = .61). In addition, average routine length at 36 months was significantly positively correlated with average routine length at 42 months (r = .58).

Next, to determine if bedtime routine lengths were significantly different across time, a one-way ANOVA was calculated, with age as the factor. Because one-way ANOVA assumes data are normally distributed, prior to conducting analyses, normality of the data was tested via the Shapiro-Wilk test for normality (Shapiro & Wilk, 1965). The Shapiro-Wilk test was chosen because it is the most powerful and omnibus test in cases of non-normality (Oztuna, Elhan, & Tuccar, 2006). Average routine length at 30 months was not normally distributed ($W_{Shapiro\text{-}Wilk}$ (372)= .915, $p < .001$). Similarly, average routine length at 36 months was not normally distributed ($W_{Shapiro\text{-}Wilk}$ (298)= .912, $p < .001$), nor was average routine length normally distributed at 42 months ($W_{Shapiro\text{-}Wilk}$ (273)= .957, $p < .001$). However, as demonstrated by Harwell, Rubinstein, Hayes, and Olds (1992), the effect of non-normality on the *F* test in ANOVA had a negligible effect on power, and a slight inflation of α. Recent work by Cain, Zhang, & Yuan (2016) demonstrated that the effect of non-normality on the inflation of α was only evident in samples smaller than 105. Therefore, despite the statistically significant non-normal distribution of average routine length at 30, 36, and 42 months, one-way ANOVA was used to test whether the length of the bedtime routine changed or remained the same across time. The omnibus *F* test was not significant ($F_{(2,940)}$= .397, $p = .672$), indicating that the length of the bedtime routine did not significantly change from 30 to 36 to 42 months. Thus, hypothesis 2a was not supported.

Longitudinal stability of the bedtime routine activities. To test hypothesis 2b, that the proportion of individual activities during the bedtime routine would change across time, a series of paired samples *t*-tests were computed. First, the incidence of each bedtime routine activity for each child was aggregated across the two-week data collection period at each age and used to create proportion scores. For instance, if a bath occurred 11 out of the 14 nights of the data collection period, the proportion score for bath for that individual child would be 0.79. Proportion scores indicated how common a particular bedtime activity was for each child, with higher scores indicating the particular activity was more common. Paired sample *t*-tests were then calculated to test the mean difference between the activity proportion scores at each age (Table 4.15). To account for multiple comparisons between all the bedtime routine activities at each age, a Sidak-Bonferroni correction was chosen because it is less stringent than a Bonferroni correction while maintaining power (Simes, 1986). The Sidak-Bonferroni correction was calculated with the following formula:

$$\alpha_{Sidak-B} = 1 - (1 - \alpha_{FW})^{\left(\frac{1}{c}\right)} \quad (2)$$

where α_{FW} is equal to the family-wise alpha level (0.05), and c is equal to the number of comparisons being made. Three comparisons were made for each bedtime routine activity: 30 to 36 months, 36 to 42 months, and 30 to 42 months, so $c = 3$ for calculating the Sidak-Bonferroni test correction, which set alpha at 0.01695. Therefore, any mean difference that had a p-value less than 0.01695 was considered to be statistically significant.

Table 4.15
Paired Samples t-tests of Routine Activity Proportion Scores Across Time

	30 Months		36 Months		42 Months		30 to 36 Months	36 to 42 Months	30 to 42 months
Routine Activity	*M*	*SD*	*M*	*SD*	*M*	*SD*	*t*-test	*t*-test	*t*-test
Bath	0.35	0.27	0.33	0.28	0.34	0.27	2.18	-1.63	0.34
PJ	0.73	0.30	0.73	0.31	0.71	0.33	0.63	0.29	1.21
Teeth	0.70	0.30	9.71	0.29	0.73	0.30	-0.66	-1.55	-2.16
Drink	0.29	0.38	0.35	0.39	0.32	0.40	-1.95	-0.21	-2.16
Pray	0.19	0.34	0.14	0.30	0.14	0.29	**3.38***	-0.03	**3.04***
Potty	0.11	0.25	0.12	0.27	0.11	0.27	-0.35	0.17	-0.85
Snack	0.12	0.24	0.08	0.19	0.08	0.20	**2.97***	0.29	**3.05***
Cuddle	0.13	0.28	0.08	0.21	0.08	0.22	**3.99***	0.64	**3.86***
Play	0.03	0.10	0.03	0.11	0.03	0.11	0.49	-0.55	-0.20
Music	0.21	0.33	0.13	0.27	0.13	0.26	**4.54***	0.63	**4.07***
Object	0.03	0.14	0.01	0.09	0.01	0.08	1.69	-0.04	2.03
Read	0.62	0.31	0.60	0.30	0.60	0.31	2.14	-1.40	0.39
Tech	0.18	0.25	0.21	0.29	0.22	0.29	-2.00	-0.84	-1.81
Talk	0.02	0.12	0.02	0.11	0.01	0.10	1.28	0.14	1.06
Medicine	0.01	0.09	0.01	0.07	0.03	0.13	1.20	-1.26	-1.74
Pickup	0.02	0.10	0.01	0.06	0.01	0.04	**2.58***	0.54	2.40
Other	0.04	0.15	0.01	0.06	0.02	0.10	**3.07***	-0.46	1.74

Note. Sidak-Bonferroni corrected alpha: $*p < .01695$; 30 to 36 months $df = 315$; 36 to 42 months $df = 268$; 30 to 42 months $df = 285$. Positive *t*-test values indicate a decrease in the activity across time, whereas negative *t*-test values indicate a positive increase in the activity across time.

Of the 17 bedtime routine activities examined, the proportions of six activities (praying, giving a snack, cuddling, playing music or singing, picking up, and "other") significantly decreased from 30 to 36 months, and the proportions of four activities (praying, giving a snack, cuddling, and playing music or singing) significantly decreased from 30 to 42 months. Interestingly, there were no activities that were significantly different between 36 and 42 months, suggesting that bedtime routine activities were more stable from 36 to 42 months than from 30 to 36 months. In addition, there were no activities that significantly increased across time.

To better understand the practical significance of these decreases in the occurrence of these activities across time, Cohen's *d* effect sizes were calculated on all significant differences (Table 4.16).

Table 4.16
Cohen's D Effect Sizes for Significant Decreases Across Time

	30 to 36 months	36 to 42 months	30 to 42 months
Pray	0.130	---	0.132
Snack	0.155	---	0.184
Cuddle	0.215	---	0.259
Music	0.243	---	0.249
Pickup	0.122	---	---
Other	0.234	---	---

Using Cohen's guidelines for characterizing size of effect (small = .20, medium = .50, large = 80; Cohen, 1988), decreases between 30 and 36 months in the incidence of cuddling, playing music/singing, and "other" were small effects, as well as decreases in the incidence of cuddling and playing music/singing between 30 and 42 months were small effects. Decreases in the incidence of praying, giving a snack, and picking up between 30 and 36 months, as well as between 30 and 42 months were less than the .20 cutoff to be characterized as a small effect.

In sum, hypothesis 2b was partially supported. Only six of the 17 bedtime routine activities proportions changed across time. All changes in routine activity proportions were small and decreased across time, while no activity increased from 30 to 36 to 42 months.

Research Aim 3: Child-Level Characteristics that Impact Bedtime Routines and Sleep

The goal of the third research aim was to investigate how child characteristics, specifically temperamental negative affect, were related to (a) the consistency of bedtime routines on a nightly basis; (b) the longitudinal stability of bedtime routines from 30 to 36 to 42 months; and (c) whether there were transactional relations between negative affect and bedtime routines. Three hypotheses were tested in this research aim:

3a. Children's negative affect is associated with the consistency of the bedtime routine on a nightly basis, although no specific hypotheses were made regarding direction of effects.

3b. Children's negative affect is associated with the longitudinal stability of both the length of bedtime routine and the activities in the bedtime routine across time, although no specific hypotheses were made regarding direction of effects.

3c. Transactional relations between children's negative affect and bedtime routines will be identified.

Negative affect and bedtime routine consistency. To test hypothesis 3a, that children's negative affect is associated with the consistency of the bedtime routine on a nightly basis, correlations were examined between negative affect, average routine length variability, and average deviation from the normal routine at all three ages (Tables 4.4 – 4.6). Negative affect was significantly and positively correlated with deviation from the normal routine at 30 months (r = .11), with children higher in negative affect having more deviations from their normal routine activities. There were no other significant correlations between negative affect and the bedtime routine measures at any age. Thus, hypothesis 3a was only partially supported.

Negative affect and longitudinal stability of bedtime routines. As outlined in the previous section, there were no significant changes in the length of the bedtime routine and few changes in the activities of the bedtime routine from 30 to 36 to 42 months. Therefore, in order to examine hypothesis 3b, that children's negative affect is associated with the longitudinal stability of the bedtime routine across time, correlations were computed between negative affect at each age and change scores of the six activity proportion scores that significantly decreased from 30 to 36 months. Because no activity changed from 36 to 42 months, associations between negative affect and change in activities from 36 to 42 months were not examined further. To calculate change scores in the bedtime routine activities, differences between average activity proportion scores were calculated between 30 and 36 months, and then correlations were computed between these change scores and negative affect at each age. There was only one significant correlation between negative affect and change in bedtime routine activities from 30 to 36 months. Negative affect at 30 months was correlated with change in music use from 30 to 36 months (r = .13), with children higher in negative affect at 30 months experiencing more change in the use of music during the bedtime routine from 30 to 36 months. Negative affect was not associated with change in any other bedtime routine activity. Thus, hypothesis 3b, that negative affect is associated with the longitudinal stability of the bedtime routine, was not supported.

Transactional relations between temperament and bedtime routines across time.

Transactional relations are dynamic influences between a child and their caregiving environment, such that both the child and their caregiving environment change as a result of the interactions between them. In the context of child temperament and bedtime routines, transactional relations would be evident if temperament, specifically negative affect, at an earlier age influenced the bedtime routine at a later age, which then influenced negative affect at a yet later age, or if bedtime routines at one age influenced negative affect at a later age, which in turn influenced bedtime routines at an even later age. To test hypothesis 3c, that transactional relations between children's negative affect and bedtime routines will be identified, cross-lagged path models were computed across time from 30 to 36 to 42 months. Figure 4.11 shows the general form of the full model that was tested. Three models were tested: bedtime routine length, routine length variability, and deviation from the normal routine in separate models with negative affect.

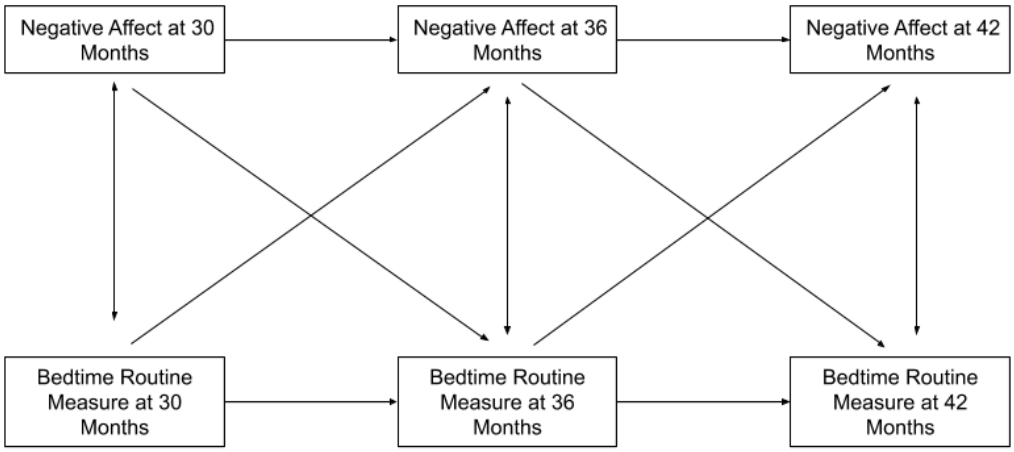


Figure 4.11. Cross lagged path model between negative affect and measures of the bedtime routine across time. Separate models were run between negative affect and routine length, negative affect and routine length variability, and negative affect and deviation from the normal routine.

The first model between negative affect and bedtime routine length had adequate fit statistics (χ^2 = 71.523, *p* < .05; *RMSEA* = .204; *CFI* = .908, *SRMR* = .054); however, the only significant paths were within-variable: negative affect at 30 months predicted negative affect at 36 months, which predicted negative affect at 42 months; and bedtime routine length at 30 months predicted bedtime routine length at 36 months, which predicted bedtime routine length at 42 months. All of the cross-lagged paths of interest that would serve as evidence of transactional relations from negative affect at one age to bedtime routine length at a later age, and from bedtime routine length at one age to negative affect at a later age, were not significant.

The second model testing associations between negative affect and routine length variability across time also had adequate fit statistics (χ^2 = 53.627, *p* < .05; *RMSEA* = .175, *CFI* = .913, *SRMR* = .06); however, the only significant paths were again within-variable: negative affect at 30 months predicted negative affect at 36 months, which predicted negative affect at 42 months; and routine length variability at 30 months predicted routine length variability at 36 months, which predicted routine length variability at 42 months. No cross-lagged paths from negative affect at one age to routine length variability at a later age, or from routine length variability at one age to negative affect at a later age, were significant.

The third model between negative affect and deviation from the normal routine also had adequate model fit statistics ($\chi^2 = 49.866, p < .05$; *RMSEA* = .168; *CFI* = .909; *SRMR* = .052). The only significant paths were within-variable as with the first two models, and no cross-lagged paths that would indicate transactional relations were significant.

In sum, the lack of significant cross-lagged associations between bedtime routines and temperamental negative affect in any of the three models tested demonstrates that transactional relations were not identified in the present study, and hypothesis 3c was not supported. In other words, negative affect and bedtime routines did not develop in a transactional manner such that negative affect at one age was associated with bedtime routines at a later age, which in turn would be associated with negative affect at an even later age, and vice versa.

Post-hoc exploratory analyses. Although no a priori hypotheses were made, post-hoc cross-lagged path models were computed between negative affect and the sleep outcome measures to investigate whether there were transactional relations between negative affect and sleep measures across time from 30 to 36 to 42 months, given prior research indicating relations between temperament and sleep in young children (e.g., Molfese et al., 2015; Sher et al., 1992; Sher et al., 1998). Results were similar to those reported above for testing of hypothesis 3d: model fit statistics indicated adequate model fit, however the only significant paths were within-variable, with no significant cross-variables associations. Thus, there was no support for transactional relations between negative affect and sleep measures.

CHAPTER 5: DISCUSSION

This study represents an in-depth examination of bedtime routines and sleep in a large sample of toddler children. Data were collected nightly across a two-week time period, three times over the course of one year. Parents reported on the bedtime routine and sleep duration via a daily sleep diary, and objective measures of sleep were obtained via actigraphy. Using a variety of methods and statistical analyses, three main aims were investigated: the examination of the consistency of the bedtime routine on a nightly basis, the longitudinal stability of the bedtime routine across time (i.e., 30, 36, and 42 months), and the child-level characteristics that impact bedtime routines and sleep. Five main findings emerged: (a) children experience variability in their bedtime routines when measured on a nightly basis; (b) nightly variability in the length of the bedtime routine is more important for sleep outcomes than is nightly variability in the activities of the bedtime routine; (c) nightly sleep measures do not impact bedtime routines the following night; (d) bedtime routine lengths and activities are stable across ages; and (e) negative affect is not associated with bedtime routines or associated with sleep. Each finding will be discussed below.

Children experience some variability in their bedtime routines when measured on a nightly basis. The average length of children's bedtime routines was approximately 45 minutes, but each child's bedtime routine length on any individual night could vary by as much as 14 to 23 minutes more or less from their average routine length across all three ages. This means that on any given night, a child's bedtime routine could range anywhere from 30 minutes to an hour long. Because no prior research has reported on the average length of bedtime routines in children, nor how variable the lengths of bedtime routines are from night to night, it is unknown whether routines ranging from half an hour to an hour each night are developmentally appropriate. However, Mindell and Williamson (2017) suggested that from a practical standpoint, bedtime routines longer than 30-40 minutes may be maladaptive because longer bedtime routines naturally push the bedtime later, resulting in shorter sleep duration.

The individual activities in a child's bedtime routine (e.g. bath, reading, snuggling, etc.) varied by one to two per night, meaning that on any given night, children experienced one to two bedtime routine activities that were different than their normal bedtime routine activities. It is reasonable to expect some variability from night to night in the activities of the bedtime routine that are completed. Parental work schedules, evening extracurricular activities, and other family home life demands (e.g. household chores, sick children, visiting relatives, etc.) all have the potential to impact the evenings of children and their families, including the enactment of bedtime routines. A difference of one to two activities per night from the normal bedtime routine may be normal or even expected for most families. In addition, whether this nightly variability in the bedtime routine activities is practically meaningful for toddlers and their parents may, in part, depend on individual family bedtime routines. For toddlers who have a relatively simple bedtime routine of three activities (e.g. bath, brush teeth, and reading), a deviation from the normal routine of one to two activities may be more disruptive than for toddlers who have more complex routines consisting of six or seven activities.

These findings are concordant with prior research indicating that families differ in how consistently they implement a bedtime routine on a nightly basis (e.g., Hale et al., 2009; Yoo et al., 2010), but this is the first study to quantify consistency of bedtime routines from night to night. Prior research has only examined the consistency of bedtime routines using a global parent rating, such as "How often do you follow the same bedtime routine?", or "What is the bedtime routine you followed on 4 of the past 5 weeknights?". These global ratings are useful for understanding in general the consistency of a family's bedtime routine, but are vulnerable to reporting bias. Parents may have difficulty in recalling the bedtime routine from several nights prior or may be inclined to report they follow a consistent bedtime routine because it is socially desirable to do so. In contrast, the use of nightly reports of the bedtime routine in the present study reduces these reporting biases, because parents were asked to report each night what bedtime routine was enacted, rather than having to recall a prior night's routine, and eliminating the need for parents to self-evaluate the "consistency" of their routine. On the other hand, just because parents were asked to fill out the sleep diary nightly does not mean they actually did so. It is entirely possible that some parents forgot to fill out the diary for a night or a few nights, and then filled out more than one diary night at the same time. Regardless, the level of detail provided about the consistency of the bedtime routine from night to night in the present study could not have been achieved without the use of nightly reports via the sleep diary.

Nightly variability in the length of the bedtime routine is more important for sleep outcomes than is nightly variability in the activities of the bedtime routine. While some variability in both the length and the activities of the nightly bedtime routine was found, results from the multilevel models indicate that it is the nightly variability in the length of the bedtime routine that matters most for sleep outcomes. At all three ages, nightly routine length variability was associated with the sleep outcomes, while nightly deviation from the normal routine activities did not relate to any sleep outcome at any age. This is an important contribution to the literature because these results indicate that keeping consistent routine lengths from night to night is more important for optimal sleep than is completing the same activities in the bedtime routine from night to night.

Previous research has identified consistent bedtime routines as important factors for positive sleep outcomes in children (e.g. Jones & Ball, 2014; Mindell et al., 2006; Morgenthaler et al., 2006). However, this is the first study to examine the length of the bedtime routine separately from the activities of the bedtime routine. While variability in the length and activities in the bedtime routine were significantly positively correlated, the associations were not strong (ranging from $r = .12$ at 42 months to $r = .18$ at 36 months), indicating that there are likely other factors that contribute to variability in the length or the activities of nightly bedtime routines.

These findings suggest that what makes bedtime routines important for children's sleep outcomes is that parents are carving out dedicated time to spend with their children before bed, while what they are doing during that time (e.g. bathing, reading, playing, singing songs, etc.) may be less important. However, the present study did not examine directly how individual bedtime routine activities were associated with sleep outcomes, and instead focused on whether those activities were the same from night to night. Mindell and Williamson (2017) noted that engagement in positive and healthy bedtime routine activities is critical for optimal outcomes, and that maladaptive bedtime routine activities such as watching television, using electronics, or other stimulating activities such as running around are linked with poorer sleep. It is unknown if a child's sleep would be equally negatively impacted by maladaptive bedtime routine activities if they were a part of the normal routine. For instance, a child who is accustomed to falling asleep in front of the television (i.e. TV watching is a "normal" part of the routine) may not have poorer sleep on a nightly basis than a child who watches television only occasionally during the bedtime routine. Future research should examine for whom positive and maladaptive bedtime routine activities matter most.

Nightly sleep does not impact bedtime routines the following night. This is the first study to examine how bedtime routine and sleep relate to each other from night to night, and it was hypothesized that how a child slept on a particular night would relate to a child's bedtime routine the following night. In other words, parents may be motivated to change the bedtime routine on a particular night because they know (or believe) their child's sleep night before was not optimal. Contrary to hypotheses, nightly sleep was unrelated to bedtime routine length variability or deviation from the normal routine on the following night, as defined in the present study.

One reason may be that parents assume their toddler is getting enough sleep, so there is no need to alter the routine on any given night to improve their toddler's sleep. Indeed, research has consistently shown that parents tend to overestimate their child's sleep when compared to objective measures such as actigraphy (Dayyat, Spruyt, Molfese & Gozal, 2011; Molfese et al., 2015; Nelson et al., 2014; Prokasky et al., 2019). It is also likely that there are other family-level factors that have more of an influence on the variability in a toddler's nightly bedtime routine, such as family obligations or activities in the evening. In order to understand how these family-level factors may influence the enactment of a nightly bedtime routine, future research on bedtime routines in children should expand the focus to family life during the entire evening, rather than just the hour or so before a child is in bed for the night.

Bedtime routines are stable across time. Contrary to the hypotheses, the length of the bedtime routine and the frequency of a majority of the routine activities completed at each age was stable from 30 to 36 to 42 months. These findings are an important contribution to the literature because no prior research has examined the longitudinal stability of the bedtime routine across time.

The average length of the bedtime routine was remarkably consistent at all three ages: 44 minutes at 30, 36, and 42 months of age. In addition, the majority of the 17 routine activities examined did not significantly change in frequency from 30 to 36 to 42 months. The six of 17 activities that did significantly change in frequency (praying, giving a snack, cuddling, playing music/singing, picking up, and other) had very small to small effect sizes, meaning that even though these activities changed in frequency across time, the amount of change was negligible. In addition, all significant changes were from 30 to 36 months; no activity significantly changed in frequency from 36 to 42 months. These findings were surprising because prior research has suggested that family routines change over time as children develop and members of the family renegotiate their roles within the family (Fiese et al., 2002; Fiese, 2006; Spagnola & Fiese, 2007). One might reason that as a bedtime routine is enacted night after night over time, parents and children would become more efficient in enacting the bedtime routine, thus leading to shorter bedtime routines. In addition, Mindell and Williamson (2017) reported in cross-sectional work that in comparison to infants, toddlers engage in more active routine activities around bedtime, such as singing songs, reading books or running around. In contrast, the present study found a small decrease in singing songs, and no change in reading books or running around/playing. These discrepant findings are not entirely unexpected, however, given that the Mindell and Williamson study used infants as a comparison group, whereas the present study compared essentially younger versus older toddlers, and the Mindell and Williamson study was cross-sectional while the present study was longitudinal. Likewise, it may be that some parents view 30-month-old children as "too young" for some bedtime routine activities, such as playing games or using technology, while also viewing 42-month-old children as "too old" for other activities, like cuddling.

There are a few potential reasons why the present study found very little change in bedtime routines across time despite prior research suggesting otherwise. First, while early childhood is a period of rapid change, the duration of the present study was just one year, which may have been too short of a time period to capture significant change. Second, the present study examined bedtime routines in toddlerhood specifically, and it may be that examining transitions between distinct developmental periods, such as infancy to toddlerhood, or toddlerhood to preschool, would reveal more change in the bedtime routine than investigation within a particular developmental period. Finally, the definition of a routine in general is "specific, patterned interactions that are *repeated regularly over time…* and are recognized by a *continuity in behavior* [emphasis added] " (Fiese et al., 2002), and a bedtime routine specifically is: "the set of *predictable* activities that occur *in the hour or so* [emphasis added] before lights out and before the child falls asleep" (Mindell and Williamson, 2017). That which makes a routine a routine is consistency in behavior over time, hampering the possibility of significant change, at least in the short term.

Negative affect is weakly associated with bedtime routines and not associated with sleep. Negative affect was weakly correlated with deviation from the normal routine, suggesting that children higher in negative affect had slightly less consistent routines on a nightly basis, at least in terms of the activities enacted, but only at 30 months of age. In addition, negative affect was only associated with the longitudinal stability of one bedtime routine activity, with children higher in negative affect experiencing more change in the use of music/singing from 30 to 36 months. Transactional relations between negative affect and bedtime routines were also not identified, evidence of lack of associations between temperament and bedtime routines.

These weak and inconsistent findings were unexpected because, although not yet tested explicitly, associations between temperament and bedtime routines have been theorized (Sadeh & Anders, 1993) and suggested (e.g. Bornstein, 2009; Sameroff & Mackenzie, 2003; Thomas & Chess, 1977) in the extant literature. Further, prior research has linked temperament traits with sleep outcomes in children (e.g. Molfese et al., 2015; Sher et al., 1992; Sher et al., 1998). The lack of findings in the present study may be due to the fact that prior research has examined individual temperament traits, such as rhythmicity, withdrawal, fear, and soothability, and their relations to sleep outcomes, while the present study used a composite of several temperament traits. Alternatively, it could be that overall negative affect was low in this sample: an average of 3.60 at 30 months to an average of 3.87 at 42 months, while the possible range of negative affect scores from the Children's Behavior Questionnaire (CBQ; Rothbart et al., 2001) is 1 to 7, with higher scores indicating higher negative affect. Scores ranging from 3 to 4 on the CBQ correspond with response categories of "slightly untrue of my child" to "neither true nor false of my child". Perhaps overall negative affect was not high enough in the present sample to have a demonstrable impact on bedtime routines or sleep measures. Future research should examine whether negative affect is differentially related to bedtime routines or sleep measures for children with overall higher levels of negative affect.

Limitations and Future Directions

Several limitations warrant mention. First, the sample in the current study was primarily White and middle- to upper-middle class, which limits generalizability of the current findings. Because prior research has already identified differences between White and non-White families and between poor and non-poor families in the implementation of bedtime routines (e.g. Hale et al., 2009; Yoo et al., 2010), future research should examine the nightly consistency, longitudinal stability, and child characteristics impacting bedtime routines in more racially and socially diverse samples.

Second, the participant burden was quite high in the present study. Specifically, in addition to several questionnaires, parents were asked to complete a sleep diary every night for at least two weeks, three times over the course of one year. Parents were also asked to monitor their child's compliance with wearing the actigraph over the same time period. Even though parents were asked to fill out the sleep diary nightly does not mean that the sleep diary was actually filled out nightly. This could have reduced the variability in the reported bedtime routine because parents would have been relying on their recollections of previous nights' bedtime routines. To better understand if and how parents' daily diary reporting habits influence reports of bedtime routines and sleep, future research should examine parental compliance with daily reporting of bedtime routines and sleep, including if and how often parents actually fill out the diaries each night, and if there is an ideal length of time (one week vs. two) to collect daily diary data before parents quit reporting daily. Nevertheless, daily reports of the bedtime routine provided a level of precision in measuring bedtime routines that is not available when parents are asked to make a global rating such as "What is the bedtime routine you follow on most nights?"

A related limitation is how parents were asked to report on the bedtime routine in the sleep diaries. Parents in the present study were not given a definition of what was to be considered a part of the bedtime routine (e.g., "Only consider those activities that occur in the hour or so before bedtime"), nor were they asked what activities were a normal part of their routine, or what they considered to be the most important or non-negotiable parts of the bedtime routine.

One area for future research is a deeper examination of the content of the bedtime routines themselves. While the present study examined 17 different bedtime routine activities, the focus was primarily on the consistency and longitudinal stability of those activities across nights and time, thus the main variable of interest was deviation from the normal routine, and not the individual activities themselves. Building on the work by Hale and colleagues which categorized bedtime routines based on the activities completed (e.g., language-based versus hygiene-based routines), future research could expand on this work by conducting a Latent Class Analysis (LCA) on bedtime routine activities to empirically identify different "types" of bedtime routines. Then, these types could be examined for relations to sleep outcomes (do children who experience a "soothing" bedtime routine have better sleep outcomes than children who don't?), pre-academic skills (do children who experience "language-based" routines have better language skills than those who don't?), and relations to individual differences (are children higher in temperamental negative affect more likely to have "soothing" versus "interactive" bedtime routines?). This work could be further extended with a Latent Transition Analysis (LTA) which could identify if and how children move between types of bedtime routines across time. For example, children may transition from a hygiene-based routine as infants or young toddlers (consisting of bathing, brushing teeth, and putting on pajamas) to a more language-based routine (reading, talking about day, singing songs) at preschool age as their language skills become more developed.

Finally, one additional area for future research is examining bedtime routines and sleep in children who stay at home with a parent versus children who attend childcare. For example, for children whose parents both work outside the home and the child attends childcare during the day, children's sleep schedules during the week are largely determined by their parents' work schedules. Parents typically need to arrive at work at a specific time, which dictates what time children need to be woken up, regardless of what time children went to bed the night before. However, for children who do not attend child care and stay at home with a parent or other caregiver, there are fewer constraints on a child's sleep schedule, which may lead to more variability in their sleep or bedtime routines on a nightly basis. For these children, parents may feel free to implement a longer bedtime routine, because their child does not need to go to bed by a certain time in order to be able to wake up at a certain time. Conversely, children who attend childcare may have more consistent bedtime routines and sleep schedules during the week, but more variable bedtime routines and sleep schedules between weeknights and weekends because parents may view the weekend as a “catch-up” period, allowing their child to stay up later in the evening, or sleep later in the mornings.

Implications

There are several implications of this study for theory, practice, and future research. First and foremost, further application and testing of the Transactional Model of Children’s Sleep (Sadeh & Anders, 1993) is warranted because the present study found no evidence of transactional relations between bedtime routines, sleep measures, and temperamental negative affect. It may be that bedtime routines, sleep, and negative affect do not develop in a transactional nature, or it may be that the measurement time scale of the present study was too large to detect transactional relations. Specifically, the present study tested transactional relations between bedtime routines and negative affect at six-month intervals. However, bedtime routines happen nightly, while negative affect develops over time. An inconsistent or maladaptive bedtime routine on one night may result in poor sleep that night, which in turn could amplify the child’s display of negative affect in the short term (i.e., the following day), and may influence how the bedtime routine is implemented the following night. If these transactions were sporadic across time, reciprocal influences between bedtime routines and negative affect wouldn’t be detected when measuring at six-month intervals. In any case, further examination of transactional relations, including investigation of different measurement times scales, is warranted.

Second, further refinement of how best to measure and study bedtime routines is necessary. Bedtime routines are complex processes, and are difficult to reduce to easily quantifiable data for analyses. Bedtime routines happen within dynamic family systems, which are difficult to measure. Qualitative or mixed-methods analyses of bedtime routines could provide important information about the interplay between bedtime routines and sleep that is not readily quantifiable. Longitudinal ethnographic research methods could help further elucidate how bedtime routines develop within the larger family system over time.

Finally, this research can help inform practices of professionals and providers (e.g. doctors, childcare workers) working with toddlers and their families. Sleep is an important area for investigation for toddlers who are displaying behavioral difficulties during the day, and implementing consistent bedtime routines is a good first step in addressing bedtime resistance or sleeping difficulties. In addition, professionals can communicate to parents the importance of "carving out" dedicated time for their children before bed, not only to improve children's sleep, but also to enhance the parent-child relationship.

Conclusions

In sum, the present study addressed several key gaps in the research base on bedtime routines and sleep in young children. First, toddlers experience a fair amount of variability in their bedtime routine on a nightly basis, and this variability does impact their nightly sleep. Second, despite this nightly variability in the bedtime routine, across time bedtime routines are fairly stable, both in the length of the bedtime routine and in the activities involved in the bedtime routine. Finally, at least in the toddler years, children's temperamental negative affect is generally unrelated to their bedtime routines or sleep. Because poor sleep can impact children's behavioral, social, academic and health outcomes, parents and professionals working with children should consider the duration and quality of children's sleep. Consistent bedtime routines can help ensure toddlers get sufficient and quality sleep in the early years.

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APPENDIX A: PATH COEFFICIENTS FROM CROSS-LAGGED PATH MODELS

Table A.1
All Path Coefficients from Autoregressive Cross-Lagged Path Models with Routine Length Variability and Actigraph Recorded Sleep Onset Time at 30, 36, and 42 Months

			30 month est. B (SE)	36 month est. B (SE)	42 month est. B (SE)
Autoregressive Lag 1 path coefficients					
RLV1	to	RLV2	0.298 (0.052) *	0.331 (0.065)*	0.151 (0.067)*
RLV2	to	RLV3	0.291 (0.062) *	0.167 (0.09)	0.099 (0.062)
RLV3	to	RLV4	0.243 (0.05) *	0.125 (0.033)*	0.201 (0.063)*
RLV4	to	RLV5	0.426 (0.068) *	0.178 (0.079)*	0.132 (0.084)
RLV5	to	RLV6	0.118 (0.041)*	0.247 (0.058)*	0.132 (0.062)*
RLV6	to	RLV7	0.137 (0.057)*	0.262 (0.062)*	0.145 (0.087)
RLV7	to	RLV8	0.324 (0.079) *	0.14 (0.069)*	0.215 (0.055)*
RLV8	to	RLV9	0.098 (0.069)	0.124 (0.074)	0.194 (0.073)*
RLV9	to	RLV10	0.105 (0.059)	0.152 (0.063)*	0.163 (0.079)*
RLV10	to	RLV11	0.026 (0.05)	0.279 (0.062)*	0.041 (0.1)
RLV11	to	RLV12	-0.004 (0.078)	0.135 (0.074)	0.239 (0.085)*
RLV12	to	RLV13	0.17 (0.062)*	0.262 (0.092)*	0.161 (0.059)*
RLV13	to	RLV14	0.493 (0.125) *	-0.042 (0.113)	-0.032 (0.158)
SONSET1	to	SONSET2	0.583 (0.039) *	0.611 (0.064)*	0.691 (0.057)*
SONSET2	to	SONSET3	0.262 (0.065) *	0.239 (0.069)*	0.591 (0.1)*
SONSET3	to	SONSET4	0.332 (0.057) *	0.284 (0.059)*	0.243 (0.068)*
SONSET4	to	SONSET5	0.208 (0.057) *	0.39 (0.059)*	0.449 (0.071)*
SONSET5	to	SONSET6	0.347 (0.041) *	0.315 (0.065)*	0.551 (0.087)*
SONSET6	to	SONSET7	0.463 (0.053) *	0.225 (0.074)*	0.535 (0.067)*
SONSET7	to	SONSET8	0.256 (0.072) *	0.339 (0.075)*	0.222 (0.065)*
SONSET8	to	SONSET9	0.254 (0.061) *	0.29 (0.093)*	0.281 (0.089)*
SONSET9	to	SONSET10	0.377 (0.06) *	0.276 (0.069)*	0.213 (0.073)*
SONSET10	to	SONSET11	0.359 (0.067) *	0.443 (0.086)*	0.282 (0.1)*
SONSET11	to	SONSET12	0.297 (0.083) *	0.279 (0.068)*	0.068 (0.08)
SONSET12	to	SONSET13	0.196 (0.049) *	0.338 (0.079)*	0.275 (0.086)*
SONSET13	to	SONSET14	0.365 (0.073) *	0.332 (0.078)*	0.332 (0.067)*
Autoregressive Lag 2 Path Coefficients					
RLV1	to	RLV3	0.249 (0.059) *	0.333 (0.097)*	0.168 (0.065)*
RLV2	to	RLV4	0.365 (0.055) *	0.131 (0.053)*	0.204 (0.052)*
RLV3	to	RLV5	0.063 (0.065)	0.213 (0.037)*	0.093 (0.07)
RLV4	to	RLV6	0.187 (0.052) *	0.205 (0.069)*	0.204 (0.068)*

RLV5	to	RLV7	0.135 (0.039)*	0.271 (0.059)*	0.142 (0.082)
RLV6	to	RLV8	0.187 (0.067)*	0.14 (0.07)*	0.179 (0.07)*
RLV7	to	RLV9	0.2 (0.095)*	0.147 (0.073)*	-0.014 (0.055)
RLV8	to	RLV10	0.143 (0.073)	0.207 (0.07)*	0.268 (0.091)*
RLV9	to	RLV11	0.075 (0.05)	0.061 (0.057)	0.149 (0.079)
RLV10	to	RLV12	0.046 (0.064)	0.138 (0.07)*	0.166 (0.084)*
RLV11	to	RLV13	0.18 (0.069)*	-0.061 (0.102)	0.137 (0.062)*
RLV12	to	RLV14	0.316 (0.161)*	0.594 (0.214)*	0.485 (0.131)*
SONSET1	to	SONSET3	0.436 (0.058) *	0.534 (0.075)*	0.058 (0.104)
SONSET2	to	SONSET4	0.371 (0.062) *	0.352 (0.062)*	0.349 (0.08)*
SONSET3	to	SONSET5	0.307 (0.06) *	0.359 (0.054)*	0.162 (0.064)*
SONSET4	to	SONSET6	0.397 (0.04) *	0.359 (0.064)*	0.209 (0.088)*
SONSET5	to	SONSET7	0.178 (0.047) *	0.353 (0.072)*	0.11 (0.074)
SONSET6	to	SONSET8	0.24 (0.069)*	0.123 (0.069)	0.11 (0.06)
SONSET7	to	SONSET9	0.452 (0.067) *	0.201 (0.085)*	0.051 (0.062)
SONSET8	to	SONSET10	0.216 (0.06) *	0.322 (0.074)*	0.564 (0.072)*
SONSET9	to	SONSET11	0.245 (0.061) *	0.181 (0.071)*	0.121 (0.108)
SONSET10	to	SONSET12	0.122 (0.09)	0.355 (0.075)*	0.325 (0.086)*
SONSET11	to	SONSET13	0.343 (0.057) *	0.302 (0.069)*	0.229 (0.077)*
SONSET12	to	SONSET14	0.066 (0.06)	0.088 (0.092)	0.29 (0.072)*
Autoregressive Lag 7 Path Coefficients					
RLV1	to	RLV8	0.221 (0.072)*	0.183 (0.072)*	0.201 (0.067)*
RLV2	to	RLV9	0.222 (0.088)*	0.36 (0.076)*	0.139 (0.064)*
RLV3	to	RLV10	0.223 (0.076)*	0.052 (0.043)	0.119 (0.093)
RLV4	to	RLV11	0.202 (0.058) *	0.138 (0.095)	0.247 (0.088)*
RLV5	to	RLV12	0.167 (0.054)*	0.247 (0.067)*	0.164 (0.073)*
RLV6	to	RLV13	0.161 (0.077)*	0.549 (0.115)*	0.102 (0.067)
RLV7	to	RLV14	0.581 (0.156) *	0.232 (0.2)	0.016 (0.117)
SONSET1	to	SONSET8	0.311 (0.056) *	0.372 (0.08)*	0.457 (0.063)*
SONSET2	to	SONSET9	0.173 (0.059)*	0.329 (0.076)*	0.379 (0.077)*
SONSET3	to	SONSET10	0.07 (0.057)	0.187 (0.07)*	0.129 (0.051)*
SONSET4	to	SONSET11	0.227 (0.055) *	0.178 (0.082)*	0.407 (0.096)*
SONSET5	to	SONSET12	0.324 (0.073) *	0.325 (0.078)*	0.396 (0.074)*
SONSET6	to	SONSET13	0.304 (0.064) *	0.249 (0.08)*	0.193 (0.071)*
SONSET7	to	SONSET14	0.43 (0.09) *	0.339 (0.079)*	0.063 (0.075)
Within Night Cross Variable Path Coefficients					
RLV1	to	SONSET1	0.007 (0.004)	0.011 (0.004)*	0.008 (0.004)
RLV2	to	SONSET2	0.007 (0.003)*	0.007 (0.004)	0.006 (0.003)*
RLV3	to	SONSET3	0.013 (0.003) *	-0.003 (0.002)	0.013 (0.004)*
RLV4	to	SONSET4	0.004 (0.004)	0.015 (0.005)*	0.001 (0.005)

RLV5	to	SONSET5	0.007 (0.003)*	0.001 (0.004)	0.007 (0.004)
RLV6	to	SONSET6	0.009 (0.003)*	0.002 (0.004)	0.001 (0.005)
RLV7	to	SONSET7	0.011 (0.003) *	0.01 (0.004)*	0.012 (0.004)*
RLV8	to	SONSET8	-0.005 (0.003)	0.009 (0.004)*	0.004 (0.004)
RLV9	to	SONSET9	0.006 (0.003)	0.007 (0.005)	0.007 (0.004)
RLV10	to	SONSET10	0.008 (0.003)*	0.01 (0.004)*	0.001 (0.004)
RLV11	to	SONSET11	0.012 (0.004)*	0.013 (0.005)*	0.005 (0.005)
RLV12	to	SONSET12	0.001 (0.005)	0.007 (0.004)	0.004 (0.006)
RLV13	to	SONSET13	0.014 (0.003) *	0.009 (0.003)*	0.008 (0.006)
RLV14	to	SONSET14	-0.006 (0.003)*	0 (0.002)	0.003 (0.003)
Cross Lagged Path Coefficients from sleep to BR the following night					
SONSET1	to	RLV2	0.036 (0.784)	-0.118 (1.212)	1.065 (1.177)
SONSET2	to	RLV3	-0.63 (0.927)	1.687 (1.469)	1.544 (1.102)
SONSET3	to	RLV4	1.543 (0.751)*	1.529 (0.858)	1.131 (0.829)
SONSET4	to	RLV5	1.33 (0.986)	0.103 (1.024)	0.469 (1.102)
SONSET5	to	RLV6	0.811 (0.731)	-1.295 (0.976)	1.417 (0.98)
SONSET6	to	RLV7	1.508 (0.855)	0.796 (1.011)	-0.558 (1.351)
SONSET7	to	RLV8	2.202 (1.17)	-1.7 (1.13)	-0.321 (1.137)
SONSET8	to	RLV9	-1.07 (1.16)	1.051 (1.407)	2.104 (1.254)
SONSET9	to	RLV10	0.952 (1.039)	0.595 (1.036)	-0.548 (1.448)
SONSET10	to	RLV11	0.851 (0.968)	0.401 (1.045)	3.311 (1.287)*
SONSET11	to	RLV12	2.166 (1.178)	-1.59 (1.002)	1.923 (1.103)
SONSET12	to	RLV13	0.147 (1.01)	1.159 (1.505)	0.172 (0.991)
SONSET13	to	RLV14	-1.404 (2.008)	0.405 (2.583)	4.868 (2.231)*
Cross Lagged Path Coefficients from BR to sleep the following night					
RLV1	to	SONSET2	0.004 (0.003)	-0.003 (0.004)	-0.003 (0.003)
RLV2	to	SONSET3	-0.004 (0.004)	-0.001 (0.004)	0 (0.004)
RLV3	to	SONSET4	0 (0.003)	0.003 (0.002)	0.004 (0.004)
RLV4	to	SONSET5	0.006 (0.004)	-0.002 (0.004)	-0.012 (0.005)*
RLV5	to	SONSET6	-0.005 (0.002)*	0.007 (0.004)	-0.004 (0.005)
RLV6	to	SONSET7	0 (0.003)	0 (0.004)	0.002 (0.004)
RLV7	to	SONSET8	0.008 (0.004)	0.004 (0.004)	0 (0.004)
RLV8	to	SONSET9	-0.005 (0.003)	-0.005 (0.005)	0.003 (0.004)
RLV9	to	SONSET10	-0.001 (0.003)	-0.009 (0.004)*	-0.002 (0.004)
RLV10	to	SONSET11	-0.009 (0.003)*	0.006 (0.004)	0.002 (0.006)
RLV11	to	SONSET12	-0.001 (0.005)	-0.006 (0.004)	0.001 (0.004)
RLV12	to	SONSET13	0.002 (0.004)	-0.001 (0.004)	-0.002 (0.005)
RLV13	to	SONSET14	-0.002 (0.004)	-0.002 (0.003)	-0.003 (0.005)

* $p < .05$

Table A.2

All Path Coefficients from Autoregressive Cross-Lagged Path Models with Deviation from Normal Routine and Actigraph Recorded Sleep Onset Time at 30, 36, and 42 Months

			30 month est. B (SE)	36 month est. B (SE)	42 month est. B (SE)
Autroregressive Lag 1 Path Coefficients					
DNR1	to	DNR2	0.597 (0.037)*	0.665 (0.046)*	0.644 (0.048)*
DNR2	to	DNR3	0.458 (0.044)*	0.375 (0.05)*	0.423 (0.053)*
DNR3	to	DNR4	0.47 (0.052)*	0.472 (0.053)*	0.326 (0.06)*
DNR4	to	DNR5	0.34 (0.047)*	0.507 (0.052)*	0.332 (0.052)*
DNR5	to	DNR6	0.43 (0.049)*	0.424 (0.057)*	0.453 (0.052)*
DNR6	to	DNR7	0.488 (0.048)*	0.358 (0.054)*	0.417 (0.058)*
DNR7	to	DNR8	0.082 (0.052)	0.139 (0.055)*	0.209 (0.065)*
DNR8	to	DNR9	0.384 (0.044)*	0.514 (0.047)*	0.291 (0.052)*
DNR9	to	DNR10	0.254 (0.048)*	0.257 (0.057)*	0.27 (0.062)*
DNR10	to	DNR11	0.29 (0.054)*	0.202 (0.057)*	0.323 (0.066)*
DNR11	to	DNR12	0.448 (0.051)*	0.402 (0.052)*	0.281 (0.052)*
DNR12	to	DNR13	0.37 (0.048)*	0.399 (0.055)*	0.251 (0.056)*
DNR13	to	DNR14	0.225 (0.088)*	0.159 (0.091)	0.069 (0.105)
SONSET1	to	SONSET2	0.621 (0.043)*	0.601 (0.063)*	0.682 (0.059)*
SONSET2	to	SONSET3	0.142 (0.062)*	0.37 (0.075)*	0.513 (0.09)*
SONSET3	to	SONSET4	0.34 (0.053)*	0.336 (0.059)*	0.276 (0.066)*
SONSET4	to	SONSET5	0.272 (0.057)*	0.315 (0.055)*	0.283 (0.073)*
SONSET5	to	SONSET6	0.313 (0.041)*	0.347 (0.06)*	0.533 (0.074)*
SONSET6	to	SONSET7	0.489 (0.052)*	0.25 (0.072)*	0.516 (0.065)*
SONSET7	to	SONSET8	0.311 (0.066)*	0.358 (0.071)*	0.205 (0.066)*
SONSET8	to	SONSET9	0.277 (0.062)*	0.304 (0.084)*	0.274 (0.075)*
SONSET9	to	SONSET10	0.375 (0.058)*	0.261 (0.069)*	0.295 (0.068)*
SONSET10	to	SONSET11	0.28 (0.076)*	0.405 (0.083)*	0.283 (0.099)*
SONSET11	to	SONSET12	0.173 (0.071)*	0.256 (0.066)*	0.138 (0.074)
SONSET12	to	SONSET13	0.212 (0.051)*	0.375 (0.077)*	0.257 (0.079)*
SONSET13	to	SONSET14	0.415 (0.08)*	0.3 (0.076)*	0.361 (0.061)*
Autoregressive Lag 2 Path Coefficients					
DNR1	to	DNR3	0.363 (0.042)*	0.42 (0.053)*	0.225 (0.055)*
DNR2	to	DNR4	0.323 (0.053)*	0.234 (0.052)*	0.277 (0.055)*
DNR3	to	DNR5	0.393 (0.049)*	0.229 (0.051)*	0.45 (0.051)*
DNR4	to	DNR6	0.315 (0.047)*	0.279 (0.057)*	0.217 (0.054)*
DNR5	to	DNR7	0.265 (0.049)*	0.262 (0.054)*	0.161 (0.055)*
DNR6	to	DNR8	0.073 (0.056)	-0.07 (0.054)	0.062 (0.064)
DNR7	to	DNR9	0.06 (0.041)	0.028 (0.044)	0.081 (0.053)

DNR8	to	DNR10	0.105 (0.046)*	0.187 (0.056)*	0.081 (0.057)
DNR9	to	DNR11	0.146 (0.05)*	0.154 (0.053)*	0.176 (0.067)*
DNR10	to	DNR12	0.182 (0.053)*	0.26 (0.052)*	0.181 (0.058)*
DNR11	to	DNR13	0.275 (0.052)*	0.193 (0.058)*	0.234 (0.05)*
DNR12	to	DNR14	-0.033 (0.085)	-0.153 (0.096)	0.072 (0.1)
SONSET1	to	SONSET3	0.487 (0.06)*	0.367 (0.085)*	0.158 (0.092)
SONSET2	to	SONSET4	0.362 (0.058)*	0.357 (0.066)*	0.341 (0.077)*
SONSET3	to	SONSET5	0.267 (0.058)*	0.304 (0.053)*	0.221 (0.067)*
SONSET4	to	SONSET6	0.39 (0.041)*	0.346 (0.054)*	0.219 (0.076)*
SONSET5	to	SONSET7	0.189 (0.046)*	0.376 (0.069)*	0.149 (0.069)*
SONSET6	to	SONSET8	0.235 (0.069)*	0.115 (0.068)	0.135 (0.06)*
SONSET7	to	SONSET9	0.455 (0.067)*	0.21 (0.08)*	0.106 (0.06)
SONSET8	to	SONSET10	0.214 (0.058)*	0.305 (0.073)*	0.474 (0.063)*
SONSET9	to	SONSET11	0.285 (0.073)*	0.198 (0.07)*	0.176 (0.106)
SONSET10	to	SONSET12	0.19 (0.084)*	0.339 (0.075)*	0.343 (0.081)*
SONSET11	to	SONSET13	0.271 (0.05)*	0.262 (0.066)*	0.257 (0.069)*
SONSET12	to	SONSET14	0.08 (0.07)	0.097 (0.089)	0.235 (0.065)*
Augoregressive Lag 7 Path Coefficients					
DNR1	to	DNR8	-0.049 (0.047)	0.031 (0.052)	0.039 (0.052)
DNR2	to	DNR9	-0.035 (0.043)	0.054 (0.039)	-0.021 (0.042)
DNR3	to	DNR10	-0.083 (0.033)*	-0.047 (0.036)	-0.002 (0.045)
DNR4	to	DNR11	0.002 (0.034)	-0.053 (0.038)	0.065 (0.049)
DNR5	to	DNR12	-0.024 (0.035)	-0.005 (0.036)	0.024 (0.042)
DNR6	to	DNR13	0.004 (0.034)	-0.007 (0.037)	-0.028 (0.042)
DNR7	to	DNR14	-0.007 (0.058)	-0.07 (0.064)	-0.056 (0.083)
SONSET1	to	SONSET8	0.295 (0.055)*	0.37 (0.076)*	0.458 (0.064)*
SONSET2	to	SONSET9	0.098 (0.053)	0.312 (0.072)*	0.305 (0.066)*
SONSET3	to	SONSET10	0.083 (0.056)	0.195 (0.071)*	0.114 (0.051)*
SONSET4	to	SONSET11	0.243 (0.063)*	0.195 (0.084)*	0.417 (0.089)*
SONSET5	to	SONSET12	0.334 (0.07)*	0.338 (0.078)*	0.331 (0.066)*
SONSET6	to	SONSET13	0.328 (0.065)*	0.244 (0.078)*	0.196 (0.065)*
SONSET7	to	SONSET14	0.335 (0.097)*	0.327 (0.075)*	0.102 (0.071)
Within Night Cross Variable Path Coefficients					
DNR1	to	SONSET1	0.095 (0.033)*	-0.001 (0.04)	0.041 (0.043)
DNR2	to	SONSET2	0.025 (0.037)	0.029 (0.045)	0.003 (0.044)
DNR3	to	SONSET3	0.027 (0.044)	0.023 (0.052)	-0.13 (0.059)*
DNR4	to	SONSET4	0.003 (0.042)	-0.013 (0.049)	-0.021 (0.053)
DNR5	to	SONSET5	0.1 (0.043)*	0.046 (0.046)	-0.02 (0.052)
DNR6	to	SONSET6	0.027 (0.032)	0.071 (0.042)	-0.05 (0.063)
DNR7	to	SONSET7	-0.006 (0.033)	0.006 (0.052)	-0.053 (0.06)

DNR8	to	SONSET8	-0.03 (0.039)	-0.045 (0.047)	-0.087 (0.049)
DNR9	to	SONSET9	0.014 (0.042)	-0.031 (0.058)	-0.041 (0.059)
DNR10	to	SONSET10	0.025 (0.043)	0.05 (0.054)	-0.094 (0.056)
DNR11	to	SONSET11	0.108 (0.051)*	0.029 (0.062)	-0.082 (0.068)
DNR12	to	SONSET12	-0.018 (0.057)	0.051 (0.059)	0.067 (0.063)
DNR13	to	SONSET13	0.076 (0.047)	-0.089 (0.059)	0.112 (0.072)
DNR14	to	SONSET14	-0.069 (0.041)	-0.003 (0.04)	-0.046 (0.039)
Cross Lagged Path Coefficients from Sleep to the Bedtime Routine the Following Night					
SONSET1	to	DNR2	0.022 (0.066)	0.027 (0.092)	-0.142 (0.084)
SONSET2	to	DNR3	-0.03 (0.061)	-0.039 (0.072)	0.001 (0.071)
SONSET3	to	DNR4	-0.03 (0.064)	-0.046 (0.067)	0.018 (0.069)
SONSET4	to	DNR5	0.128 (0.059)*	0.004 (0.07)	0.007 (0.065)
SONSET5	to	DNR6	0.041 (0.063)	0.056 (0.078)	-0.028 (0.069)
SONSET6	to	DNR7	0.059 (0.068)	-0.176 (0.092)	0.04 (0.059)
SONSET7	to	DNR8	-0.108 (0.073)	0.013 (0.076)	-0.009 (0.071)
SONSET8	to	DNR9	-0.035 (0.058)	-0.05 (0.067)	0.138 (0.073)
SONSET9	to	DNR10	0.054 (0.055)	0.118 (0.065)	-0.042 (0.082)
SONSET10	to	DNR11	0.053 (0.067)	-0.022 (0.076)	0.173 (0.086)*
SONSET11	to	DNR12	0.01 (0.058)	0.001 (0.066)	0.008 (0.06)
SONSET12	to	DNR13	0.083 (0.051)	0.071 (0.064)	0.074 (0.064)
SONSET13	to	DNR14	-0.126 (0.112)	-0.126 (0.109)	-0.044 (0.116)
Cross Lagged Path Coefficients from the Bedtime Routine to Sleep the Following Night					
DNR1	to	SONSET2	-0.03 (0.035)	-0.055 (0.049)	-0.035 (0.046)
DNR2	to	SONSET3	-0.047 (0.043)	-0.034 (0.05)	0.12 (0.056)*
DNR3	to	SONSET4	0.017 (0.043)	0.002 (0.05)	0.052 (0.051)
DNR4	to	SONSET5	-0.065 (0.042)	-0.012 (0.046)	-0.103 (0.057)
DNR5	to	SONSET6	0.019 (0.032)	-0.047 (0.042)	0.048 (0.058)
DNR6	to	SONSET7	0.009 (0.034)	0.027 (0.048)	0.115 (0.054)*
DNR7	to	SONSET8	-0.025 (0.036)	0.088 (0.055)	0.057 (0.049)
DNR8	to	SONSET9	-0.005 (0.041)	-0.022 (0.057)	0.01 (0.052)
DNR9	to	SONSET10	0.001 (0.041)	0.044 (0.049)	0.069 (0.055)
DNR10	to	SONSET11	0.013 (0.052)	0.055 (0.062)	0.024 (0.076)
DNR11	to	SONSET12	0.064 (0.06)	0.003 (0.055)	-0.013 (0.06)
DNR12	to	SONSET13	0.033 (0.047)	0.212 (0.069)*	-0.07 (0.067)
DNR13	to	SONSET14	-0.058 (0.056)	-0.037 (0.055)	-0.14 (0.059)*

*$p < .05$

Table A.3

All Path Coefficients from Autoregressive Cross-Lagged Path Models with Routine Length Variability (RLV)and Actigraph Recorded Sleep Duration (ARSL) at 30, 36, and 42 Months

			30 month est. B (SE)	36 month est. B (SE)	42 month est. B (SE)
Autoregressive Lag 1 Path Coefficients					
RLV1	to	RLV2	0.303 (0.052)*	0.332 (0.064)*	0.16 (0.066)*
RLV2	to	RLV3	0.286 (0.062)*	0.169 (0.09)	0.105 (0.061)
RLV3	to	RLV4	0.253 (0.05)*	0.124 (0.033)*	0.206 (0.062)*
RLV4	to	RLV5	0.422 (0.068)*	0.19 (0.074)*	0.136 (0.084)
RLV5	to	RLV6	0.122 (0.04)*	0.245 (0.058)*	0.143 (0.062)*
RLV6	to	RLV7	0.151 (0.057)*	0.256 (0.062)*	0.157 (0.086)
RLV7	to	RLV8	0.363 (0.077)*	0.121 (0.067)	0.219 (0.054)*
RLV8	to	RLV9	0.102 (0.07)	0.132 (0.073)	0.208 (0.073)*
RLV9	to	RLV10	0.111 (0.058)	0.159 (0.062)*	0.159 (0.08)*
RLV10	to	RLV11	0.034 (0.05)	0.266 (0.062)*	0.046 (0.102)
RLV11	to	RLV12	0.022 (0.078)	0.128 (0.074)	0.297 (0.083)*
RLV12	to	RLV13	0.168 (0.062)*	0.266 (0.091)*	0.16 (0.059)*
RLV13	to	RLV14	0.449 (0.127)*	-0.032 (0.109)	-0.016 (0.156)
ARSL1	to	ARSL2	0.451 (0.048)*	0.588 (0.069)*	0.557 (0.064)*
ARSL2	to	ARSL3	0.37 (0.053)*	0.261 (0.062)*	0.506 (0.099)*
ARSL3	to	ARSL4	0.42 (0.065)*	0.422 (0.069)*	0.341 (0.073)*
ARSL4	to	ARSL5	0.267 (0.053)*	0.27 (0.075)*	0.362 (0.074)*
ARSL5	to	ARSL6	0.34 (0.061)*	0.361 (0.063)*	0.615 (0.104)*
ARSL6	to	ARSL7	0.441 (0.049)*	0.437 (0.074)*	0.491 (0.069)*
ARSL7	to	ARSL8	0.164 (0.067)*	0.241 (0.069)*	0.036 (0.085)
ARSL8	to	ARSL9	0.225 (0.059)*	0.324 (0.069)*	0.299 (0.082)*
ARSL9	to	ARSL10	0.439 (0.075)*	0.365 (0.089)*	0.241 (0.067)*
ARSL10	to	ARSL11	0.24 (0.063)*	0.452 (0.068)*	0.376 (0.115)*
ARSL11	to	ARSL12	0.217 (0.073)*	0.262 (0.079)*	0.264 (0.082)*
ARSL12	to	ARSL13	0.342 (0.056)*	0.207 (0.084)*	0.319 (0.081)*
ARSL13	to	ARSL14	0.411 (0.078)*	0.339 (0.079)*	0.337 (0.061)*
Autoregressive Lag 2 Path Coefficients					
RLV1	to	RLV3	0.238 (0.059)*	0.35 (0.097)*	0.17 (0.064)*
RLV2	to	RLV4	0.364 (0.055)*	0.141 (0.053)*	0.215 (0.052)*
RLV3	to	RLV5	0.07 (0.065)	0.209 (0.037)*	0.098 (0.069)
RLV4	to	RLV6	0.17 (0.053)*	0.187 (0.069)*	0.2 (0.069)*
RLV5	to	RLV7	0.137 (0.039)*	0.274 (0.059)*	0.129 (0.082)
RLV6	to	RLV8	0.196 (0.067)*	0.146 (0.07)*	0.175 (0.07)*
RLV7	to	RLV9	0.187 (0.094)*	0.165 (0.072)*	-0.013 (0.055)

RLV8	to	RLV10	0.139 (0.074)	0.206 (0.069)*	0.28 (0.088)*
RLV9	to	RLV11	0.083 (0.049)	0.064 (0.056)	0.145 (0.08)
RLV10	to	RLV12	0.041 (0.064)	0.132 (0.07)	0.175 (0.083)
RLV11	to	RLV13	0.185 (0.068)*	-0.047 (0.102)	0.139 (0.062)*
RLV12	to	RLV14	0.373 (0.161)*	0.596 (0.207)*	0.49 (0.131)*
ARSL1	to	ARSL3	0.246 (0.048)*	0.428 (0.072)*	0.154 (0.095)
ARSL2	to	ARSL4	0.328 (0.061)*	0.235 (0.062)*	0.277 (0.087)*
ARSL3	to	ARSL5	0.402 (0.06)*	0.426 (0.075)*	0.183 (0.065)*
ARSL4	to	ARSL6	0.454 (0.056)*	0.312 (0.067)*	0.312 (0.099)*
ARSL5	to	ARSL7	0.198 (0.056)*	0.161 (0.07)*	0.096 (0.1)
ARSL6	to	ARSL8	0.371 (0.062)*	0.176 (0.071)*	0.213 (0.079)*
ARSL7	to	ARSL9	0.325 (0.059)*	0.181 (0.063)*	0.228 (0.076)*
ARSL8	to	ARSL10	0.152 (0.07)*	0.249 (0.081)*	0.303 (0.059)*
ARSL9	to	ARSL11	0.344 (0.068)*	0.232 (0.084)*	0.326 (0.111)*
ARSL10	to	ARSL12	0.132 (0.071)	0.256 (0.077)*	0.292 (0.098)*
ARSL11	to	ARSL13	0.326 (0.058)*	0.411 (0.074)*	0.27 (0.073)*
ARSL12	to	ARSL14	0.186 (0.077)*	0.311 (0.086)*	0.248 (0.066)*
Autoregressive Lag 7 Path Coefficients					
RLV1	to	RLV8	0.221 (0.073)*	0.178 (0.072)*	0.206 (0.067)*
RLV2	to	RLV9	0.213 (0.089)*	0.387 (0.073)*	0.137 (0.064)*
RLV3	to	RLV10	0.23 (0.076)*	0.053 (0.042)	0.104 (0.091)
RLV4	to	RLV11	0.202 (0.058)*	0.154 (0.094)	0.281 (0.09)*
RLV5	to	RLV12	0.176 (0.054)*	0.239 (0.068)*	0.16 (0.073)*
RLV6	to	RLV13	0.175 (0.077)*	0.552 (0.113)*	0.101 (0.066)
RLV7	to	RLV14	0.539 (0.154)*	0.115 (0.2)	0.054 (0.116)
ARSL1	to	ARSL8	0.095 (0.053)	0.26 (0.074)*	0.468 (0.092)*
ARSL2	to	ARSL9	0.196 (0.053)*	0.2 (0.06)*	0.209 (0.11)
ARSL3	to	ARSL10	0.049 (0.071)	0.166 (0.079)*	0.12 (0.055)*
ARSL4	to	ARSL11	0.14 (0.052)*	0.213 (0.071)*	0.253 (0.092)*
ARSL5	to	ARSL12	0.433 (0.062)*	0.184 (0.071)*	0.284 (0.108)*
ARSL6	to	ARSL13	0.064 (0.056)	0.206 (0.072)*	0.152 (0.063)*
ARSL7	to	ARSL14	0.17 (0.078)*	0.18 (0.069)*	0.116 (0.058)*
Within Night Cross Variable Path Coefiificents					
RLV1	to	ARSL1	-0.794 (0.361)*	-0.125 (0.35)	-0.128 (0.329)
RLV2	to	ARSL2	-0.713 (0.325)*	-0.353 (0.341)	0.052 (0.249)
RLV3	to	ARSL3	-0.398 (0.243)	-0.027 (0.174)	-0.38 (0.32)
RLV4	to	ARSL4	-0.239 (0.297)	-0.21 (0.359)	-0.084 (0.353)
RLV5	to	ARSL5	-0.095 (0.213)	0.603 (0.333)	-0.001 (0.304)
RLV6	to	ARSL6	-0.736 (0.324)*	-0.432 (0.317)	-0.365 (0.411)
RLV7	to	ARSL7	-0.145 (0.282)	-0.447 (0.328)	-1.088 (0.349)*

RLV8	to	ARSL8	0.675 (0.26)*	-0.354 (0.323)	0.109 (0.409)
RLV9	to	ARSL9	-0.355 (0.213)	-0.294 (0.3)	-0.636 (0.368)
RLV10	to	ARSL10	-0.257 (0.258)	-0.67 (0.346)	-0.072 (0.277)
RLV11	to	ARSL11	-0.898 (0.284)*	-0.907 (0.321)*	-0.361 (0.393)
RLV12	to	ARSL12	-0.002 (0.304)	-0.403 (0.296)	-0.678 (0.396)
RLV13	to	ARSL13	-0.45 (0.25)	0.032 (0.214)	-0.263 (0.391)
RLV14	to	ARSL14	0.138 (0.217)	-0.181 (0.144)	0.024 (0.186)
Cross Lagged Path Coefficients from Sleep to the Bedtime Routine the Following Night					
ARSL1	to	RLV2	0.005 (0.009)	-0.017 (0.016)	0.007 (0.016)
ARSL2	to	RLV3	-0.005 (0.011)	-0.012 (0.018)	0.025 (0.015)
ARSL3	to	RLV4	-0.013 (0.01)	-0.01 (0.013)	-0.016 (0.012)
ARSL4	to	RLV5	-0.016 (0.012)	-0.013 (0.014)	0.005 (0.015)
ARSL5	to	RLV6	-0.015 (0.01)	-0.017 (0.012)	0.012 (0.015)
ARSL6	to	RLV7	-0.003 (0.009)	-0.009 (0.013)	0.026 (0.017)
ARSL7	to	RLV8	0 (0.013)	0.012 (0.013)	0.011 (0.014)
ARSL8	to	RLV9	-0.001 (0.016)	0.023 (0.017)	-0.003 (0.015)
ARSL9	to	RLV10	0.005 (0.015)	-0.023 (0.016)	0.001 (0.016)
ARSL10	to	RLV11	0.007 (0.012)	-0.011 (0.013)	-0.039 (0.019)*
ARSL11	to	RLV12	-0.015 (0.017)	0.017 (0.015)	0.01 (0.015)
ARSL12	to	RLV13	-0.006 (0.015)	0.004 (0.024)	0.001 (0.013)
ARSL13	to	RLV14	-0.006 (0.029)	-0.084 (0.036)*	-0.066 (0.029)*
Cross Lagged Path Coefficients from the Bedtime Routine to Sleep the Following Night					
RLV1	to	ARSL2	-0.349 (0.298)	0.492 (0.367)	0.099 (0.276)
RLV2	to	ARSL3	0.201 (0.287)	0.188 (0.276)	0.264 (0.314)
RLV3	to	ARSL4	0.18 (0.275)	-0.203 (0.175)	0.089 (0.305)
RLV4	to	ARSL5	-0.588 (0.272)*	-0.576 (0.381)	0.541 (0.323)
RLV5	to	ARSL6	0.458 (0.215)*	-0.523 (0.332)	0.491 (0.389)
RLV6	to	ARSL7	0.651 (0.279)*	0.34 (0.358)	0.039 (0.351)
RLV7	to	ARSL8	-0.46 (0.342)	-0.118 (0.334)	-0.353 (0.379)
RLV8	to	ARSL9	0.395 (0.236)	0.165 (0.29)	-0.007 (0.372)
RLV9	to	ARSL10	-0.052 (0.248)	0.284 (0.369)	-0.033 (0.282)
RLV10	to	ARSL11	0.491 (0.227)*	-0.038 (0.297)	-0.152 (0.552)
RLV11	to	ARSL12	0.1 (0.315)	0.471 (0.323)	0.199 (0.337)
RLV12	to	ARSL13	0.628 (0.252)*	0.002 (0.316)	0.422 (0.334)
RLV13	to	ARSL14	-0.172 (0.306)	0.113 (0.193)	0.263 (0.3)

*$p < .05$

Table A.4

All Path Coefficients from Autoregressive Cross-Lagged Path Models with Deviation from Normal Routine (DNR)and Actigraph Recorded Sleep Duration (ARSL) at 30, 36, and 42 Months

			30 month est. B (SE)	36 month est. B (SE)	42 month est. B (SE)
Autoregressive Lag 1 Path Coefficients					
DNR1	to	DNR2	0.602 (0.037)*	0.664 (0.046)*	0.625 (0.048)*
DNR2	to	DNR3	0.457 (0.044)*	0.371 (0.049)*	0.421 (0.053)*
DNR3	to	DNR4	0.461 (0.052)*	0.469 (0.052)*	0.306 (0.061)*
DNR4	to	DNR5	0.334 (0.048)*	0.519 (0.053)*	0.334 (0.053)*
DNR5	to	DNR6	0.433 (0.048)*	0.426 (0.057)*	0.458 (0.053)*
DNR6	to	DNR7	0.489 (0.048)*	0.347 (0.054)*	0.411 (0.058)*
DNR7	to	DNR8	0.075 (0.053)	0.138 (0.055)*	0.208 (0.065)*
DNR8	to	DNR9	0.386 (0.044)*	0.509 (0.047)*	0.285 (0.052)*
DNR9	to	DNR10	0.257 (0.048)*	0.255 (0.058)*	0.272 (0.062)*
DNR10	to	DNR11	0.29 (0.054)*	0.197 (0.056)*	0.309 (0.067)*
DNR11	to	DNR12	0.447 (0.05)*	0.418 (0.053)*	0.281 (0.053)*
DNR12	to	DNR13	0.369 (0.049)*	0.405 (0.055)*	0.255 (0.056)*
DNR13	to	DNR14	0.208 (0.088)*	0.161 (0.092)	0.059 (0.104)
ARSL1	to	ARSL2	0.499 (0.048)*	0.617 (0.067)*	0.586 (0.065)*
ARSL2	to	ARSL3	0.36 (0.052)*	0.25 (0.064)*	0.457 (0.088)*
ARSL3	to	ARSL4	0.383 (0.063)*	0.421 (0.066)*	0.35 (0.071)*
ARSL4	to	ARSL5	0.308 (0.051)*	0.277 (0.072)*	0.359 (0.074)*
ARSL5	to	ARSL6	0.354 (0.062)*	0.334 (0.061)*	0.568 (0.095)*
ARSL6	to	ARSL7	0.44 (0.048)*	0.424 (0.072)*	0.468 (0.068)*
ARSL7	to	ARSL8	0.185 (0.066)*	0.217 (0.067)*	0.078 (0.08)
ARSL8	to	ARSL9	0.256 (0.057)*	0.318 (0.066)*	0.274 (0.079)*
ARSL9	to	ARSL10	0.471 (0.075)*	0.39 (0.085)*	0.333 (0.062)*
ARSL10	to	ARSL11	0.192 (0.063)*	0.474 (0.066)*	0.282 (0.109)*
ARSL11	to	ARSL12	0.26 (0.066)*	0.313 (0.077)*	0.273 (0.075)*
ARSL12	to	ARSL13	0.351 (0.056)*	0.195 (0.081)*	0.314 (0.076)*
ARSL13	to	ARSL14	0.493 (0.077)*	0.381 (0.078)*	0.346 (0.059)*
Autoregressive Lag 2 Path Coefficients					
DNR1	to	DNR3	0.363 (0.042)*	0.417 (0.053)*	0.225 (0.055)*
DNR2	to	DNR4	0.331 (0.053)*	0.233 (0.051)*	0.286 (0.055)*
DNR3	to	DNR5	0.401 (0.049)*	0.226 (0.051)*	0.448 (0.052)*
DNR4	to	DNR6	0.307 (0.047)*	0.282 (0.057)*	0.208 (0.055)*
DNR5	to	DNR7	0.268 (0.049)*	0.265 (0.055)*	0.165 (0.056)*
DNR6	to	DNR8	0.069 (0.056)	-0.069 (0.054)	0.062 (0.064)
DNR7	to	DNR9	0.06 (0.041)	0.028 (0.044)	0.091 (0.053)

DNR8	to	DNR10	0.102 (0.046)*	0.187 (0.057)*	0.081 (0.057)
DNR9	to	DNR11	0.149 (0.05)*	0.157 (0.054)*	0.198 (0.067)*
DNR10	to	DNR12	0.182 (0.053)*	0.272 (0.052)*	0.182 (0.059)*
DNR11	to	DNR13	0.286 (0.052)*	0.193 (0.058)*	0.239 (0.05)*
DNR12	to	DNR14	-0.044 (0.085)	-0.18 (0.093)	0.075 (0.1)
ARSL1	to	ARSL3	0.253 (0.05)*	0.424 (0.076)*	0.193 (0.09)*
ARSL2	to	ARSL4	0.357 (0.059)*	0.276 (0.061)*	0.248 (0.08)*
ARSL3	to	ARSL5	0.359 (0.057)*	0.387 (0.072)*	0.169 (0.065)*
ARSL4	to	ARSL6	0.445 (0.056)*	0.353 (0.063)*	0.314 (0.094)*
ARSL5	to	ARSL7	0.19 (0.056)*	0.152 (0.068)*	0.145 (0.093)
ARSL6	to	ARSL8	0.346 (0.062)*	0.199 (0.07)*	0.194 (0.075)*
ARSL7	to	ARSL9	0.278 (0.057)*	0.164 (0.061)*	0.285 (0.074)*
ARSL8	to	ARSL10	0.166 (0.069)*	0.264 (0.078)*	0.265 (0.057)*
ARSL9	to	ARSL11	0.361 (0.072)*	0.211 (0.081)*	0.296 (0.105)*
ARSL10	to	ARSL12	0.111 (0.064)	0.217 (0.075)*	0.325 (0.086)*
ARSL11	to	ARSL13	0.346 (0.058)*	0.374 (0.073)*	0.279 (0.07)*
ARSL12	to	ARSL14	0.189 (0.077)*	0.302 (0.084)*	0.216 (0.064)*
Autoregressive Lag 7 Path Coefficients					
DNR1	to	DNR8	-0.05 (0.047)	0.03 (0.052)	0.038 (0.052)
DNR2	to	DNR9	-0.038 (0.042)	0.052 (0.039)	-0.026 (0.042)
DNR3	to	DNR10	-0.08 (0.033)*	-0.041 (0.036)	-0.002 (0.045)
DNR4	to	DNR11	0 (0.034)	-0.052 (0.038)	0.064 (0.05)
DNR5	to	DNR12	-0.028 (0.035)	-0.005 (0.036)	0.025 (0.042)
DNR6	to	DNR13	0.011 (0.034)	-0.003 (0.037)	-0.028 (0.042)
DNR7	to	DNR14	-0.019 (0.058)	-0.066 (0.064)	-0.055 (0.083)
ARSL1	to	ARSL8	0.115 (0.053)*	0.269 (0.073)*	0.462 (0.09)*
ARSL2	to	ARSL9	0.192 (0.051)*	0.21 (0.059)*	0.197 (0.106)
ARSL3	to	ARSL10	0.045 (0.069)	0.139 (0.077)	0.14 (0.054)*
ARSL4	to	ARSL11	0.159 (0.055)*	0.177 (0.068)*	0.267 (0.087)*
ARSL5	to	ARSL12	0.426 (0.06)*	0.169 (0.068)*	0.219 (0.096)*
ARSL6	to	ARSL13	0.07 (0.054)	0.226 (0.067)*	0.179 (0.06)*
ARSL7	to	ARSL14	0.163 (0.077)*	0.142 (0.07)*	0.146 (0.055)*
Within Night Cross Variable Path Coefficients					
DNR1	to	ARSL1	-9.161 (3.076)*	0.546 (3.145)	5.603 (3.19)
DNR2	to	ARSL2	-0.209 (3.45)	1.692 (3.731)	-1.533 (3.708)
DNR3	to	ARSL3	-3.701 (3.303)	-1.149 (3.525)	10.198 (4.284)*
DNR4	to	ARSL4	-3.385 (3.48)	5.681 (3.503)	4.33 (3.664)
DNR5	to	ARSL5	-1.014 (3.042)	2.205 (4.06)	-3.755 (3.548)
DNR6	to	ARSL6	-2.272 (3.345)	-5 (3.632)	2.658 (5.202)
DNR7	to	ARSL7	-3.292 (2.958)	-0.775 (4.225)	0.246 (4.964)

DNR8	to	ARSL8	2.457 (3.26)	5.457 (3.966)	8.774 (4.802)
DNR9	to	ARSL9	-1.904 (3.142)	1.096 (3.898)	-2.54 (5.527)
DNR10	to	ARSL10	-4.664 (4.14)	-1.425 (4.664)	4.325 (4.19)
DNR11	to	ARSL11	-0.586 (3.613)	-9.708 (4.138)*	-10.075 (4.962)*
DNR12	to	ARSL12	3.009 (3.863)	-3.063 (4.563)	-4.144 (4.758)
DNR13	to	ARSL13	-4.026 (3.463)	-1.667 (4.536)	3.602 (5.07)
DNR14	to	ARSL14	1.157 (2.844)	1.157 (3.109)	1.221 (2.586)
Cross Lagged Path Coefficients from Sleep to the Bedtime Routine the Following Night					
ARSL1	to	DNR2	0 (0.001)	0 (0.001)	0.003 (0.001)*
ARSL2	to	DNR3	0 (0.001)	0.001 (0.001)	0.001 (0.001)
ARSL3	to	DNR4	-0.001 (0.001)	0.002 (0.001)*	0.002 (0.001)
ARSL4	to	DNR5	-0.001 (0.001)	-0.001 (0.001)	0 (0.001)
ARSL5	to	DNR6	-0.001 (0.001)	-0.001 (0.001)	0.001 (0.001)
ARSL6	to	DNR7	0 (0.001)	0.001 (0.001)	0 (0.001)
ARSL7	to	DNR8	-0.001 (0.001)	0 (0.001)	0 (0.001)
ARSL8	to	DNR9	0 (0.001)	0.001 (0.001)	0 (0.001)
ARSL9	to	DNR10	0 (0.001)	-0.001 (0.001)	0.001 (0.001)
ARSL10	to	DNR11	-0.001 (0.001)	0 (0.001)	-0.001 (0.001)
ARSL11	to	DNR12	-0.001 (0.001)	0.001 (0.001)	0 (0.001)
ARSL12	to	DNR13	0 (0.001)	-0.001 (0.001)	0 (0.001)
ARSL13	to	DNR14	-0.001 (0.002)	0 (0.002)	0.001 (0.002)
Cross Lagged Path Coefficients from the Bedtime Routine to Sleep the Following Night					
DNR1	to	ARSL2	1.765 (3.304)	3.746 (4.076)	0.443 (3.678)
DNR2	to	ARSL3	5.312 (3.25)	1.53 (3.369)	-7.3 (4.087)
DNR3	to	ARSL4	1.264 (3.49)	-2.479 (3.603)	-7.27 (3.506)*
DNR4	to	ARSL5	-3.254 (3.01)	-0.572 (4.08)	8.397 (3.879)*
DNR5	to	ARSL6	0.064 (3.241)	4.365 (3.625)	-4.297 (4.916)
DNR6	to	ARSL7	1.956 (3.029)	5.685 (3.919)	-6.948 (4.622)
DNR7	to	ARSL8	5.081 (3.031)	-5.119 (4.677)	-7.652 (4.856)
DNR8	to	ARSL9	0.024 (3.094)	4.089 (3.76)	-1.033 (5)
DNR9	to	ARSL10	8.834 (3.754)*	-0.598 (4.32)	-0.692 (4.122)
DNR10	to	ARSL11	0.489 (3.904)	-7.025 (4.098)	6.046 (5.774)
DNR11	to	ARSL12	-2.801 (4.095)	3.61 (4.389)	3.382 (4.537)
DNR12	to	ARSL13	4.132 (3.5)	1.827 (5.264)	1.904 (4.715)
DNR13	to	ARSL14	0.113 (3.866)	-2.039 (4.166)	4.202 (3.862)

* $p < .05$

Table A.5
All Path Coefficients from Autoregressive Cross-Lagged Path Models with Routine Length Variability (RLV)and Parent Reported Sleep Duration (PRSL) at 30, 36, and 42 Months

			30 month est. B (SE)	36 month est. B (SE)	42 month est. B (SE)
Autoregressive Lag 1 Path Coefficients					
RLV1	to	RLV2	0.294 (0.052)*	0.331 (0.064)*	0.154 (0.067)*
RLV2	to	RLV3	0.277 (0.062)*	0.177 (0.092)	0.114 (0.062)
RLV3	to	RLV4	0.255 (0.05)*	0.124 (0.034)*	0.212 (0.062)*
RLV4	to	RLV5	0.422 (0.067)*	0.18 (0.076)*	0.134 (0.084)
RLV5	to	RLV6	0.122 (0.041)*	0.225 (0.059)*	0.155 (0.063)*
RLV6	to	RLV7	0.149 (0.057)*	0.259 (0.063)*	0.129 (0.086)
RLV7	to	RLV8	0.356 (0.076)*	0.097 (0.068)	0.22 (0.056)*
RLV8	to	RLV9	0.097 (0.069)	0.146 (0.076)	0.207 (0.073)*
RLV9	to	RLV10	0.105 (0.059)	0.127 (0.063)*	0.152 (0.079)
RLV10	to	RLV11	0.029 (0.05)	0.26 (0.063)*	0.038 (0.102)
RLV11	to	RLV12	0.01 (0.077)	0.121 (0.075)	0.281 (0.083)*
RLV12	to	RLV13	0.175 (0.063)*	0.283 (0.093)*	0.162 (0.06)*
RLV13	to	RLV14	0.469 (0.128)*	-0.036 (0.112)	-0.026 (0.158)
PRSL1	to	PRSL2	0.476 (0.043)*	0.64 (0.059)*	0.634 (0.057)*
PRSL2	to	PRSL3	0.467 (0.057)*	0.178 (0.057)*	0.47 (0.07)*
PRSL3	to	PRSL4	0.282 (0.062)*	0.284 (0.058)*	0.221 (0.066)*
PRSL4	to	PRSL5	0.183 (0.045)*	0.193 (0.059)*	0.275 (0.065)*
PRSL5	to	PRSL6	0.325 (0.051)*	0.345 (0.06)*	0.315 (0.062)*
PRSL6	to	PRSL7	0.361 (0.054)*	0.349 (0.06)*	0.254 (0.063)*
PRSL7	to	PRSL8	0.173 (0.06)*	0.25 (0.059)*	0.309 (0.076)*
PRSL8	to	PRSL9	0.308 (0.066)*	0.336 (0.075)*	0.144 (0.064)*
PRSL9	to	PRSL10	0.317 (0.061)*	0.2 (0.06)*	0.2 (0.069)*
PRSL10	to	PRSL11	0.36 (0.066)*	0.345 (0.059)*	0.392 (0.077)*
PRSL11	to	PRSL12	0.322 (0.058)*	0.279 (0.071)*	0.16 (0.059)*
PRSL12	to	PRSL13	0.299 (0.053)*	0.358 (0.066)*	0.163 (0.064)*
PRSL13	to	PRSL14	0.396 (0.086)*	0.122 (0.121)	0.335 (0.076)*
Autoregressive Lag 2 Path Coefficients					
RLV1	to	RLV3	0.243 (0.059)*	0.335 (0.097)*	0.172 (0.065)*
RLV2	to	RLV4	0.37 (0.055)*	0.14 (0.054)*	0.205 (0.052)*
RLV3	to	RLV5	0.061 (0.065)	0.207 (0.037)*	0.092 (0.069)
RLV4	to	RLV6	0.194 (0.052)*	0.188 (0.068)*	0.204 (0.068)*
RLV5	to	RLV7	0.133 (0.039)*	0.276 (0.059)*	0.143 (0.083)
RLV6	to	RLV8	0.19 (0.066)*	0.149 (0.071)*	0.179 (0.071)*
RLV7	to	RLV9	0.193 (0.094)*	0.177 (0.073)*	-0.014 (0.055)

RLV8	to	RLV10	0.141 (0.074)	0.214 (0.068)*	0.287 (0.087)*
RLV9	to	RLV11	0.078 (0.05)	0.067 (0.057)	0.156 (0.08)
RLV10	to	RLV12	0.043 (0.063)	0.137 (0.07)	0.155 (0.085)
RLV11	to	RLV13	0.189 (0.068)*	-0.028 (0.103)	0.136 (0.062)*
RLV12	to	RLV14	0.398 (0.156)*	0.601 (0.209)*	0.438 (0.134)*
PRSL1	to	PRSL3	0.255 (0.053)*	0.427 (0.068)*	0.088 (0.074)
PRSL2	to	PRSL4	0.377 (0.069)*	0.294 (0.056)*	0.189 (0.066)*
PRSL3	to	PRSL5	0.351 (0.05)*	0.316 (0.055)*	0.319 (0.061)*
PRSL4	to	PRSL6	0.309 (0.044)*	0.351 (0.058)*	0.212 (0.066)*
PRSL5	to	PRSL7	0.195 (0.056)*	0.252 (0.065)*	0.255 (0.058)*
PRSL6	to	PRSL8	0.247 (0.056)*	0.168 (0.06)*	0.292 (0.071)*
PRSL7	to	PRSL9	0.246 (0.062)*	0.293 (0.065)*	0.165 (0.062)*
PRSL8	to	PRSL10	0.18 (0.065)*	0.284 (0.071)*	0.352 (0.068)*
PRSL9	to	PRSL11	0.225 (0.063)*	0.183 (0.053)*	0.205 (0.084)*
PRSL10	to	PRSL12	0.098 (0.068)	0.159 (0.069)*	0.135 (0.068)*
PRSL11	to	PRSL13	0.123 (0.052)*	0.135 (0.071)	0.276 (0.055)*
PRSL12	to	PRSL14	0.144 (0.085)	0.208 (0.111)	0.045 (0.069)
Autoregressive Lag 7 Path Coefficients					
RLV1	to	RLV8	0.204 (0.073)*	0.185 (0.073)*	0.205 (0.067)*
RLV2	to	RLV9	0.214 (0.087)*	0.352 (0.076)*	0.135 (0.064)*
RLV3	to	RLV10	0.21 (0.076)*	0.024 (0.043)	0.107 (0.09)
RLV4	to	RLV11	0.2 (0.058)*	0.125 (0.096)	0.224 (0.091)*
RLV5	to	RLV12	0.173 (0.054)*	0.241 (0.068)*	0.156 (0.073)*
RLV6	to	RLV13	0.171 (0.077)*	0.517 (0.118)*	0.103 (0.066)
RLV7	to	RLV14	0.524 (0.154)*	0.234 (0.197)	0.07 (0.117)
PRSL1	to	PRSL8	0.308 (0.056)*	0.279 (0.069)*	0.119 (0.072)
PRSL2	to	PRSL9	0.314 (0.063)*	0.129 (0.062)*	0.394 (0.062)*
PRSL3	to	PRSL10	0.311 (0.055)*	0.298 (0.058)*	0.283 (0.065)*
PRSL4	to	PRSL11	0.264 (0.059)*	0.163 (0.055)*	0.274 (0.082)*
PRSL5	to	PRSL12	0.278 (0.061)*	0.223 (0.063)*	0.452 (0.062)*
PRSL6	to	PRSL13	0.288 (0.053)*	0.28 (0.062)*	0.248 (0.066)*
PRSL7	to	PRSL14	0.348 (0.088)*	0.154 (0.09)	0.203 (0.08)*
Within Night Cross Variable Path Coefficients					
RLV1	to	PRSL1	-0.009 (0.003)*	-0.005 (0.003)	-0.007 (0.003)*
RLV2	to	PRSL2	-0.008 (0.003)*	-0.011 (0.003)*	-0.008 (0.003)*
RLV3	to	PRSL3	-0.01 (0.003)*	-0.012 (0.002)*	-0.012 (0.003)*
RLV4	to	PRSL4	-0.004 (0.004)	-0.007 (0.004)	-0.003 (0.004)
RLV5	to	PRSL5	-0.007 (0.002)*	-0.005 (0.003)	-0.012 (0.004)*
RLV6	to	PRSL6	-0.009 (0.004)*	-0.007 (0.004)*	-0.001 (0.004)
RLV7	to	PRSL7	-0.001 (0.003)	-0.012 (0.004)*	-0.016 (0.003)*

RLV8	to	PRSL8	-0.001 (0.003)	-0.014 (0.003)*	-0.009 (0.004)*
RLV9	to	PRSL9	-0.009 (0.003)*	-0.014 (0.003)*	-0.01 (0.003)*
RLV10	to	PRSL10	-0.006 (0.003)*	-0.008 (0.003)*	-0.004 (0.003)
RLV11	to	PRSL11	-0.008 (0.003)*	-0.011 (0.003)*	-0.008 (0.004)*
RLV12	to	PRSL12	-0.006 (0.003)	-0.007 (0.003)*	-0.015 (0.003)*
RLV13	to	PRSL13	-0.012 (0.003)*	-0.008 (0.002)*	-0.004 (0.004)
RLV14	to	PRSL14	-0.016 (0.002)*	-0.015 (0.002)*	-0.008 (0.002)*
Cross Lagged Path Coefficients from Sleep to the Bedtime Routine the Following Night					
PRSL1	to	RLV2	-0.478 (0.846)	-1.036 (1.158)	-0.865 (1.351)
PRSL2	to	RLV3	-0.223 (0.998)	-0.726 (1.443)	0.035 (1.162)
PRSL3	to	RLV4	-0.88 (0.774)	0.02 (0.837)	-1.328 (0.991)
PRSL4	to	RLV5	-1.866 (0.925)*	-1.039 (0.918)	-1.086 (1.185)
PRSL5	to	RLV6	0.057 (0.783)	-1.509 (0.978)	0.807 (1.043)
PRSL6	to	RLV7	-0.806 (0.769)	-0.338 (0.943)	2.003 (1.422)
PRSL7	to	RLV8	-1.98 (1.038)	-0.867 (1.048)	0.095 (1.239)
PRSL8	to	RLV9	-0.369 (1.226)	0.676 (1.285)	-0.522 (1.129)
PRSL9	to	RLV10	-0.551 (1.091)	-2.951 (1.129)*	-0.083 (1.287)
PRSL10	to	RLV11	-0.81 (0.889)	-1.348 (1.059)	-2.024 (1.247)
PRSL11	to	RLV12	-2.076 (0.975)*	1.26 (1.202)	-0.833 (1.128)
PRSL12	to	RLV13	0.926 (1.002)	1.909 (1.642)	-0.316 (0.97)
PRSL13	to	RLV14	0.271 (2.149)	0.543 (3.119)	-4.793 (2.503)
Cross Lagged Path Coefficients from the Bedtime Routine to Sleep the Following Night					
RLV1	to	PRSL2	0 (0.003)	0 (0.003)	0.004 (0.003)
RLV2	to	PRSL3	0.01 (0.003)*	0.006 (0.003)	0.003 (0.003)
RLV3	to	PRSL4	-0.002 (0.003)	0.001 (0.002)	-0.002 (0.003)
RLV4	to	PRSL5	-0.002 (0.003)	0 (0.004)	0.003 (0.004)
RLV5	to	PRSL6	0.002 (0.002)	-0.002 (0.004)	0.002 (0.004)
RLV6	to	PRSL7	-0.005 (0.004)	-0.003 (0.004)	0.005 (0.003)
RLV7	to	PRSL8	-0.002 (0.004)	0.001 (0.003)	0.005 (0.003)
RLV8	to	PRSL9	-0.001 (0.003)	0.008 (0.004)*	0 (0.004)
RLV9	to	PRSL10	0.003 (0.003)	0.007 (0.003)*	0.004 (0.004)
RLV10	to	PRSL11	0.008 (0.003)*	0 (0.003)	-0.007 (0.005)
RLV11	to	PRSL12	0.001 (0.003)	0.005 (0.004)	0.001 (0.003)
RLV12	to	PRSL13	0.003 (0.003)	0.003 (0.003)	0.004 (0.003)
RLV13	to	PRSL14	0.011 (0.005)*	-0.002 (0.003)	0.004 (0.004)

*$p < .05$

Table A.6

All Path Coefficients from Autoregressive Cross-Lagged Path Models with Deviation from Normal Routine (DNR)and Parent Reported Sleep Duration (PRSL) at 30, 36, and 42 Months

			30 month est. B (SE)	36 month est. B (SE)	42 month est. B (SE)
Autoregressive Lag 1 Path Coefficients					
DNR1	to	DNR2	0.597 (0.037)*	0.666 (0.046)*	0.637 (0.048)*
DNR2	to	DNR3	0.46 (0.044)*	0.371 (0.05)*	0.423 (0.053)*
DNR3	to	DNR4	0.47 (0.052)*	0.469 (0.053)*	0.324 (0.06)*
DNR4	to	DNR5	0.335 (0.048)*	0.505 (0.052)*	0.333 (0.052)*
DNR5	to	DNR6	0.435 (0.048)*	0.427 (0.057)*	0.454 (0.052)*
DNR6	to	DNR7	0.49 (0.048)*	0.345 (0.054)*	0.414 (0.057)*
DNR7	to	DNR8	0.079 (0.052)	0.138 (0.055)*	0.211 (0.065)*
DNR8	to	DNR9	0.385 (0.044)*	0.517 (0.047)*	0.287 (0.053)*
DNR9	to	DNR10	0.255 (0.048)*	0.252 (0.058)*	0.273 (0.062)*
DNR10	to	DNR11	0.291 (0.054)*	0.191 (0.056)*	0.303 (0.066)*
DNR11	to	DNR12	0.446 (0.05)*	0.405 (0.052)*	0.281 (0.052)*
DNR12	to	DNR13	0.368 (0.049)*	0.404 (0.056)*	0.257 (0.056)*
DNR13	to	DNR14	0.215 (0.088)*	0.167 (0.091)	0.055 (0.102)
PRSL1	to	PRSL2	0.47 (0.045)*	0.652 (0.06)*	0.651 (0.057)*
PRSL2	to	PRSL3	0.36 (0.056)*	0.193 (0.058)*	0.527 (0.067)*
PRSL3	to	PRSL4	0.299 (0.056)*	0.296 (0.055)*	0.214 (0.062)*
PRSL4	to	PRSL5	0.222 (0.044)*	0.211 (0.056)*	0.267 (0.066)*
PRSL5	to	PRSL6	0.312 (0.049)*	0.38 (0.057)*	0.284 (0.056)*
PRSL6	to	PRSL7	0.399 (0.052)*	0.355 (0.06)*	0.266 (0.063)*
PRSL7	to	PRSL8	0.195 (0.057)*	0.26 (0.058)*	0.273 (0.065)*
PRSL8	to	PRSL9	0.329 (0.068)*	0.327 (0.073)*	0.176 (0.064)*
PRSL9	to	PRSL10	0.297 (0.056)*	0.19 (0.057)*	0.19 (0.067)*
PRSL10	to	PRSL11	0.365 (0.065)*	0.379 (0.059)*	0.395 (0.073)*
PRSL11	to	PRSL12	0.331 (0.057)*	0.274 (0.067)*	0.199 (0.058)*
PRSL12	to	PRSL13	0.293 (0.054)*	0.355 (0.065)*	0.137 (0.06)*
PRSL13	to	PRSL14	0.393 (0.094)*	0.212 (0.125)	0.359 (0.076)*
Autoregressive Lag 2 Path Coefficients					
DNR1	to	DNR3	0.36 (0.042)*	0.423 (0.053)*	0.225 (0.055)*
DNR2	to	DNR4	0.322 (0.053)*	0.237 (0.052)*	0.279 (0.055)*
DNR3	to	DNR5	0.4 (0.049)*	0.227 (0.051)*	0.449 (0.052)*
DNR4	to	DNR6	0.312 (0.046)*	0.278 (0.057)*	0.22 (0.054)*
DNR5	to	DNR7	0.269 (0.049)*	0.271 (0.054)*	0.163 (0.055)*
DNR6	to	DNR8	0.068 (0.056)	-0.07 (0.054)	0.059 (0.064)

DNR7	to	DNR9	0.061 (0.041)	0.023 (0.044)	0.09 (0.053)
DNR8	to	DNR10	0.102 (0.046)*	0.181 (0.057)*	0.081 (0.057)
DNR9	to	DNR11	0.141 (0.05)*	0.165 (0.054)*	0.2 (0.067)*
DNR10	to	DNR12	0.177 (0.053)*	0.262 (0.051)*	0.182 (0.058)*
DNR11	to	DNR13	0.282 (0.052)*	0.193 (0.058)*	0.239 (0.05)*
DNR12	to	DNR14	-0.045 (0.085)	-0.171 (0.093)	0.076 (0.098)
PRSL1	to	PRSL3	0.299 (0.056)*	0.412 (0.071)*	0.094 (0.074)
PRSL2	to	PRSL4	0.37 (0.062)*	0.272 (0.056)*	0.194 (0.065)*
PRSL3	to	PRSL5	0.329 (0.049)*	0.326 (0.052)*	0.305 (0.058)*
PRSL4	to	PRSL6	0.318 (0.043)*	0.371 (0.056)*	0.239 (0.062)*
PRSL5	to	PRSL7	0.171 (0.054)*	0.257 (0.066)*	0.217 (0.058)*
PRSL6	to	PRSL8	0.243 (0.054)*	0.219 (0.059)*	0.294 (0.066)*
PRSL7	to	PRSL9	0.288 (0.063)*	0.294 (0.065)*	0.185 (0.06)*
PRSL8	to	PRSL10	0.216 (0.063)*	0.289 (0.069)*	0.355 (0.067)*
PRSL9	to	PRSL11	0.216 (0.061)*	0.197 (0.053)*	0.211 (0.079)*
PRSL10	to	PRSL12	0.089 (0.069)	0.149 (0.068)*	0.132 (0.068)
PRSL11	to	PRSL13	0.12 (0.054)*	0.13 (0.072)	0.299 (0.053)*
PRSL12	to	PRSL14	0.203 (0.09)*	0.19 (0.119)	0.069 (0.067)
Autoregressive Lag 7 Path Coefficients					
DNR1	to	DNR8	-0.049 (0.047)	0.03 (0.052)	0.039 (0.052)
DNR2	to	DNR9	-0.039 (0.042)	0.054 (0.039)	-0.026 (0.042)
DNR3	to	DNR10	-0.08 (0.033)*	-0.043 (0.036)	-0.004 (0.045)
DNR4	to	DNR11	0.003 (0.034)	-0.052 (0.037)	0.063 (0.049)
DNR5	to	DNR12	-0.027 (0.035)	-0.005 (0.036)	0.025 (0.042)
DNR6	to	DNR13	0.009 (0.033)	-0.003 (0.037)	-0.029 (0.042)
DNR7	to	DNR14	-0.015 (0.058)	-0.07 (0.064)	-0.057 (0.082)
PRSL1	to	PRSL8	0.293 (0.053)*	0.245 (0.07)*	0.15 (0.068)*
PRSL2	to	PRSL9	0.241 (0.061)*	0.139 (0.062)*	0.341 (0.058)*
PRSL3	to	PRSL10	0.264 (0.053)*	0.306 (0.057)*	0.263 (0.059)*
PRSL4	to	PRSL11	0.272 (0.059)*	0.119 (0.055)*	0.318 (0.077)*
PRSL5	to	PRSL12	0.282 (0.06)*	0.236 (0.061)*	0.424 (0.061)*
PRSL6	to	PRSL13	0.301 (0.054)*	0.274 (0.061)*	0.245 (0.063)*
PRSL7	to	PRSL14	0.291 (0.096)*	0.077 (0.096)	0.181 (0.079)*
Within Night Cross Variable Path Coefficients					
DNR1	to	PRSL1	-0.029 (0.028)	0.043 (0.029)	0.027 (0.032)
DNR2	to	PRSL2	-0.017 (0.034)	0.041 (0.037)	-0.019 (0.038)
DNR3	to	PRSL3	-0.059 (0.038)	0.023 (0.038)	0.011 (0.044)
DNR4	to	PRSL4	-0.06 (0.04)	0.008 (0.041)	0.048 (0.04)
DNR5	to	PRSL5	-0.052 (0.035)	-0.02 (0.04)	0.009 (0.043)
DNR6	to	PRSL6	0.044 (0.035)	-0.032 (0.037)	-0.006 (0.045)

DNR7	to	PRSL7	0.028 (0.039)	-0.02 (0.042)	0.023 (0.048)
DNR8	to	PRSL8	-0.011 (0.035)	-0.007 (0.041)	0.133 (0.049)*
DNR9	to	PRSL9	-0.065 (0.041)	0.043 (0.047)	0.082 (0.05)
DNR10	to	PRSL10	-0.009 (0.042)	-0.05 (0.044)	0.001 (0.048)
DNR11	to	PRSL11	0.008 (0.043)	-0.034 (0.043)	-0.005 (0.05)
DNR12	to	PRSL12	0.016 (0.043)	-0.093 (0.045)*	-0.059 (0.049)
DNR13	to	PRSL13	-0.056 (0.041)	-0.002 (0.049)	-0.004 (0.049)
DNR14	to	PRSL14	-0.02 (0.051)	-0.067 (0.062)	0.017 (0.04)
Cross Lagged Path Coefficients from Sleep to the Bedtime Routine the Following Night					
PRSL1	to	DNR2	-0.061 (0.07)	-0.027 (0.091)	0.068 (0.092)
PRSL2	to	DNR3	0.085 (0.063)	0.052 (0.067)	-0.1 (0.074)
PRSL3	to	DNR4	0.038 (0.062)	0.075 (0.071)	0.011 (0.075)
PRSL4	to	DNR5	-0.065 (0.056)	0.189 (0.07)*	-0.017 (0.077)
PRSL5	to	DNR6	-0.008 (0.066)	-0.032 (0.079)	0.013 (0.071)
PRSL6	to	DNR7	0.005 (0.065)	0.078 (0.075)	0.024 (0.074)
PRSL7	to	DNR8	-0.014 (0.068)	0.074 (0.07)	-0.097 (0.082)
PRSL8	to	DNR9	-0.034 (0.067)	0.017 (0.069)	-0.015 (0.075)
PRSL9	to	DNR10	-0.028 (0.055)	-0.039 (0.064)	-0.039 (0.077)
PRSL10	to	DNR11	-0.108 (0.064)	-0.101 (0.07)	-0.014 (0.082)
PRSL11	to	DNR12	-0.084 (0.056)	0.036 (0.068)	-0.004 (0.061)
PRSL12	to	DNR13	-0.065 (0.055)	-0.02 (0.069)	0.031 (0.063)
PRSL13	to	DNR14	0.038 (0.114)	0.141 (0.122)	0.371 (0.128)*
Cross Lagged Path Coefficients from the Bedtime Routine to Sleep the Following Night					
DNR1	to	PRSL2	0.032 (0.032)	-0.048 (0.04)	-0.014 (0.039)
DNR2	to	PRSL3	0.093 (0.038)*	-0.032 (0.037)	-0.031 (0.042)
DNR3	to	PRSL4	0.012 (0.041)	0.002 (0.04)	-0.034 (0.039)
DNR4	to	PRSL5	0.031 (0.035)	0.061 (0.04)	0.031 (0.044)
DNR5	to	PRSL6	-0.063 (0.036)	-0.046 (0.038)	-0.015 (0.043)
DNR6	to	PRSL7	-0.01 (0.041)	0.033 (0.041)	-0.015 (0.045)
DNR7	to	PRSL8	0.001 (0.033)	-0.04 (0.045)	-0.071 (0.053)
DNR8	to	PRSL9	0.014 (0.04)	-0.05 (0.047)	-0.019 (0.043)
DNR9	to	PRSL10	0.004 (0.039)	0.079 (0.045)	0.011 (0.052)
DNR10	to	PRSL11	-0.043 (0.046)	-0.037 (0.043)	0.016 (0.056)
DNR11	to	PRSL12	-0.052 (0.044)	-0.002 (0.046)	-0.013 (0.045)
DNR12	to	PRSL13	0.032 (0.04)	-0.002 (0.048)	0.019 (0.047)
DNR13	to	PRSL14	0.011 (0.061)	0.1 (0.076)	0.011 (0.056)

*$p < .05$

Table A.7

All Path Coefficients from Autoregressive Cross-Lagged Path Models with Routine Length Variability (RLV) and Actigraph Recorded Sleep Latency (SLAT) at 30, 36, and 42 Months

			30 month est. B (SE)	36 month est. B (SE)	42 month est. B (SE)
Autoregressive Lag 1 Path Coefficients					
RLV1	to	RLV2	0.296 (0.052)*	0.336 (0.064)*	0.157 (0.066)*
RLV2	to	RLV3	0.285 (0.062)*	0.18 (0.089)*	0.112 (0.062)
RLV3	to	RLV4	0.264 (0.05)*	0.133 (0.033)*	0.206 (0.063)*
RLV4	to	RLV5	0.437 (0.067)*	0.196 (0.074)*	0.135 (0.084)
RLV5	to	RLV6	0.124 (0.041)*	0.227 (0.058)*	0.153 (0.062)*
RLV6	to	RLV7	0.154 (0.056)*	0.249 (0.062)*	0.155 (0.086)
RLV7	to	RLV8	0.378 (0.076)*	0.104 (0.067)	0.202 (0.054)*
RLV8	to	RLV9	0.095 (0.07)	0.14 (0.073)	0.201 (0.072)*
RLV9	to	RLV10	0.108 (0.058)	0.164 (0.062)*	0.154 (0.079)
RLV10	to	RLV11	0.03 (0.05)	0.276 (0.061)*	0.066 (0.101)
RLV11	to	RLV12	0.036 (0.076)	0.095 (0.074)	0.28 (0.082)*
RLV12	to	RLV13	0.179 (0.063)*	0.266 (0.091)*	0.159 (0.058)*
RLV13	to	RLV14	0.507 (0.125)*	-0.046 (0.112)	0.024 (0.158)
SLAT1	to	SLAT2	0.524 (0.039)*	0.147 (0.067)*	0.337 (0.068)*
SLAT2	to	SLAT3	0.204 (0.078)*	0.104 (0.08)	0.241 (0.079)*
SLAT3	to	SLAT4	0.173 (0.051)*	0.221 (0.059)*	0.148 (0.078)
SLAT4	to	SLAT5	0.293 (0.073)*	0.289 (0.072)*	0.22 (0.067)*
SLAT5	to	SLAT6	0.155 (0.048)*	0.171 (0.08)*	0.403 (0.144)*
SLAT6	to	SLAT7	0.306 (0.07)*	0.204 (0.073)*	0.357 (0.076)*
SLAT7	to	SLAT8	0.199 (0.078)*	0.217 (0.081)*	0.174 (0.061)*
SLAT8	to	SLAT9	0.166 (0.045)*	0.382 (0.11)*	0.349 (0.087)*
SLAT9	to	SLAT10	0.366 (0.1)*	0.107 (0.079)	0.354 (0.094)*
SLAT10	to	SLAT11	0.17 (0.06)*	0.006 (0.093)	0.188 (0.124)
SLAT11	to	SLAT12	0.233 (0.082)*	0.274 (0.086)*	-0.004 (0.077)
SLAT12	to	SLAT13	0.167 (0.058)*	0.289 (0.077)*	0.311 (0.078)*
SLAT13	to	SLAT14	0.176 (0.086)*	0.31 (0.106)*	0.308 (0.088)*
Autoregressive Lag 2 Path Coefficients					
RLV1	to	RLV3	0.242 (0.059)*	0.336 (0.099)*	0.173 (0.065)*
RLV2	to	RLV4	0.367 (0.055)*	0.144 (0.052)*	0.212 (0.052)*
RLV3	to	RLV5	0.066 (0.065)	0.212 (0.036)*	0.094 (0.069)
RLV4	to	RLV6	0.192 (0.052)*	0.228 (0.067)*	0.208 (0.069)*
RLV5	to	RLV7	0.136 (0.039)*	0.288 (0.059)*	0.142 (0.082)
RLV6	to	RLV8	0.193 (0.066)*	0.147 (0.07)*	0.177 (0.071)*
RLV7	to	RLV9	0.199 (0.094)*	0.159 (0.071)*	-0.007 (0.055)

RLV8	to	RLV10	0.138 (0.075)	0.21 (0.069)*	0.281 (0.088)*
RLV9	to	RLV11	0.084 (0.049)	0.068 (0.057)	0.154 (0.081)
RLV10	to	RLV12	0.028 (0.064)	0.126 (0.069)	0.178 (0.084)*
RLV11	to	RLV13	0.186 (0.068)*	-0.035 (0.103)	0.135 (0.063)*
RLV12	to	RLV14	0.38 (0.158)*	0.596 (0.21)*	0.472 (0.132)*
SLAT1	to	SLAT3	0.352 (0.061)*	0.507 (0.071)*	0.073 (0.07)
SLAT2	to	SLAT4	0.312 (0.056)*	0.193 (0.071)*	0.281 (0.073)*
SLAT3	to	SLAT5	0.115 (0.062)	0.256 (0.061)*	0.25 (0.069)*
SLAT4	to	SLAT6	0.292 (0.052)*	0.267 (0.084)*	0.2 (0.123)
SLAT5	to	SLAT7	0.144 (0.07)*	0.129 (0.076)	0.239 (0.103)*
SLAT6	to	SLAT8	0.294 (0.09)*	0.138 (0.071)*	0.062 (0.063)
SLAT7	to	SLAT9	0.207 (0.057)*	0.083 (0.102)	0.055 (0.059)
SLAT8	to	SLAT10	0.221 (0.071)*	0.151 (0.08)	0.19 (0.092)*
SLAT9	to	SLAT11	0.417 (0.09)*	0.181 (0.087)*	0.239 (0.139)
SLAT10	to	SLAT12	0.295 (0.078)*	0.371 (0.09)*	0.238 (0.088)*
SLAT11	to	SLAT13	0.293 (0.065)*	0.128 (0.075)	0.016 (0.067)
SLAT12	to	SLAT14	0.199 (0.061)*	0.119 (0.115)	0.208 (0.081)*
Autoregressive Lag 7 Path Coefficients					
RLV1	to	RLV8	0.22 (0.072)*	0.172 (0.073)*	0.203 (0.067)*
RLV2	to	RLV9	0.215 (0.087)*	0.365 (0.073)*	0.141 (0.064)*
RLV3	to	RLV10	0.223 (0.077)*	0.052 (0.042)	0.109 (0.092)
RLV4	to	RLV11	0.204 (0.058)*	0.118 (0.095)	0.25 (0.091)*
RLV5	to	RLV12	0.18 (0.054)*	0.243 (0.067)*	0.167 (0.073)*
RLV6	to	RLV13	0.166 (0.077)*	0.544 (0.113)*	0.104 (0.067)
RLV7	to	RLV14	0.496 (0.156)*	0.247 (0.198)	0.045 (0.117)
SLAT1	to	SLAT8	0.053 (0.057)	0.264 (0.111)*	0.207 (0.073)*
SLAT2	to	SLAT9	0.056 (0.048)	0.273 (0.115)*	0.125 (0.08)
SLAT3	to	SLAT10	0.03 (0.07)	0.244 (0.071)*	0.284 (0.095)*
SLAT4	to	SLAT11	0.051 (0.076)	0.17 (0.105)	0.486 (0.131)*
SLAT5	to	SLAT12	0.286 (0.086)*	0.074 (0.092)	0.303 (0.117)*
SLAT6	to	SLAT13	-0.013 (0.098)	0.115 (0.071)	0.167 (0.069)*
SLAT7	to	SLAT14	0.128 (0.098)	0.184 (0.078)*	0.039 (0.07)
Within Night Cross Variable Path Coefficients					
RLV1	to	SLAT1	-0.156 (0.161)	0.035 (0.153)	-0.069 (0.156)
RLV2	to	SLAT2	0.116 (0.127)	0.051 (0.131)	-0.187 (0.11)
RLV3	to	SLAT3	-0.162 (0.12)	-0.149 (0.088)	-0.038 (0.125)
RLV4	to	SLAT4	-0.086 (0.108)	-0.291 (0.165)	-0.083 (0.15)
RLV5	to	SLAT5	-0.189 (0.099)	-0.208 (0.146)	-0.253 (0.119)*
RLV6	to	SLAT6	0.058 (0.111)	-0.161 (0.166)	-0.288 (0.219)
RLV7	to	SLAT7	0.175 (0.136)	-0.264 (0.173)	-0.183 (0.164)

RLV8	to	SLAT8	-0.165 (0.132)	-0.081 (0.152)	0.057 (0.148)
RLV9	to	SLAT9	-0.069 (0.085)	-0.264 (0.221)	-0.08 (0.15)
RLV10	to	SLAT10	-0.12 (0.146)	-0.106 (0.142)	-0.062 (0.14)
RLV11	to	SLAT11	-0.101 (0.153)	-0.118 (0.177)	0.037 (0.229)
RLV12	to	SLAT12	-0.065 (0.162)	0.144 (0.15)	-0.126 (0.195)
RLV13	to	SLAT13	0.109 (0.135)	-0.105 (0.092)	-0.084 (0.169)
RLV14	to	SLAT14	-0.222 (0.109)*	-0.016 (0.069)	-0.063 (0.094)
Cross Lagged Path Coefficients from Sleep to the Bedtime Routine the Following Night					
SLAT1	to	RLV2	-0.029 (0.021)	0.03 (0.045)	-0.038 (0.036)
SLAT2	to	RLV3	0.031 (0.027)	0 (0.052)	0.009 (0.038)
SLAT3	to	RLV4	0.014 (0.023)	0.058 (0.029)*	0.011 (0.035)
SLAT4	to	RLV5	-0.048 (0.036)	0.065 (0.037)	-0.032 (0.04)
SLAT5	to	RLV6	-0.003 (0.024)	-0.077 (0.03)*	0.051 (0.04)
SLAT6	to	RLV7	0.005 (0.031)	-0.032 (0.032)	-0.003 (0.037)
SLAT7	to	RLV8	-0.06 (0.037)	-0.033 (0.03)	-0.019 (0.033)
SLAT8	to	RLV9	-0.024 (0.033)	0.07 (0.042)	0.005 (0.047)
SLAT9	to	RLV10	-0.016 (0.046)	-0.017 (0.026)	-0.026 (0.048)
SLAT10	to	RLV11	-0.01 (0.025)	-0.017 (0.036)	0.012 (0.042)
SLAT11	to	RLV12	-0.056 (0.036)	-0.053 (0.04)	-0.005 (0.027)
SLAT12	to	RLV13	0.02 (0.029)	-0.03 (0.055)	-0.009 (0.03)
SLAT13	to	RLV14	0.102 (0.068)	-0.043 (0.094)	0.124 (0.083)
Cross Lagged Path Coefficients from the Bedtime Routine to Sleep the Following Night					
RLV1	to	SLAT2	0.013 (0.112)	-0.345 (0.148)*	-0.159 (0.123)
RLV2	to	SLAT3	0.054 (0.138)	-0.011 (0.141)	0.156 (0.124)
RLV3	to	SLAT4	0.021 (0.104)	0.089 (0.08)	-0.068 (0.127)
RLV4	to	SLAT5	0.103 (0.125)	0.145 (0.168)	-0.229 (0.135)
RLV5	to	SLAT6	-0.1 (0.076)	0.165 (0.171)	-0.015 (0.207)
RLV6	to	SLAT7	-0.039 (0.134)	-0.118 (0.171)	0.176 (0.165)
RLV7	to	SLAT8	0.154 (0.179)	0.114 (0.156)	-0.144 (0.136)
RLV8	to	SLAT9	-0.192 (0.093)*	0.074 (0.21)	0.068 (0.152)
RLV9	to	SLAT10	-0.051 (0.132)	-0.035 (0.153)	0.137 (0.151)
RLV10	to	SLAT11	-0.036 (0.132)	0.013 (0.157)	-0.005 (0.289)
RLV11	to	SLAT12	0.046 (0.168)	0.022 (0.159)	-0.114 (0.155)
RLV12	to	SLAT13	-0.148 (0.15)	-0.069 (0.142)	0.095 (0.144)
RLV13	to	SLAT14	-0.167 (0.149)	-0.081 (0.097)	0.152 (0.17)

* $p < .05$

Table A.8

All Path Coefficients from Autoregressive Cross-Lagged Path Models with Deviation from Normal Routine (DNR) and Actigraph Recorded Sleep Latency (SLAT) at 30, 36, and 42 Months

			30 month est. B (SE)	36 month est. B (SE)	42 month est. B (SE)
Autoregressive Lag 1 Path Coefficients					
DNR1	to	DNR2	0.6 (0.037)*	0.664 (0.046)*	0.642 (0.048)*
DNR2	to	DNR3	0.459 (0.044)*	0.375 (0.05)*	0.42 (0.053)*
DNR3	to	DNR4	0.467 (0.052)*	0.472 (0.053)*	0.323 (0.06)*
DNR4	to	DNR5	0.339 (0.048)*	0.503 (0.053)*	0.331 (0.052)*
DNR5	to	DNR6	0.434 (0.048)*	0.427 (0.057)*	0.447 (0.052)*
DNR6	to	DNR7	0.49 (0.048)*	0.349 (0.055)*	0.422 (0.058)*
DNR7	to	DNR8	0.08 (0.052)	0.147 (0.056)*	0.209 (0.065)*
DNR8	to	DNR9	0.384 (0.044)*	0.514 (0.047)*	0.287 (0.052)*
DNR9	to	DNR10	0.258 (0.048)*	0.251 (0.058)*	0.277 (0.062)*
DNR10	to	DNR11	0.295 (0.054)*	0.196 (0.057)*	0.307 (0.066)*
DNR11	to	DNR12	0.459 (0.05)*	0.405 (0.052)*	0.28 (0.052)*
DNR12	to	DNR13	0.368 (0.048)*	0.406 (0.055)*	0.258 (0.056)*
DNR13	to	DNR14	0.217 (0.088)*	0.163 (0.091)	0.042 (0.104)
SLAT1	to	SLAT2	0.512 (0.038)*	0.141 (0.068)*	0.307 (0.074)*
SLAT2	to	SLAT3	0.12 (0.084)	0.172 (0.083)*	0.219 (0.069)*
SLAT3	to	SLAT4	0.171 (0.048)*	0.152 (0.053)*	0.171 (0.08)*
SLAT4	to	SLAT5	0.323 (0.071)*	0.338 (0.073)*	0.235 (0.063)*
SLAT5	to	SLAT6	0.149 (0.047)*	0.15 (0.077)	0.349 (0.135)*
SLAT6	to	SLAT7	0.3 (0.069)*	0.218 (0.072)*	0.35 (0.072)*
SLAT7	to	SLAT8	0.257 (0.074)*	0.212 (0.079)*	0.147 (0.067)*
SLAT8	to	SLAT9	0.17 (0.045)*	0.385 (0.104)*	0.406 (0.072)*
SLAT9	to	SLAT10	0.338 (0.097)*	0.087 (0.077)	0.369 (0.093)*
SLAT10	to	SLAT11	0.112 (0.069)	-0.073 (0.093)	0.147 (0.11)
SLAT11	to	SLAT12	0.143 (0.065)*	0.262 (0.078)*	-0.04 (0.076)
SLAT12	to	SLAT13	0.167 (0.057)*	0.314 (0.076)*	0.246 (0.069)*
SLAT13	to	SLAT14	0.293 (0.096)*	0.308 (0.097)*	0.353 (0.081)*
Autoregressive Lag 2 Path Coefficients					
DNR1	to	DNR3	0.36 (0.042)*	0.423 (0.053)*	0.221 (0.055)*
DNR2	to	DNR4	0.327 (0.053)*	0.235 (0.052)*	0.276 (0.055)*
DNR3	to	DNR5	0.398 (0.049)*	0.23 (0.051)*	0.447 (0.051)*
DNR4	to	DNR6	0.314 (0.047)*	0.278 (0.057)*	0.224 (0.053)*
DNR5	to	DNR7	0.269 (0.049)*	0.265 (0.055)*	0.158 (0.055)*
DNR6	to	DNR8	0.069 (0.056)	-0.072 (0.054)	0.061 (0.064)

DNR7	to	DNR9	0.06 (0.041)	0.023 (0.044)	0.095 (0.053)
DNR8	to	DNR10	0.103 (0.046)*	0.184 (0.057)*	0.073 (0.058)
DNR9	to	DNR11	0.14 (0.05)*	0.152 (0.054)*	0.193 (0.067)*
DNR10	to	DNR12	0.188 (0.053)*	0.257 (0.051)*	0.181 (0.058)*
DNR11	to	DNR13	0.27 (0.052)*	0.194 (0.058)*	0.239 (0.05)*
DNR12	to	DNR14	-0.037 (0.085)	-0.181 (0.093)	0.1 (0.1)
SLAT1	to	SLAT3	0.383 (0.066)*	0.515 (0.076)*	0.081 (0.066)
SLAT2	to	SLAT4	0.312 (0.054)*	0.203 (0.071)*	0.216 (0.071)*
SLAT3	to	SLAT5	0.094 (0.055)	0.268 (0.055)*	0.223 (0.067)*
SLAT4	to	SLAT6	0.295 (0.051)*	0.285 (0.081)*	0.222 (0.114)
SLAT5	to	SLAT7	0.171 (0.066)*	0.087 (0.068)	0.304 (0.098)*
SLAT6	to	SLAT8	0.302 (0.088)*	0.12 (0.07)	0.071 (0.065)
SLAT7	to	SLAT9	0.219 (0.06)*	0.096 (0.097)	0.041 (0.056)
SLAT8	to	SLAT10	0.237 (0.069)*	0.134 (0.076)	0.23 (0.085)*
SLAT9	to	SLAT11	0.506 (0.113)*	0.265 (0.086)*	0.17 (0.126)
SLAT10	to	SLAT12	0.35 (0.072)*	0.347 (0.089)*	0.28 (0.081)*
SLAT11	to	SLAT13	0.251 (0.051)*	0.091 (0.07)	0.038 (0.063)
SLAT12	to	SLAT14	0.18 (0.074)*	0.137 (0.106)	0.166 (0.072)*
Autoregressive Lag 7 Path Coefficients					
DNR1	to	DNR8	-0.05 (0.047)	0.032 (0.052)	0.039 (0.052)
DNR2	to	DNR9	-0.039 (0.042)	0.054 (0.039)	-0.025 (0.042)
DNR3	to	DNR10	-0.08 (0.033)*	-0.044 (0.036)	-0.001 (0.045)
DNR4	to	DNR11	0.001 (0.034)	-0.054 (0.038)	0.067 (0.049)
DNR5	to	DNR12	-0.026 (0.035)	-0.004 (0.036)	0.025 (0.042)
DNR6	to	DNR13	0.009 (0.033)	-0.004 (0.037)	-0.024 (0.042)
DNR7	to	DNR14	-0.016 (0.058)	-0.067 (0.064)	-0.066 (0.083)
SLAT1	to	SLAT8	0.037 (0.056)	0.297 (0.11)*	0.216 (0.079)*
SLAT2	to	SLAT9	0.073 (0.05)	0.243 (0.109)*	0.153 (0.076)*
SLAT3	to	SLAT10	0.047 (0.061)	0.224 (0.069)*	0.237 (0.094)*
SLAT4	to	SLAT11	0.004 (0.104)	0.195 (0.114)	0.458 (0.118)*
SLAT5	to	SLAT12	0.258 (0.082)*	0.094 (0.093)	0.342 (0.117)*
SLAT6	to	SLAT13	0.052 (0.094)	0.144 (0.071)*	0.21 (0.064)*
SLAT7	to	SLAT14	0.145 (0.146)	0.175 (0.076)*	0.051 (0.067)
Within Night Cross Variable Path Coefficients					
DNR1	to	SLAT1	1.608 (1.353)	-0.864 (1.363)	0.892 (1.526)
DNR2	to	SLAT2	-0.805 (1.254)	1.05 (1.543)	-0.143 (1.739)
DNR3	to	SLAT3	-0.468 (1.777)	-0.941 (1.891)	0.056 (1.797)
DNR4	to	SLAT4	0.949 (1.268)	-1.986 (1.55)	-0.055 (1.603)
DNR5	to	SLAT5	-1.101 (1.479)	0.575 (1.799)	-0.346 (1.376)
DNR6	to	SLAT6	1.346 (1.158)	4.512 (1.817)*	-3.258 (2.706)

DNR7	to	SLAT7	0.263 (1.377)	-3.388 (1.995)	-2.751 (2.307)
DNR8	to	SLAT8	-2.238 (1.683)	-2.854 (1.794)	-1.423 (2.044)
DNR9	to	SLAT9	-1.097 (1.297)	-0.357 (2.788)	2.161 (2.129)
DNR10	to	SLAT10	1.696 (2.217)	-2.734 (1.969)	-0.24 (2.289)
DNR11	to	SLAT11	3.384 (2.192)	0.583 (2.276)	-3.916 (2.834)
DNR12	to	SLAT12	0.853 (2.155)	1.303 (2.268)	-0.736 (2.365)
DNR13	to	SLAT13	0.349 (1.887)	1.626 (2.064)	1.145 (2.189)
DNR14	to	SLAT14	-0.032 (1.573)	-1.151 (1.525)	-1.684 (1.457)
Cross Lagged Path Coefficients from Sleep to the Bedtime Routine the Following Night					
SLAT1	to	DNR2	-0.001 (0.002)	0 (0.003)	-0.004 (0.003)
SLAT2	to	DNR3	0.001 (0.002)	-0.001 (0.003)	-0.003 (0.003)
SLAT3	to	DNR4	0.003 (0.002)	0 (0.002)	-0.002 (0.003)
SLAT4	to	DNR5	0 (0.002)	-0.002 (0.003)	-0.002 (0.003)
SLAT5	to	DNR6	-0.001 (0.002)	-0.001 (0.002)	-0.006 (0.003)*
SLAT6	to	DNR7	0 (0.003)	-0.002 (0.003)	0.002 (0.002)
SLAT7	to	DNR8	-0.001 (0.002)	0.002 (0.002)	-0.001 (0.002)
SLAT8	to	DNR9	-0.001 (0.002)	-0.001 (0.002)	0.003 (0.003)
SLAT9	to	DNR10	0.001 (0.002)	0.001 (0.002)	-0.002 (0.003)
SLAT10	to	DNR11	-0.002 (0.002)	-0.001 (0.003)	0.003 (0.003)
SLAT11	to	DNR12	-0.003 (0.002)	-0.003 (0.002)	0 (0.002)
SLAT12	to	DNR13	0.004 (0.001)*	0 (0.002)	0.003 (0.002)
SLAT13	to	DNR14	-0.004 (0.004)	0 (0.004)	0.008 (0.004)
Cross Lagged Path Coefficients from the Bedtime Routine to Sleep the Following Night					
DNR1	to	SLAT2	0.988 (1.194)	0.1 (1.696)	-2.202 (1.74)
DNR2	to	SLAT3	-0.526 (1.757)	-1.498 (1.812)	-0.901 (1.652)
DNR3	to	SLAT4	-0.498 (1.271)	0.498 (1.589)	-0.591 (1.541)
DNR4	to	SLAT5	1.413 (1.468)	1.706 (1.785)	0.85 (1.491)
DNR5	to	SLAT6	-1.954 (1.128)	-3.731 (1.814)*	2.032 (2.552)
DNR6	to	SLAT7	0.293 (1.404)	0.64 (1.853)	4.013 (2.178)
DNR7	to	SLAT8	-1.236 (1.562)	0.685 (2.159)	-1.204 (2)
DNR8	to	SLAT9	-1.157 (1.278)	-1.995 (2.717)	-2.842 (1.904)
DNR9	to	SLAT10	-2.088 (1.998)	-1.011 (1.821)	1 (2.262)
DNR10	to	SLAT11	2.522 (2.363)	-1.231 (2.176)	-0.728 (3.209)
DNR11	to	SLAT12	4.011 (2.345)	-1.388 (2.145)	-1.598 (2.233)
DNR12	to	SLAT13	2.179 (1.858)	-0.489 (2.416)	-2.828 (2.043)
DNR13	to	SLAT14	-3.369 (2.14)	-0.383 (2.054)	-3.769 (2.153)

* $p < .05$