EFFECTS OF SLEEP SCHEDULE ON TRAINING OF EXECUTIVE FUNCTION SKILLS

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Submitted to the Faculty of the University Graduate School

in partial fulfillment of the requirements for the degree

Doctor of Philosophy

in the School of Education

Indiana University

August 2014

Accepted by the Graduate Faculty, Indiana University, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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July 21, 2014

This dissertation is dedicated to the children who have touched my heart:

their stories continue to motivate me today.

Acknowledgements

I would like extend my overwhelming appreciation to all the individuals who have been part of my graduate education at Indiana University. Their support, guidance, and encouragement have been instrumental in my graduate career. To each of these people, I am extremely grateful.

My deepest thanks to my dissertation chair, Dr. John Bates, who has guided me through the dissertation process with wisdom, patience, and interest. His encouragement and mentorship has been greatly appreciated and he continues to be an inspiration influence on me. He has provided exceptional career guidance, and his faith has fostered confidence and excitement about my work. I am also very thankful for the guidance I received from Dr. Thomas Huberty throughout my time here; he has extended unique professional development opportunities to me and has been truly supportive. Thank you to Dr. Jack Cummings for assisting me with each milestone of my graduate career, from my first practicum experience to the completion of my dissertation. Much thanks to Dr. David Estell for launching me in my journey of statistical analysis, beginning with our popularity paper. I am grateful to Angela Staples for her input, support, and guidance in Dr. Bates' Social Development Lab and with helping me design, formulate, and grow with this project.

I am indebted to the people who were directly involved with the research collection for this study. I especially thank Katie Cullison, my fantastic teammate on this project, for her skills and assistance in gathering data; Alli Cipra, my fellow researcher, for her organizational skills; and Meghan Hanrahan, my lab coordinator, for her willingness to always lend a hand. To these individuals, thank you for giving so much of your time and effort to this study.

I would also like to sincerely thank all the preschools, including their principals, directors, teachers, and parents who have allowed me to conduct research in their schools and with their children. I could not have done this without them. Their generosity of time and spirit have contributed to our knowledge of sleep and the training of executive function skills, and is greatly appreciated.

My sincerest gratitude to my peers and colleagues – especially in the Social Development Lab – for their feedback and patience. I am also very appreciative of my clinical supervisors who made it a priority to provide excellent supervision. Thank you to my lab-mates, Isaac Petersen and Trista Chan, for their support and friendship, and to all my friends for helping me achieve a balanced life.

A huge and heartfelt thank you to my family who have encouraged me and given me the tools to succeed and the determination to pursue whatever I want in life. Your love, support, patience, and enthusiasm have made it all possible. To my wonderful brother Michael, for his ongoing gentle encouragement (and constantly reminding me of the importance of backing up my files) and occasional competitive nature to see who will finish first – I win.

Last but certainly not least, I am extremely grateful to my wonderful fiancée Andrew, whose love, endless support, and comedic relief are unwavering. He never stopped believing I was capable of seemingly impossible feats and his strength in these beliefs helped me rise to the occasion. He deserves an honorary doctorate degree for his many years of reading drafts of my papers and manuscripts.

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The purpose of this study was to examine the effects of sleep schedule on the learning trajectories, acquisition, and consolidation for preschoolers participating in a training program targeting attention. This study expanded on current literature by examining the effect of training attention skills and focused on sleep in preschoolers using an experimental design. Explorations of how changes in bedtime play a role in training attention in preschoolers were made.

Sleep is important for daytime functioning and sleep loss has many implications, including risk for poorer academic performance and learning. Early intervention and preventive measures addressing executive functions can help children better manage their behaviors in work and play situations. Studies have shown that attention skills in children can be trained. This study expanded on current literature by assessing the generalization of attention training to other executive function skills, such as inhibition, cognitive flexibility, and working memory. Research has mainly focused on inhibition and working memory, and more recently, attention. To hopefully improve understanding of the attention skills in preschoolers, an additional variable of sleep restriction was evaluated.

Findings indicated, contrary to initial prediction, that children who were sleep restricted performed better during post-test assessment compared to children who followed their typical bedtime schedules. Sleep restricted preschoolers performed better in all executive function areas that were assessed in this study, which included inhibition, cognitive flexibility, working memory, and attention. Findings revealed that acute sleep restriction in preschoolers increased the effects of attention training. Differences in findings from this study and other studies are addressed.

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Chapter I

Introduction

Overview

Sleep is important for children's daytime functioning. Studies have shown that more children are suffering from sleep difficulties and sleep problems than ever before (Kahn, Van de Merckt, Rebuffat, Mozin, Sottiaux, Blum, & Hennart, 1989; Meijer, Habekothe, & Van den Wittenboer, 2000; Sadeh, 2007). Sleep deprivation has adverse effects on academic performance and learning (Buckhalt, El-Sheikh, Keller, & Kelly, 2009; Curcio, Ferrara, & DeGennaro, 2006; Wolfson & Carskadon, 2003) as well as academic and cognitive functioning later in life (Gregory, Caspi, Moffitt, & Poulton, 2009). Most of this research has focused on school-aged children (Carskadon, Harvey, & Dement, 1981a; Peters, Biggs, Bauer, Lushington, Kennedy, Martin, & Dorrian, 2009; Randazzo, Muehlbach, Schweitzer, & Walsh, 1998; Ravid, Afek, Suraiya, Shasha, & Pillar, 2009; Sadeh, 2007; Sadeh, Gruber, & Raviv, 2003), adolescents (Beebe, DiFrancesco, Tlustos, McNally, & Holland, 2009; Beebe, Fallone, Godiwala, Flanigan, Martin, Schaffner, & Amin, 2008; Fallone, Acebo, Arnedt, Seifer, & Carskadon, 2001; Groeger, Zijlstra, & Dijk, 2004; Lanche, 2008), and adults (Durmer & Dinges, 2005; Groeger, Zijlstra, & Dijk, 2004; Rupp, Wesenten, Bliese, & Balkin, 2009), while relatively few studies have focused on preschool children.

Studies on preschool children are needed because important development occurs during early childhood. The proposed research was designed to produce knowledge relevant to future efforts to improve the preparation of preschoolers for kindergarten. Adequate school readiness skills can help ensure a successful transition into kindergarten and encourage learning at a child's fullest potential. To aid in a child's growth, interventions and preventive methods have been developed to address the effects of sleep problems upon school-aged child functioning (Buckhalt, Wolfson, & El-Sheikh, 2009), but these tools may be needed for toddlers and preschoolers as well. This would help young children develop the skills necessary to succeed when they enter elementary school.

This study examined the effects of sleep on the development of essential school readiness skills for preschoolers. It focused on the acquisition and growth of attention skills through the use of a training program. It also investigated how variations in sleep, including sleep restrictions, impact skill consolidation. Answers to these questions had clinical and educational implications.

This study expanded on the work of Rueda, Rothbart, McCandliss, Saccomanno, and Posner (2005) and examined the effects of sleep schedule on training attention. It further examined potential generalization of the trained attention skills to other executive function skills, and the effect sleep had on the generalization of these skills, thereby adding to current knowledge of preschool development. Because this study produced information about risk and protective factors in child development, it further advanced the theoretical understanding of the process through which individual differences in children’s development of self-regulation arise. It contributed to methodological improvements in research as well as new applications of previously used procedures for training self-regulation.

The purpose of this study was to examine the effects of sleep schedule on the learning trajectories, acquisition, and consolidation for preschoolers participating in a training program targeting attention. Additionally, this study explored the generalization of the trained attention skills to other executive function skills of inhibition, cognitive flexibility, and working memory. This study expanded on current literature by examining the effect of training attention skills and focuses on sleep in preschoolers using an experimental design. Explorations of how changes in bedtime and the significance of sleep play a role in training attention in preschoolers were made.

Chapter II

Literature Review

A review of research provided the background to help frame this study. First, an overview of executive function was presented, highlighting the training of attention skills. Next, current research and the understanding of sleep was reviewed, looking specifically at sleep restriction. Finally, critiques of current research were brought up, highlighting how this study expanded on this knowledge by identifying targeted questions that this study sought to address.

Executive Function

Executive function is a concept that psychologists use to describe a cognitive system that directs and manages other cognitive processes. It includes a set of cognitive abilities that control and regulate other abilities and behaviors necessary for goal-directed behavior. Executive function emerges in infancy and continues to develop well into adolescence (Anderson, 2001; Blakemore, & Choudhury, 2006; Brocki & Bohlin, 2004; Klenberg, Korkman, & Lahti-Nuuttila, 2001; Luciana, Conklin, Hooper, & Yarger, 2005; Paus, 2005). Although there is no single behavior that defines executive function or executive dysfunction, it is generally agreed that executive functioning includes the ability to initiate and stop actions, to monitor and change behavior as needed, and to plan future behavior when faced with novel tasks and situations. The executive function system allows individuals to anticipate outcomes and adapt to changing situations, as well as form concepts and think abstractly.

The concept of executive function often refers to the process of making decisions and carrying them out, as in the context of problem solving. Within the problem-solving framework, executive function can be broken down into subfunctions, all occurring in a specific sequence (Zelazo, Carter, Reznick, & Frye, 1997). This process includes: (1) defining the problem, (2) coming up with a plan for solving the problem, (3) executing and carrying out the plan, and (4) evaluating the outcomes and the attempted solution. It is important to note that although this problem solving process is commonly utilized by adults, children only gradually acquire the ability to act in such a deliberate, planful fashion.

Experts tend to agree that the three components of executive function are inhibition, working memory, and cognitive flexibility (Diamond, Barnett, Thomas, & Munro, 2007). Planning, problem-solving, and reasoning are aspects of executive functioning; however, it is believed they derive from the three core abilities. All three executive functioning skills are processed in the prefrontal cortex.

Inhibition refers to the ability to resist a strong inclination to do one thing in order to do something that is considered to be more or most appropriate or needed. The ability to inhibit attention to distraction makes it possible to engage in selective, focused, and sustained attention. The ability to inhibit a strong behavioral inclination helps increase the possibility of making change possible. Inhibition provides a means to gain control over attention and actions rather than being controlled by external stimuli, emotions, or habitual behavior tendencies.

Working memory is the ability to hold or maintain information while also mentally working with or manipulating that information. It includes the ability to hold information in mind despite distraction and while another task is simultaneously being completed. Information that is loaded onto working memory can be newly learned or retrieved from long-term storage. This ability to hold information in the mind makes it possible to depict connections between seemingly unconnected items.

Cognitive flexibility is the ability to adjust to changed demands or priorities. This includes the capability to consider something from a fresh or different perspective, switch between perspectives, adjust to change, and think "outside the box." Cognitive flexibility builds on inhibition and working memory.

Self-regulation concepts are quite similar to executive function concepts. However, in terms of measurement, executive function focuses more on cognition in emotionally neutral situations, and involves behavior as measured with objective tasks. Self-regulation measures, on the other hand, focuses more on social situations, usually with strong motivational components, and often relying on parent or teacher report.

Executive function abilities are considered to be high-level abilities that can influence more basic abilities like attention, memory, and motor skills. As a result, it is difficult to assess executive function directly. Tests that measure other abilities, specifically those that investigate the more complex aspects of attention, memory, and motor skills are often used to evaluate executive functions. Tasks used with toddlers typically include some variation of the following tasks: reverse categorization (Carlson, Mandell, & Williams, 2004); multilocation search (Zelazo, Reznick, & Spinazolla, 1998); and shape Stroop (Kochanska, Murray, & Harlan, 2000). Tasks for preschoolers usually include some variation of the following tasks: day/night (Gerstadt, Hong, & Diamond, 1994); grass/snow (Carlson & Moses, 2001); bear/dragon (Reed, Pien, & Rothbart, 1984); hand game (Hughes, 1998); spatial conflict (Gerardi-Caulton, 2000); whisper (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996); tower (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996); pinball (Reed, Pien, & Rothbart, 1984); motor sequencing (Carlson & Moses, 2001; Welsh, Pennington, & Groisser, 1991); count and label (Gordon & Olson, 1998); backward digit span (Davis & Pratt, 1995); standard dimensional change card sort (Standard DCCS; Frye, Zelazo, & Palfai, 1995; Zelazo, Muller, Frye, & Marcovitch, 2003); less is more (Carlson, Davis, & Leach, 2005); Simon says (Strommen, 1973);

and Kansas Reflection-Impulsivity Scale for Preschoolers (KRISP; Carlson & Moses, 2001). In fact, many studies of executive function in children rely on these batteries of complex executive functioning tasks (Brocki & Bohlin, 2004; Hughes, 1998; Welsh, Pennington, & Groisser, 1991). There are also other tests that are designed to assess cognitive function directly, thereby measuring executive functions indirectly. These include Dimensional Change Card Sort (Frye, Zelazo, & Palfai, 1995), the Wisconsin Card Sorting Task (Grant & Berg, 1948), and the Flexible Item Selection Task (Jacques & Zelazo, 2001).

Executive functions provide the ability to initiate and complete tasks and to persevere when faced with challenges. Executive functions allow us to recognize unexpected situations and make alternative plans quickly when unusual events arise and interfere with normal routines. This is beneficial, especially in work and school situations, as it provides the skills necessary to manage the stresses of daily life and be successful.

In addition to acquiring skills to address everyday challenges, executive functions also enable individuals to inhibit inappropriate behaviors. Individuals with poor executive functioning skills often struggle in interacting with others, because they may say or do things that are viewed as bizarre or offensive. They may also demonstrate poor regulation by being impulsive and say or do or say things that could get them in trouble. This is because these urges may not be appropriately suppressed when executive function skills are weak.

Executive function deficits not only appear to play a role in antisocial behavior, but are also often associated with a number of other psychological and health problems. Some psychiatric and developmental disorders include obsessive-compulsive disorder, oppositional defiant disorder, conduct disorder, Tourette's syndrome, depression, schizophrenia, attention-deficit/hyperactivity disorder, and autism. Chronic heavy users of drugs and alcohol have shown poor executive function skills as demonstrated on tests of executive function. Although some of these deficits may result from heavy substance use, it has also been suggested that problems with executive functions may contribute to the development of substance use disorders (Aytaclar, Tartar, Kirisci, & Lu, 1999; Nigg, Wong, Martel, Jester, Puttler, Glass, Adams, Fitzgerald, & Zucker, 2006). Therefore, techniques to improve executive function skills are necessary as they may address a wide range of concerns, both directly and indirectly.

Training Executive Function

Reflecting the importance of executive function in behavioral adaption and social integration (Blair, 2002; Fox, Schmidt, Calkins, & Rubin, 1996; Hughes, 1998; Kochanska, Murray, & Harlan, 2000), multiple studies have focused on the development of executive function. Research has shown that repetitive practice, or training, of the fundamental skills necessary for executive function is beneficial. Consequently, many researchers are beginning to examine the possibilities of training various executive functioning skills in young children (Birchard & Crowl, 1975; Clements & Barnes, 1978; Goetz, Ayala, Hatfield, Marshall, & Etzel, 1983; Holmes, Gathercole, & Dunning, 2009; Klingberg, 2008; Holmes, Gathercole, Place, Dunning, Hilton, & Elliott, 2009; Klingberg, Fernell, Olesen, Johnson, Gustafsson, Dahlstrom, Gillberg, Forssberg, & Westerberg, 2005; McGuigan, 2007; McNab, Varrone, Fardee, Jucaite, Bystritsky, Forssberg, & Klingberg, 2009; Olsen, Westerberg, & Klingberg, 2004; Rossiter, 1998; Sloper, Glenn, & Cunningham, 1986; Thorell, Lindqvist, Nutley, Bohlin, & Klingberg, 2009; Westerberg, Jacobaeus, Hirvikoski, Clevberger, Ostensson, Bartfai, & Klingberg, 2007; Westerberg & Klingberg, 2007). Furthermore, it is recognized that executive function largely develops during childhood and thus researchers acknowledge the importance of building executive function skills in children. Early childhood may, because of rapid development of attentional and cognitive skills, be an area in which some skills have notable benefits. Children can greatly benefit from training due to their current stage in development. Therefore, researchers are beginning to explore and study training programs designed for young children.

Attention training. Training the self-regulation skill of attention has demonstrated significant importance as it plays a large role in self-regulation and functions in conjunction with working memory and other tasks that require cognitive control. Attention training increases the efficiency of self-regulation skills and executive function skills (Posner & Raichle, 1995). This is accomplished by utilizing cognitive training techniques that train a child to stay on-task and pay attention (Tamm, McCandliss, Liang, Wigal, Posner, & Swanson, 2008). Jones, Rothbart, and Posner (2003) proposed that use of attention training early in development, between the ages of three and five, may enhance attention and executive control networks since the brain has the greatest plasticity for the development and growth of these areas. Therefore, implementing attention training with preschool children may have a long-term impact on the functional development of their brain systems.

Evidence suggests that computerized game-like tasks can be used to assess and train attentional functions in children (Berger, Jones, Rothbart, & Posner, 2000). Researchers have designed attention games that are developmentally appropriate for many age groups, including young children. Some researchers have addressed training attention skills in young children indirectly by targeting other executive function skills, such as working memory, and examining the generalization of skills (Klingberg, Fernell, Olesen, Johnson, Gustafsson, Dahlstrom, Gillberg, Forssberg, & Westerberg, 2005; Klingberg, Forssberg & Westerberg, 2002; Westerberg, Hirvikoski, Forssberg, & Klingberg, 2004). Findings have indicated improvements in both working memory and attention, as demonstrated by a decrease in symptoms of inattention. Studies of training that target attention directly (Dowsett & Livesey, 2000; Kerns, Eso, & Thomson, 1999; Rueda, Fan, McCandliss, Halparin, Gruber, Lercari, & Posner, 2004; Tamm, Hughes, Ames, Pickering, Silver, Stavinoha, Castillo, Rintelmann, Moore, Foxwell, Bolanos, Hines, Nakonezny, & Emslie, 2009) have found that children demonstrated improvements in attention and both teachers and parents reported a decrease in inattentive behaviors. Furthermore, Rueda et al. (2004) found that children who received attention training demonstrated a more developmentally advanced performance on an attention task.

Current research indicates attention can be trained and attention training techniques can be successfully adapted and used with preschoolers. This demonstrates promising evidence for interventions for children at-risk or diagnosed with attention disorders. Further studies are necessary to explore the generalizability of the attention gains achieved through attention training to other self-regulation and executive function skills.

Sleep Quality and its Effects

Importance of quality sleep. Children who experience sufficient sleep, in either quality or quantity, tend to function well and demonstrate an overall enhanced wellbeing and outlook. Sleep quality and consistency of a sleep schedule are important for children’s optimal adjustment (Bates, Viken, Alexander, Beyers, & Stockton, 2002; El-Sheikh, Kelly, Buckhalt, & Hinnant, 2010). Sleep is critical for early learning (Kurdziel, Duclos, & Spencer, 2013) and is further evidenced by improved memory function and improved performance on performance tests (Sadeh, Gruber, & Raviv, 2003). Schabus, Gruber, Parapatics, Sauter, Klosch, Anderer, Klimesch, Saletu, and Zeitlhofer (2004) found that after a quality night’s sleep, characterized by early onset, fewer interruptions, and fewer early awakenings, individuals demonstrate increased memory performance, including spatial memory, motor-skill learning, and implicit perceptual memory (Meijer, Habekothe, & Van Den Wittenboer, 2000). Walker, Brakefield, Morgan, Hobson, and Stickgold (2002) found that sufficient sleep results in a 20 percent increase in motor speed without any loss of accuracy.

Quality sleep enables children to perform better in school as sleep quality and feeling are related to school functioning (Meijer, Habekothe, & Van Den Wittenboer, 2000). Children who had no difficulty getting up in the morning because they were well-rested displayed more achievement motivation. They were more open to their teacher's influences and their increased achievement was a result of their improved sleep. Well-rested children are more ready for the school day and are at a greater advantage for school success (Lewit & Baker, 1995). Adequate and sufficient sleep results in both immediate and long-term benefits.

Effects of poor sleep. Although there is no real agreement on the definition of what poor sleep is, it can include the variables of short sleep, sleep variability, and sleep fragmentation. The effects of inadequate and inefficient sleep in children have been correlated with various problems during childhood, adolescence, and later in life as adults. Children who suffer from sleep difficulties may also experience deficits in other types of functioning (Roberts, Roberts, & Chen, 2001). Disruptions in the quality and duration of sleep can have a negative effect on a child as it impacts daytime performance, including adjustment and academic performance (Dahl, 1996b; Dewald, Meijer, Oort, Kerkhof, & Bogels, 2010; El-Sheikh, Buckhalt, Cummings, & Keller, 2007; Meijer & Van Den Wittenboer, 2004). Children with insufficient sleep reported problems with concentration and motivation (Meijer, Habekothe, & Van Den Wittenboer, 2000). They feel more tired, moody, and irritable at school (Gradisar, Terrill, Johnston, & Douglas, 2008). Furthermore, the younger the person is, the greater the effect sleep loss has on daytime performance (Bliese, Wesensten, & Balkin, 2006).

Correlational research has demonstrated that children's ability to function well in a school setting is negatively affected by their poor sleep (Taras & Potts-Datema, 2005). Preschoolers who experience poor sleep have less optimal adjustment in school (Bates, Viken, Alexander, Beyers, & Stockton, 2002). Teachers recognize that the lack of sleep is highly associated with social difficulties (Aronen, Paavonen, Fjallberg, Soininen, & Torronen, 2000).

Higher cognitive processing skills such as verbal creativity, abstract thinking, and divergent thinking are sensitive to sleep deprivation (Dahl & Lewin, 2002) and have been shown to be impaired after a single night of restricting sleep from 11 to five hours, even when no changes were made to their daily routines (Carskadon, 1999; Randazzo, Muehlback, Schweitzer, & Walsh, 1998). Children's poor performance on performance tests assessing memory, attention, and arithmetic are related to their sleepiness (Carskadon, Harvey, & Dement, 1981b). In addition, reaction time, the ability to maintain attention, and reading skills were impaired.

Poor sleep has resulted in an increased manifestation of attention problems (Fallone, Acebo, Arnedt, Seifer, & Carskadon, 2001; Fallone, Acebo, Seifer, & Carskadon, 2005). Inadequate sleep and sleepiness has been correlated with a child's inability to pay attention in class (Dahl & Lewin, 2002). Aronen et al. (2000) found that a lack of sleep was associated with attention problems in school, as measured by teacher reports. Students who went to bed later were more likely to be referred for having attention problems (Giannotti, Cortesi, Sebastiani, & Ottaviano, 2002). Epstein, Chillag, and Lavie (1998) found that earlier wake times resulted in the students being more tired during the day, and thus having difficulty concentrating and paying attention in class.

Behavior problems have also been correlated with poor sleep in children. Children who exhibited sleep duration patterns as little as 0.7 hours shorter than average (Aronen, Paavonen, Fjallberg, Soininen, & Torronen, 2000) or other kinds of sleep difficulties, experienced an increase in hyperactivity and impulsivity, along with other externalizing problems (Dahl & Lewin, 2002; El-Sheikh, Buckhalt, Cummings, & Keller, 2007; Goodnight, Bates, Staples, Pettit, & Dodge, 2007; Touchette, Petit, Seguin, Boivin, Tremblay, & Montplaisir, 2007; Wolfson & Carskadon, 1998). Inhibitory efficiency (the ability to inhibit, or stop responding to irrelevant stimuli) decreased with increased sleep deprivation (Chuah, Venkatraman, Dinges, & Chee, 2006). Furthermore, correlational evidence demonstrates increased internalizing symptoms when the quality, quantity, or duration of sleep was disrupted as a product of emotional insecurity (Dahl & Lewin, 2002; El-Sheikh, Buckhalt, Cummings, & Keller, 2007; Fredriksen, Rhodes, Reddy, & Way, 2004; Gregory, Caspi, Eley, Moffitt, O'Connor, & Poulton, 2005; Pilcher & Huffcutt, 1996; Roberts, Roberts, & Chen, 2001; Wolfson & Carskadon, 1998). In addition, longitudinal research demonstrated that sleep problems during the preschool years predicted future behavioral problems during mid-adolescence (Gregory & O'Connor, 2002).

Children who have irregular sleep patterns and suffer from commonly reported and general problems in sleep, as measured by parental reports, are more likely to have poor school achievement (Bruni, Ferini-Strambi, Russo, Antignani, Innocenzi, Ottaviano, Valente, & Ottaviano, 2006; Giannotti, Cortesi, Sebastiani, & Ottaviano, 2002). Students with inadequate sleep, defined by the National Sleep Foundation (2004) as 9.9 hours or less for preschoolers ages three- to five- and six-year-olds who are in kindergarten, were more likely to have lower and poorer grades (Carskadon, 1999; Fredriksen, Rhodes, Reddy, & Way, 2004). Adolescents who do not get enough sleep reported that their lack of sleep interferes with their daytime functioning, thereby affecting their school grades (Wolfson & Carskadon, 1998). Students who struggled in school or failed school reported that they go to sleep later, sleep less, and have more irregular sleep and wake schedules compared to students who achieve A and B grades. On the other hand, students who get more sleep maintain better school and weekend sleep schedules and are better able to pay attention in class and complete their schoolwork. Moreover, students with worse grades reported greater weekend delays of sleep schedule than those with better grades. Students with higher grade point averages slept more at night and reported less daytime sleepiness than students with lower grade point averages. Chronic sleep reduction affects school achievement directly and indirectly by impacting school functioning, which results in poorer grades (Meijer, 2008).

The lack of good sleep also negatively impacts memory formation (Fogel & Smith, 2006). Declarative memory, which refers to memories that are accessible to conscious recollection, and procedural memory, which includes memories of how to perform some skill or solve a problem, are impaired by poor sleep. Sleep plays an important role in memory processes and sleep deprivation and/or fragmentation has been shown to impair the ability to form memories. Sleep loss is frequently associated with poor declarative and procedural learning in students (Curcio, Ferrara, & De Gennaro, 2006). Individuals who were sleep deprived had more difficulty recognizing and understanding their own memory performance abilities (Harrison & Horne, 2000). This further indicates poor sleep affects memory processes.

Findings have been mixed when examining the effects of sleep on working memory. Some studies have found no relationship between working memory and sleep problems in children (Sadeh, Gruber, & Raviv, 2002; Sadeh, Gruber, & Raviv, 2003). Allen (2003), in contrast, found that sleep restriction impaired working memory. Steenari, Vuontela, Paavonen, Carlson, Fjallberg, and Aronen (2003) found that in school-aged children, lower sleep efficiency and longer sleep latency were associated with a higher percentage of incorrect responses in working memory tasks for all memory load levels; however, shorter sleep duration was only associated with a higher percentage of incorrect responses for the highest memory load. Gradisar et al. (2008) found that adolescents who reported insufficient sleep performed worse on working memory tasks compared to adolescents who slept between eight and nine hours of sleep each night. Finally, Casement, Broussard, Mullington, and Press (2006) reported that working memory efficiency improved over time when individuals were permitted adequate sleep, and no improvement was found when individuals were sleep restricted, thereby indicating that sleep restriction prevented improvements in the speed of working memory. Therefore, sleep quality and quantity affects the performance of working memory tasks in children and adolescents.

It is generally believed that sleep actively influences specific components of memory consolidation (Hu, Stylos-Allan, & Walker, 2006). A single night of sleep deprivation disrupts the ability to form new episodic memories, and the retention of such memories over the course of two days is very poor. One hour of sleep restriction, in which the individual sleeps one hour less than his/her typical or average amount of sleep each night, resulted in poor memory consolidation and learning (O'Brien, Brian, Garrod, Kheirandish-Gozal, Molfese, & Molfese, 2009). These detrimental effects of sleep loss appear to be consistent across all memory types (Walker & Tharani, 2006). Findings from sleep restriction studies indicate that specific sleep stages may play distinct roles for the different types and stages of memory processing (Walker & Stickgold, 2006); however, additional research is necessary to further determine which aspects of memory functioning are affected by sleep and which processes specifically underlie memory consolidation (Curcio, Ferrara, & De Gennaro, 2006).

Findings indicate that declarative memory consolidation may depend on more subtle aspects of the learning process, such as task difficulty (Walker & Stickgold, 2006). Verbal declarative memory consolidation occurs best after a full night of sleep, especially when words were semantically unrelated (Payne, Walker, Stroynowski, & Stickgold, 2006), and is an ability that requires hippocampal-dependent processes (Van Der Helm, Gujar, Nishida, Watts, & Walker, 2009). Sleep loss appears to cause deficits in the memory coding that is associated with impairments in hippocampal function (Walker & Tharani, 2006). Slow wave sleep (SWS) plays a fundamental role in the consolidation of declarative memories (Curcio, Ferrara, & De Gennnaro, 2006).

In addition to examining the process of declarative memory consolidation, procedural memory consolidation has been studied. A good night of sleep enhances the consolidation of procedural memories, resulting in improved performance the following day (Walker, 2006). When comparing sleep restricted and non-sleep restricted individuals, those who were not sleep restricted demonstrated improved performance after sleep, and individuals who were sleep restricted showed no improvements the following day (Karni, Tanne, Rubenstein, Askenasy, & Sagi, 1994). Rapid eye movement (REM) sleep plays a fundamental role in the consolidation of procedural memories (Curcio, Ferrara, & De Gennnaro, 2006) and Stickgold, Whidbee, Schirmer, Patel, and Hobson (2000) found that REM sleep promotes memory consolidation. Ribeiro and Stickgold (2014) indicated that both REM and NREM sleep play critical roles in learning and memory. Individuals who are deprived of REM sleep the night learning occurred, but then are given the opportunity to recover the following two nights still do not show improvements in the task (Walker, 2006). It is further suggested that sleep-dependent memory consolidation appears to be an “all or nothing” event in that sleep is required within the first 24 hours after learning for consolidation of memories to occur (Walker, 2006).

In sum, quality sleep is important for all people, especially children. Children who are tired, inattentive, or restless may be less able to participate in learning opportunities that are intended to facilitate the development of cognitive skills (Jung, Molfese, Beswick, Jacobi-Vessels, & Molnar, 2009). Children who suffer from sleep deprivation are more likely to have difficulties with cognitive functioning and memory, suffer from externalizing and internalizing problems, demonstrate poor performance, and have lower grades compared to children who have an adequate amount and quality of sleep. Preschoolers who are well-rested are also more likely to achieve greater gains in cognitive scores, maintain higher cognitive scores, and develop more optimal learning-related behavior as they prepare for elementary school (Jung et al., 2009).

Sleep restriction. Although the largest part of the literature reviewed supports more sleep as better than less sleep, some clinical researchers have also considered possible benefits of sleep restriction. Researchers examining a brief period of sleep restriction have reported minimal adverse effects, and sometimes even positive effects. In fact, sleep restriction has been used as an intervention to help improve sleep problems (Christodulu & Durand, 2004), especially for preschoolers who are beginning to transition from having daytime naps to no longer having naps, as nighttime sleep becomes more consolidated, thereby eliminating the need for daytime naps. Not all children who were sleep restricted had more sleep disruptions or displayed less consistent sleep schedules (Allen, 2003), and furthermore, sleep restriction has been used to reduce sleep problems in young children, including young children with developmental delays (Durand & Christodulu, 2004). Sleep restriction interventions have been successful in improving nighttime sleep in preschoolers by eliminating bedtime disturbances and reducing nighttime awakenings, thereby improving daytime functioning. Children who went to bed later than their typical bedtime and woke up at their typical rise time, thus having one hour less of sleep for three consecutive nights, had improved sleep efficiency and quality (Allen, 2003). Such interventions can be advantageous if they prevent long periods of child distress and lead to no increase in behavior problems. Therefore, the effects of sleep restriction can be minimal and sometimes beneficial.

Sleep restriction studies designed to ensure safe, appropriate conduct have been increasingly reported (Fallone, Owens, & Deane, 2002; Sadeh, Gruber, & Raviv, 2003; Vgontzas, Zoumakis, Bixler, Lin, Follett, Kales, & Chrousos, 2004). Use of healthy children without significant functional deficits is ideal. It is important to remember that children in their normal lives frequently face mild sleep restrictions due to delayed bedtimes.

A multi-night, at-home sleep manipulation study with adolescents and children is feasible (Allen, 2003; Beebe, Fallone, Godiwala, Flanigan, Martin, Schaffner, & Amin, 2008). Children can easily decrease their sleep on demand over a short period of time solely by changing their bedtime (Allen, 2003). Healthy children as young as six years of age are able to maintain substantial changes in their usual schedules across several nights in experimental studies of sleep restriction (Fallone, Seifer, Acebo, & Carskadon, 2002). Findings from the Sexton-Radek (1997) study stressed the importance of ensuring compliance for sleep restriction. Use of actigraphy helps confirm that both the children and their parents demonstrated compliance with the experimental home-based protocol. It is beneficial to provide parents and children with specific recommendations for managing the changes in sleep schedules. Compliance with sleep study procedures increase as families are provided strategies for altering their child's sleep schedule.

Studies have examined the effects of sleep restriction in instances where individuals who were sleep restricted were able to return to baseline sleep. Studies that restricted sleep in adults every night for five to six nights noted that they could recover with a single long night of sleep and return to their basal values of typical sleep as measured by a sleepiness rating scale (Carskadon & Dement, 1981). Partial sleep deprivation (where individuals receive less than five hours of sleep in a 24-hour period) affects functioning, both cognitive and motor functioning, more than either long-term (staying awake for at least 45 continuous hours) or short-term (staying awake for at most 45 continuous hours) sleep deprivation (Pilcher & Huffcutt, 1996). Additional studies with adults have examined the effects of total sleep restriction over the course of two nights, followed by two nights of recovery sleep and found that behaviors returned to baseline after one night of recovery sleep (Drummond, Paulus, & Tapert, 2006). This indicates that adults who are sleep restricted are able to recuperate from their sleep loss.

Researchers studying sleep restriction in children have also found that children are able to recover. One night of sleep restriction does not appear to have any significant effects on school abilities, as children appear to be able to tolerate a single night of restricted sleep (Carskadon, Harvey, & Dement, 1981a; Carskadon, Harvey, & Dement, 1981b); however, they do not recover as quickly as adults from poor sleep. One week of sleep restriction for 45 minutes each night in young children, between the ages of four to eight, does not appear to be associated with changes in bedtime or other sleep measures during subsequent recovery (Dayyat, Spruyt, Roman, Molfese, & Gozal, 2008). Furthermore, the effects of minor sleep loss are eliminated after seven days of baseline sleep (O'Brien, Brian, Garrod, Kheirandish-Gozal, Molfese, & Molfese, 2009).

The Present Study

Amount and quality of sleep have been shown to have profound effects on children in learning and school readiness. However, considering the evident importance of the topic, the studies so far have not often included an attention training component. This study trained and improved the attention skills in preschool-aged children who were sleep restricted.

Research has shown that training the fundamental skills of executive function is beneficial. This study expanded on executive function training studies by building upon attention training research and further examining the generalization of attention skills to other executive function skills.

Much of the current research on sleep has been limited. In fact, the majority of current studies have focused on the adult population. There have been studies of sleep in adolescents and school-age children, but fewer studies of sleep in preschoolers (Bates, Viken, Alexander, Beyers, & Stockton, 2002; Osborne, Dayyat, Gozal, Molfese, & Molfese, 2008). This study expanded upon current research by focusing on sleep in preschoolers. In addition, much of the current research on sleep restriction has been limited. The majority of studies have been conducted with adults. A few studies have examined sleep in children. However, very few studies have included the preschool population (Dayyat, Spruyt, Roman, Molfese, & Gozal, 2008). This study furthered research knowledge by focusing on sleep restriction within a preschool population.

The majority of sleep studies to date have been correlational and there have been some longitudinal studies; however, there have been only four experimental studies, one of which is quasi-experimental (Ross & Karraker, 1999) and two of which are undergraduate theses, leaving only one referreed published experimental study (Berger, Miller, Seifer, Cares, & Lebourgeois, 2012) which had 10 participants. This present study had an experimental design, in which sleep was manipulated and the experimental group is compared to a control group consisting of preschoolers engaging in their typical sleep patterns. Use of an experimental design not only increased current sleep research knowledge, but also strengthened the relationships between sleep and performance.

The purpose of this study was to examine the effects of sleep on the training of attention skills in preschoolers and the generalization of these skills to other executive function skills, including inhibition, cognitive flexibility, and working memory. A number of questions were posed at the outset of this study to better understand the relationship between sleep restriction, attention, and attention training. Two questions of primary importance were defined at the outset of this study, alongside several secondary, less central queries.

Primary Questions

1. Does an acute sleep restriction affect the training of a preschooler's attention abilities? The attention training program followed a similar design as that used by Rueda, Rothbart, McCandliss, Saccomanno, & Posner (2005). Only one true published sleep restriction study, to date, has been documented for the preschool population.
2. Do the trained attention skills generalize to attention performance and to other executive function skills, namely inhibition, cognitive flexibility, and working memory, and are there differences between the sleep modified and control groups? No published studies to date have tested whether the training of attention skills also extend to changes in other executive function skills.

Secondary Questions

3. Are there child gender and age differences in behavior and sleep habits and do such differences exist between groups? Past studies (Blair, Denham, Kochanoff, & Whipple, 2004; Carr, Lemanek, and Armstrong, 1998; and Bournaki, 1997; Buss, Brooker, and Leuty, 2008; Else-Quest, Hyde, Goldsmith, & Van Hulle, 2006; Graves, Blake, & Kim, 2012; Klenberg, Korkman, & Lahti-Nuuttila, 2001; Kochanska,

Murray, & Harlan, 2000; Maccoby, 1988; Maccoby & Jacklin, 1974; Raaijmakers, Smidts, Sergeant, Maassen, Posthumus, Van Engeland, & Matthys, 2008) have shown many behavioral differences between boys and girls. Only Owens, Spirito, McGuinn, and Nobile (2000) indicated no gender differences for sleep habits in children and additional studies may be helpful to support this finding.

4. Are there child gender differences in performance on the attention training on the pre-test and post-test measures? Do such gender differences in performance also exist within groups? Behavioral gender differences have been reported; however, direct evaluations of performance differences with respect to gender have not. The attention training program was designed so that each subsequent game (and consequently each subsequent training session), would be more difficult than the preceding one.
5. Are age differences observed from pre-test to post-test and with respect to the attention training? Executive function skills are rapidly developing during the preschool years, and it is highly possible that an age difference of about 24 months may illustrate differences in performance.

The first question was answered by comparing the performance of attention from pre-test to post-test between preschoolers in the control group and preschoolers in the sleep modified group. It was expected based on the assumption that they would get less sleep and less likelihood of well-consolidated learning of the attention skills and less ability to perform at their peak skill level due to fatigue, that children in the sleep modified group would not demonstrate as great a gain in attention performance (as measured by mean reaction time and accuracy) from pre-test to post-test compared to children in the control group.

The second question was answered by comparing the performance of all tasks from pre-test to post-test between preschoolers in the control group and preschoolers in the sleep modified group. It was predicted that children in the control group would demonstrate some improvements in tasks from pre-test to post-test; however, fewer improvements would be observed from pre-test of post-test for children in the sleep modified group.

The third question, regarding sex differences in behavior and sleep habits, was answered comparing scores from the Children's Behavior Questionnaire, the Eyberg Child Behavior Inventory, and the Children's Sleep Habits Questionnaire for gender and for age. Much past research indicated differences in behavior between boys and girls and therefore it was expected that caregivers (which, in this study, includes parents, grandparents, and other relatives who are the primary caregiver for the child) would also report behavioral differences between genders. Given that Owens, Spirito, McGuinn, and Nobile (2000) found no gender differences with respect to sleep habits, similar findings were also expected.

The fourth question, regarding sex differences in attention training effects, was answered by comparing various aspects of the attention training between boys and girls. Comparisons were made by examining differences in performance based on training session and training game. It was expected that performance would decrease with each increasing training session and training game as the attention training program was designed so that each subsequent game would be more difficult. Given that boys typically have increased behavioral difficulties, it was expected that girls would perform better on the attention training. It was expected that with each game and with each session, children in the sleep modified group would perform worse compared to children in the control group as children in the sleep modified group would have experienced increased sleep restriction.

The fifth question, regarding effects of child age upon attention training effects, was answered by examining the differences in age for performance on the pre-test and post-test tasks and for performance on the training games. It was expected that the older children would perform better on the pre-test and post-test tasks compared to the younger children as the younger children would likely have more difficulty with the tasks designed for the older children (e.g., the five-year-olds). Additionally, it was expected that the older children would perform better on the training games as attention abilities improve with age.

Chapter III

Methodology

Participants

Children between the ages of four and six years from local preschools and their caregivers were asked to participate in this training study. Preschools were initially contacted by phone in which an appointment was set up so the experimenter could discuss the study with the preschool director. The preschool director received a letter detailing the study specifics.

All children who returned a signed consent form were contacted by phone by a research assistant. The research assistant conducted a phone screen (see Appendix A for copy of the Subject Phone Screen) with the caregiver to determine eligibility for the study. Caregivers were asked about their ability to speak and read English. This was important as caregivers were instructed to complete several questionnaires and would be corresponding with a research assistant a couple times throughout the study. In addition, the caregivers were asked about their child's ability to speak and understand English. Many components in this study required that the child understand and respond in English. The telephone interview also screened for the child's ability to participate in the study. The following exclusion criteria were applied: children who were developmentally delayed, diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD), on medication (including allergy medication), and/or had a past history of sleep problems. Caregivers were also asked if their child was functioning well with the current amount of sleep he/she is receiving. Evidence of major sleep problems or daytime functioning problems that may be a result of sleep quality or quantity the child receives, thereby possibly making the child ineligible for the study. In addition, caregivers were asked to provide information as to how much sleep their child receives, on average, each night, what time their child goes to bed, and what time their child gets up. This helped provide an idea of approximately how much sleep the child was currently receiving each night. Children who received less than 10 hours of sleep each night were excluded from the study as these children fell in the bottom 25th percentile (National Sleep Foundation, 2004) and the purpose of the study was to examine the sleep patterns for children who receive typical sleep. Based on the data caregivers initially provided during the phone screen, all children who participated in the study slept within the typical range as determined by pediatric guidelines (National Sleep Foundation, 2004). From this information, children could randomly be placed into either the control or sleep modified group as any changes to a child's sleep schedule would, in essence, keep the child within the range for typical amount of total sleep each day. In addition, this study included the child's participation in a training program at his/her preschool. Therefore, it was important that the child attended his/her preschool at least three days per week, and approximately the same time each day.

If the subject met all criteria, the caregiver was told they and their child qualified for the study and was given further details. They were informed of the study's two-week duration and the expectation that their child would wear an actigraph measuring sleep and wake times during this period. Caregivers were advised that in the second week they may be provided with a bedtime schedule that may vary up to an hour past the child's typical bedtime. They were further given a description of the training sessions their child would partake in and the questionnaires they would be asked to complete. After being presented with this information, caregivers were then asked if they were still interested in participating. Those answering in the affirmative were considered approved participants.

Participants between the ages of four and six were eligible for the study, provided that caregiver consent was obtained. Participants were semi-randomly assigned to one of two conditions (the control group or the modified sleep group), with attempts to balance age and gender and to manage several other factors as expected. The researchers collecting the data were blind to what group each child was placed into. Group placement was conducted via a random numbers table. The semi-random assignment was conducted by a research assistant to ensure that the experimenter did not know which condition each child was in.

Recruitment began in April 2010; data collection began in May 2010 and concluded in August 2010. A total of 38 caregivers consented to participating in this study. Of those, one child was excluded for medical reasons, one child did not want to participate, one child was too young, and two children moved prior to testing, resulting in a final sample of 33.

A total of 33 children and their caregivers consented and participated in this study (19 girls, 14 boys). Ages ranged from 46-months to 68-months of age (*M* = 57.67 months, *SD* = 5.87) with 21 four-year-olds and 12 five-year olds in total. Demographics of the sample per parent questionnaire packet are presented in Table 1.

Families' participation in this study, given time constraints and limitations, was satisfactory. After one month of recruitment and less than four months of data collection, 86.8 percent of those who initially consented actually participated in the study. Of the children who participated in the study, 57.6 percent were girls. Demographics of sample by group are presented in Table 2.

A total of 32 of the 33 parent questionnaire packets were returned. Of the 32 that were returned, not all were complete. According to caregiver report, five children no longer took naps, 18 children took between one and five naps a week, and nine children took six or seven naps a week. On average, according to caregiver report per phone screen data, children slept 11.78 hours (including naps, if applicable) (*SD* = .93) during the week and 11.58 hours (including naps,

Table 1

Demographics of Sample Per Parent Questionnaire Packet

			Caregiver	Caregiver Partner
Child	No. (%)	Caregiver	No. (%)	No. (%)
Gender		Gender		
Female	19 (59.4%)	Female	27 (84.4%)	4 (16.0%)
Male	13 (40.6%)	Male	5 (15.6%)	21 (84.0%)
Nuclear Family		Completed survey	32 (97.0%)	25 (75.8%)
Single Caregiver	8 (25.0%)	Age		
Mother only	8 (100.0%)	29 and younger	6 (19.4%)	7 (30.4%)
Father only	0 (0.0%)	30-34	16 (51.6%)	5 (21.7%)
Family Composition		35-39	5 (16.1%)	6 (26.1%)
Biological	6 (75.0%)	40-44	3 (9.7%)	3 (13.0%)
Blended	2 (25.0%)	45 and older	1 (3.2%)	2 (8.7%)
Two Caregivers	25 (75.8%)	Ethnicity		
Traditional	16 (64.0%)	White (Non-Hispanic)	24 (88.9%)	18 (100.0%)
Blended	9 (36.0%)	Mixed Race	2 (7.4%)	0 (0.0%)
Siblings		American Indian	1 (3.7%)	0 (0.0%)
Only Child	10 (33.3%)	Education		
Multiple Children	20 (66.7%)	Some High School	0 (0.0%)	1 (4.0%)
Preschool		GED	1 (3.1%)	2 (8.0%)
Attendance per week		High School Diploma	5 (15.6%)	6 (24.0%)
3 days	3 (9.1%)	Some College	10 (31.3%)	5 (20.0%)
4 days	1 (3.0%)	College Degree	16 (50.0%)	11 (44.0%)
5 days	29 (87.9%)	Relation to Child		
Naps per week		Biological Parent	30 (100.0%)	20 (83.3%)
No naps	5 (15.2%)	Step-Parent	0 (0.0%)	4 (16.7%)
1 nap	2 (6.1%)	Marital Status		
2 naps	0 (0.0%)	Single/Never Married	4 (13.3%)	2 (8.0%)
3 naps	3 (9.1%)	Married	16 (53.3%)	18 (72.0%)
4 naps	3 (9.1%)	Separated	1 (3.3%)	0 (0.0%)
5 naps	10 (30.3%)	Divorced	8 (26.7%)	5 (20.0%)
6 naps	4 (12.1%)	Remarried	1 (3.3%)	0 (0.0%)
7 naps	6 (18.2%)			

*One family did not return the parent packet; 32 packets were returned; however, not all were complete.

Table 2

Demographics of Sample by Group

Child	Full Sample No. (%)	Control Group No. (%)	Sleep Modified Group No. (%)
Gender	33 (100.0%)	17 (100.0%)	16 (100.0%)
Female	19 (57.6%)	10 (58.8%)	9 (56.3%)
Male	14 (42.3%)	7 (41.2%)	7 (43.8%)
Age			
46-50 mo.	3 (9.1%)	2 (11.8%)	1 (6.3%)
51-55 mo.	11 (33.3%)	5 (29.4%)	6 (37.5%)
56-60 mo.	9 (27.3%)	7 (41.2%)	2 (12.5%)
61-65 mo.	5 (15.2%)	2 (11.8%)	3 (18.8%)
66-68 mo.	5 (9.1%)	1 (5.9%)	4 (25.0%)

*There was one set of twins in this study. In the general population, the proportion of twins averages to about 3.2% for children this age (U.S. Census, 2012). This indicates that the proportion of twins in this study is similar to that of the general population.

if applicable) (*SD* = 1.49) on the weekends. On average, caregivers reported that the nighttime routine consisted of 3 steps (*M* = 3.12, *SD* = 1.43). The nighttime routine most consisted of bath time, story time, and brush teeth.

A total of 10 preschools were represented in this study: three children from Bloomington Kids Club, six children from Carousel Christian Day Care, six children from Children's Village, one child from Dee's High Achievers, two children from Monroe County Jack and Jill Daycare, Inc., two children from Monroe County United Ministries, Inc. Child Care, five children from Penny Lane East, five children from Penny Lane West, one child from The Prep School, and two children from St. Charles Daycare Ministry. Children in the sample attended preschool anywhere from three- to five-days a week (*M* = 4.85 days a week, *SD* = .51).

Experimenters

Data were collected by two trained researchers, fourth and fifth year school psychology doctoral students). Each researcher collected the data for her child in its entirety (e.g., pre-test measures, attention training, and post-test measures). Of the 33 children who participated, one child had data collected by the secondary researcher with the primary researcher's assistance to ensure that data collection followed research protocols. The primary administrator collected data from 29 children and the secondary administrator collected data from three children. There were no differences between administrators on each of the pre-test measures, post-test measures, and attention training games.

Procedures

In overview, all children completed one week for baseline analysis and one week for experimental analysis. Studies examining sleep patterns concluded that five or more nights of sleep pattern data are required for reliable measures of sleep in children and adolescents (Acebo, Sadeh, Seifer, Tzischinsky, Wolfson, Hafer, & Carskadon, 1999; Sadeh, 2002). The control group was asked to follow their typical sleep schedule patterns throughout their participation during the two weeks of the study. The modified sleep group followed their typical sleep schedule patterns only during the first week of the study, as a means to gather baseline data and determine average bed and wake-up times. During the second week of the study, the modified sleep group was provided a modified sleep schedule and caregivers were asked to put their child to bed according to this modified sleep schedule. The modified sleep schedule entailed a later bedtime of up to one hour past the child's typical bedtime. The ideal goal was that all children in the modified sleep group would go to bed one hour past their typical bedtime during the second week of the study, only on the nights of each training day. Therefore, all children in the modified sleep group would be restricted the same amount of sleep (one hour), thereby keeping this variable consistent. However, more imperative was that the children in this group be restricted on the nights of training, because this study was designed to investigate the differences in learning consolidation between typical and restricted sleep.

Prior to participation, caregivers were previously informed that there may be a possibility that they would be asked to change their child's sleep schedule no more than one hour past their typical bedtime. They were informed of this possibility on several occasions: through a parent recruitment letter, on the informed consent form, and at the end of the phone screen provided that they qualified for the study. Caregivers were also given ample opportunity to discuss any concerns or questions they had regarding the study procedures. In the parent recruitment letter and in the informed consent, a telephone number was provided where they could reach the experimenter and contact her with any questions. In addition, the experimenter was at the preschool on several occasions to answer any questions the caregivers may have. Furthermore, caregivers were given several other opportunities to ask questions or express concerns during the phone screen as well as during the two follow-up phone calls during the second week of the study.

Sleep data were obtained from all children via actigraphy, child sleep diary (see Appendix B for a sample copy of a Child Sleep Diary), and caregiver report. Average time to bed was calculated for each child based on the baseline sleep data as determined by actigraphy and the child sleep diary. From the actigraphy data and child sleep diary, a nightly average amount of sleep a child received was calculated. Children in the control group continued to go to bed at their typical bedtime. Children in the modified sleep group were instructed to go to bed up to one hour past their typical bedtime only on the days that the child participated in the training program.

Analysis of the actigraphy data, in which actigraphy data are considered to be accurate (Sadeh, Alster, Urbach, & Lavie, 1989), was conducted. The analysis of both the actigraphy data and the child sleep diary for the first week of data collection (baseline data) could have resulted in the discovery of a possible third group, a secondary control group. Children who sleep an average of 9.5 hours or less per night fall in the bottom 25th percentile as indicated by the National Sleep Foundation (2004). Therefore, children in this group would not be given a modified sleep schedule, but would rather be part of their own group: a secondary control group consisting of typical sleep restricted children. Due to the screening criteria, it was unlikely that many children would fall into this category as the screening interview would have disqualified any child who received 10 hours of sleep or less and no children were screen out due to this screening criterion. Ultimately, no study participants fell into this category, and no secondary control group was necessary.

During the initial meeting with the primary caregiver, consent for participation in the study was obtained. On the first day of the assessment (typically on a Thursday or a Friday), the experimenter gave the caregiver a packet of questionnaires to complete over the course of the two weeks. This packet included family demographic information (Appendix C), Rothbart's Children's Behavior Questionnaire (CBQ) – Short Form (refer to Appendix D for sample items), Owens' Children's Sleep Habits Questionnaire (CSHQ) (refer to Appendix E for sample items), and Eyberg Child Behavior Inventory (ECBI) (refer to Appendix F for sample items). The order in which the CBQ, CSHQ, and the ECBI were arranged in the packet was random. The child was given an actigraph to wear for the two weeks they participated in the study. Caregivers were instructed to only take the actigraph off the child during bath time or any other activities where the actigraph could potentially come into contact with water. The primary caregiver was asked to complete a sleep diary for their child for each night during the two weeks of the study. The caregiver was asked to record as best they could the times when their child woke up, fell asleep, or took a nap; caregivers were instructed to note any amount of sleep the child obtained. In the sleep diaries, the caregiver was asked to record anything unusual about the child's sleep. For example, it would be very important to indicate if the child napped in a car since the actigraph would not read this time as asleep. Caregivers were also instructed to record all times the actigraph was removed and indicated when it was put back on. If any additional unforeseen problems arise (i.e., child get sick), caregivers were encouraged to adjust the child's sleep to a more appropriate amount given the situation. To communicate such deviations from the research protocol, caregivers were instructed to make note of these changes in the child sleep diary as well as inform the research assistant during the follow-up phone calls.

The caregiver was also given a bag of small gifts for the child. These gifts consisted of small toys, bubbles, coloring books, crayons, etc. The monetary value of these gifts was one dollar or less per item. The experimenter explained that these gifts were to be given as incentives for the child to continually wear the actigraph. The experimenter instructed both caregiver and child that the child would receive a present each morning when s/he woke up wearing the actigraph.

Preschools who agreed to participate were given a $25 gift certificate and 10 books for the classroom, regardless of the number of children who participated. Compensation went to the preschool instead of the individual child, thereby allowing all children to benefit from the gifts, no matter how many children participated.

Approximately one week after the start of the assessment (typically a Wednesday or Thursday evening), the research assistant contacted the primary caregiver by phone to remind them to return the first part of the sleep diary with their child to school. The experimenter would collect the sleep diary from the child and the nap sleep diary from the child's preschool. This portion of the sleep diary was essential for analyzing actigraphy data to determine the child's baseline sleep. The sleep diary provided a guide to analyzing the actigraphy data. For example, it can be difficult to distinguishing between when the child is asleep and when the actigraph is removed (i.e., for bath time); however, this information would be provided in the sleep diary, and thus knowledge of such events could be discerned. Therefore, both the sleep diary data and the actigraphy data, although slightly different, were crucial. It was important to be aware that the caregiver's report of sleep was probably higher than the actigraph index as caregivers may not know the exact time the child falls asleep, wakes up in the morning, or the number of times the child wakes up during the night.

One week after the start of the assessment (typically on a Thursday or a Friday – the day the experimenter collected the first part of the sleep diary), the experimenter met with the child at the child's preschool for about 30 minutes, typically in the morning. During this time, the experimenter administered the Kaufman Brief Intelligence Test (KBIT), a cognitive test, to the child. This test consists of two subtests: Vocabulary and Matrices. Vocabulary measured verbal school-related skills and asked the child to name the object of the picture they are shown. Matrices measured nonverbal skills and asked the child to match a certain picture with one that corresponds with it from a set of different pictures or complete a certain picture with one that belongs in the missing part from a set of different pictures. Upon completion, the experimenter administered seven tasks/games (Day/Night, Standard Dimensional Change Card Sort, Simon Says, Flexible Item Selection Task, Word Span, Digit Span, and Backwards Digit Span) to the child (refer to Appendix G for a description of the pre-test and post-test measures). In addition, the experimenter downloaded the actigraphy data from the child. A research assistant contacted the primary caregiver by phone to inform the caregiver of the child's sleep schedule for the following week, either instructing the caregiver to adhere to the child's typical sleep schedule or to administer a modified bedtime.

During week two of the study (typically Monday through Friday), the experimenter met with the child at the child's preschool for about 30 minutes for up to five days, typically in the morning. Ideally, a minimum of three sessions would be completed, which would allow for instances for when a child misses school.

On the first day of week two of the study (typically on a Monday), the experimenter administered the Child Attention Network Test (please refer to Appendix A for a description of the pre-test and post-test measures). It should be noted that the Child Attention Network Test was administered on a different day than the pre-test assessment due to the amount of time it takes for a child to complete the Child Attention Network Test. Therefore, the pre-test assessment was administered before the weekend and the Child Attention Network Test was administered after the weekend on the same day the training began. This was considered appropriate given that the training games administered on the first day took between 10 to 15 minutes to complete, providing an adequate amount of time to administer and complete the Child Attention Network Test and the first two training games on the first day of training. It was crucial that the length of each session was within the child's ability, no more than 30 minutes, thereby following the methods of Rueda et al. (2005) and direct advice provided by M. Posner (email, January 26, 2010). The Child Attention Network Test was especially important for this study because Rueda et al. (2005) used it with the same attention training program and found significant main effects and improvements for reaction time, the number of errors, and conflicts after five days of attention training. Children in this study would ideally also had experienced five days of attention training.

Other executive function pre-test/post-test assessments were chosen in addition to those assessing attention (from the Child Attention Network Test). Such assessments evaluated inhibition (Day/Night and Simon Says), cognitive flexibility (Standard Dimensional Change Card Sort and Flexible Item Selection Task), and working memory (Word Span, Digit Span, and Backwards Digit Span). According to Carlson (2005), four-year-old children demonstrate a growth in performance for the Day/Night task and the Standard Dimensional Change Card Sort task and by age five children typically demonstrate success with these tasks (Jacques & Zelazo, 2001). The Simon Say task and Flexible Item Selection Task, meanwhile, are primarily used to assess growth in performance for five-year-old children. Therefore, the Day/Night and Standard

Dimensional Change Card Sort tasks were included to measure inhibition and cognitive flexibility for four-year-old children, while the Simon Says task and the Flexible Item Selection Task were included to measure these executive function skills among five-year-old children even though four-year-olds are typically unable to perform these tasks. Administration for the three working memory tasks (Word Span, Digit Span, and Backwards Digit Span) was dependent on the child's ongoing performance, as specified by Thorell and Wahlstedt (2006) and Wechsler (2003).

The children also participated in the computerized attention training program (Rueda et al., 2005) for three to five sessions at their preschool, in which the child received up to 105 minutes of training. The attention training program was originally adapted from NASA studies used to train monkeys for work in outer space (Rumbaugh & Washburn, 1995). A detailed manual, the Attention Assessment Manual, describes each game administered during these sessions. Completion of the attention training program occurred over the course of the week at the child's preschool. Because some children do not take naps, it was possible for those children to complete the computerized training during their preschool naptime.

Each day, the experimenter administered games from the attention training program to the child, picking up where the child previously left off. Eight different tasks (games) were administered on a rotating schedule. Each game took from approximately five to 25 minutes to complete, and the child played one or two games during each session. Each game consisted of a series of levels of increasing difficulty. Most of the games have seven levels, except for Numbers (Game 10), and Stroop (Game 11), which each have six levels. To advance to the next level in a game, the child completed a certain number of trials (in most games, this consisted of three trials) correctly in a row within the level. When the child successfully completed three trials in a row, the game automatically progressed to the next level. For example, completing three Level 2 trials in a row advanced the child to Level 3. If the child made an error, the number of successful trials completed in a row reset to zero. The levels attained by the child on each game for each day was recorded electronically with the computer program as well as on the child's protocol.

A child's progress was measured by the proportion of the number of trials it took the child to complete each game and the minimum number of trials required to complete the game (i.e., the number of trials it took the child to complete the game if no mistakes were made). Therefore, a child who completed a game with no mistakes would have a ratio of 1:1 or 1, and a child who had more difficulty completing a game would have a larger ratio.

A maximum of four training days was allowed in which children averaged 3.15 training days. A total of eight games were available to play; however none of the children had the opportunity to play the last game. Descriptive data for the attention training are presented in Table 3. Descriptive data for each game are presented in Table 4.

On the evening of the first day the child participated in the attention training program (typically on a Monday), the research assistant contacted the caregivers by phone to remind them of the child's new sleep schedule. The research assistant was also available to answer any questions and address any concerns the caregivers might have had. On the nights following each training session, the child either slept at his/her normal bedtime (control group), or was restricted up to one hour of sleep and went to bed up to one hour later (modified sleep group), all dependent on the group the child was randomly assigned to. It was possible for the child to, instead, wake up one hour earlier the following morning and still be in the sleep restricted group depending on caregiver preference; however, all caregivers were encouraged to have their child go to bed later rather than get up earlier. On the evening of the day before the final day the child

Table 3

Descriptive Data for Attention Training

	No. (%)
Number of Training Days	
2	9 (27.3%)
3	10 (30.3%)
4	14 (42.4%)
Number of Games Played	
3	1 (3.0%)
4	8 (24.2%)
5	9 (27.3%)
6	7 (21.2%)
7	8 (24.2%)
Number of Games Completed	
3	1 (3.0%)
4	8 (24.2%)
5	9 (27.3%)
6	11 (33.3%)
7	4 (12.1%)

Table 4

Descriptive Data for Attention Training Games

Games	*N*	Range	Mean
1st Game	33	.725-1.000	.908
2nd Game	33	.893-1.000	.990
3rd Game	33	.848-1.000	.974
4th Game	32	.897-1.000	.988
5th Game	24	.610-1.000	.889
6th Game	15	.660-.957	.815
7th Game	4	.881-.971	.937
8th Game	0	N/A	N/A

participated in the attention training program (typically on a Thursday), the research assistant contacted the caregivers by phone to remind the caregivers to return the packet of questionnaires and the child's sleep diary to the child's preschool the following day (to be returned typically on a Friday).

On the final day of the assessment (about two weeks after the first day of the assessment and typically on a Friday) the experimenter administered the final day of the attention training program on the computer. The experimenter, as a post-test, re-administered the eight tests used in the pre-test (Day/Night, Standard Dimensional Change Card Sort, Simon Says, Flexible Item Selection Task, Word Span, Digit Span, Backwards Digit Span, and Child Attention Network Test) to the child. Lastly, the experimenter collected the packet of questionnaires, the child's sleep diary (both the one that was completed by the caregiver and by the preschool), and the actigraph from the child and the child's preschool.

The entire research protocol was two weeks long, which included a week of baseline sleep data prior to the children using the actual computer training program. Embedded in the protocol were extra days in case the child missed school (please refer to Appendix H for a sample schedule).

Measures

Parent questionnaire packet. A total of 32 of the 33 caregivers completed the Children's Behavior Questionnaire (CBQ). The CBQ is 94-item questionnaire with responses from 1 (*extremely untrue*) to 7 (*extremely true*) designed to assess temperament in children 3 to 8 years of age. The 94-items can be placed in three broad factors: Extraversion and Surgency, Negative Affectivity, and Effortful Control. The Extraversion and Surgency factor is characterized by the Activity Level, Approach/Positive Anticipation, High Intensity Pleasure, Impulsivity, Shyness (negative), and Smiling and Laughter scales. Activity Level refers to moving actively and being full of energy. Approach/Positive Anticipation is defined by being easily excited and enthusiastic. High Intensity Pleasure is defined by enjoying adventurous activities and playing recklessly. Impulsivity is characteristic of acting without thinking. Nonshyness is described for the child as not being nervous around new and familiar people and situations. Smiling and Laughter are positive emotional response engaged in while alone or with others. The Negative Affectivity factor is characterized by the Anger/Frustration, Discomfort, Falling Reactivity/Soothability, Fear, and Sadness scales. Anger/Frustration refers to getting easily upset and irritated, sometimes leading to tantrums. Discomfort is defined by being easily bothered, uncomfortable, or upset. Low levels of Falling Reactivity/Soothability are characterized by becoming easily upset and difficult to soothe. Fear refers to being afraid of realistic and unrealistic occurrences, specifically burglars, “boogie man,” loud noises, the dark, fire, and monsters from television and/or film. Sadness is identified as getting easily upset and crying. The Effortful Control factor is characterized by the Attentional Focusing, Inhibitory Control, Low Intensity Pleasure, and Perceptual Sensitivity scales. Attentional Focusing refers to the ability to concentrate on a task without being easily distracted. Inhibitory Control is defined by being cautious and prepared, and as good at waiting and following directions. Low Intensity Pleasure is identified as enjoying the activities of snuggling, reading, singing, and talking. Perceptual Sensitivity is characteristic of being attuned to detail and noticing changes in the environment.

A total of 32 of the 33 caregivers completed the Eyberg Child Behavior Inventory (ECBI). The ECBI is a parent rating scale with 36 statements designed to assess child behavior problems. The Intensity scale measures the frequency of each problem behavior from 1 (*never*) to 7 (*always*). The Problem scale reflects the caregiver’s tolerance of the behavior and the distress caused (*yes* or *no*). The ECBI is intended to assess both the type of behavior problems and the degree to which the parent finds them problematic.

A total of 32 of the 33 caregivers completed the Children's Sleep Habits Questionnaire (CSHQ). Of the 32 questionnaires that were returned, 10 caregivers did not complete the full questionnaire (i.e., skipped some items). Therefore, the remaining 22 questionnaires were standardized and analyzed.

The CSHQ is a 33-item questionnaire with responses to items pertaining to the child's sleep habits and possible difficulties with sleep, rated from 1 (*rarely = 0 to 1 times a week*) to 3 (*usually = 5 to 7 times a week*) as well as several extra items designed to screen for common sleep problems in children. In addition, the caregivers were to consider each statement and determine if it is a problem for them. Further data regarding sleep times and amount were also obtained on the CSHQ. There were also four activities (playing alone, watching television, riding in a car, and eating meals) that caregivers were to analyze with respect to how sleepy the child was during the activity from 1 (*not sleepy*) to 3 (*falls asleep*). The CSHQ evaluateed the child's total sleep disturbance within eight different subscales: Bedtime Resistance, Sleep-Onset Delay, Sleep Duration, Sleep Anxiety, Night Wakings, Parasomnias, Sleep-Disordered Breathing, and Daytime Sleepiness. Bedtime Resistance refers to struggling at bedtime, such as demanding sleep with others possibly due to fear. Sleep-Onset Delay is defined by falling asleep after 20 minutes of being put to bed. Sleep Duration is identified as sleeping too little. Sleep Anxiety is classified as being fearful of going to sleep. Night Wakings describes children who are awake at night and may move to sleep elsewhere. Parasomnias are characterized by difficulties, including bedwetting, sleep-talking, sleepwalking, grinding teeth, and easily alarmed and awakes screaming or sweating. Sleep-Disordered Breathing includes sleep problems such as snoring, snorting, gasping, and stopping breathing. Daytime Sleepiness portrays difficulty in waking, woken up by others, being tired, and falling asleep easily.

Kaufman Brief Intelligence Test. All 33 children completed the Kaufman Brief Intelligence Test (KBIT), a cognitive assessment, approximately one week after the start of the study. The KBIT was administered by one of two trained examiners, both of whom were upper graduate level school psychology students (fourth and fifth year doctoral students) who administered various cognitive assessments throughout their graduate training.

The KBIT provides an overall measure of cognitive ability as well as subtest and composite scores that represent intellectual functioning and skills in the cognitive domains of verbal (Vocabulary subtest) and nonverbal (Matrices subtest) skills. Composite and subtest scores are reported as standard scores with a mean of 100, standard deviation of 15, and average range of 90-110. Reliability and concurrent validity estimates appear satisfactory (Hildman, Friedberg, & Wright, 1993). Kaufman and Wang (1992) found that ethnic differences on the KBIT are generally consistent with data from other intelligence tests.

Overall scores are representative of the general population. *T*-test analysis indicated no differences between genders. Descriptive statistics for the Kaufman Brief Intelligence Test are presented in Table 5.

Pre-test and post-test tasks of executive functioning. The pre-test tasks were the same as the post-test tasks. These tasks were designed to assess inhibition, cognitive flexibility, working memory, and attention. As preschoolers get older, their executive function abilities grow. It is believed that the first five years of life play a critical role in the development of executive functions (Garon, Bryson, & Smith, 2008). To account for the differences in ages for the children in this study (e.g., participants were between the ages of 46-months to 68-months of age), two

Table 5

Descriptive Data for Subscales and Composite Score on the Kauffman Brief Intelligence Test

Scale	*N*	Range	Mean	SD
Verbal (Vocabulary)	33	87-124	101.12	10.56
Nonverbal (Matrices)	33	71-124	98.94	12.55
Composite	33	84-122	100.09	10.55

tasks each were administered for the areas of inhibition and cognitive flexibility, in which one task was designed for 4-year-olds and the other task was designed for 5-year-olds. Three tasks were used to assess working memory, all of which were considered suitable for the ages of the children in this study (Thorell & Wahlstedt, 2006; Wechsler, 2003). Each item within a task increases with difficulty until the child will reaches a ceiling point. The Child Attention Network Task was designed for children as young as four (Rueda et al., 2004; Rueda et al., 2005) and thus was the only task used to assess attention. Please refer to Appendix G for description of the pre-test and post-test measures.

Both the Day/Night task (designed to assess 4-year-olds) and the Simon Says task (designed to assess 5-year-olds) were used in this study to assess inhibition.

The Standard Dimensional Change Card Sort task was designed to assess 4-year-olds and the Flexible Item Selection Task was designed to assess 5-year-olds in the area of cognitive flexibility.

Three tasks were used to assess working memory: Word Span, Digit Span, and Backwards Digit Span. Thorell and Wahlstedt (2006) used Word Span to assess working memory in children ages 48-74-months old. Digit Span and Backwards Digit Span are commonly used in cognitive measures (Wechsler, 2003) typically designed to assess working memory in children as young as 6-years-old. Given that the Word Span task is typically administered to children younger than those who complete the Digit Span and Backwards Digit Span task, it was believed that preschoolers would perform better on the Word Span task than on the Digit Span or Backwards Digit Span tasks. Additionally, children tend to remember and recall things easier and better when there is an association (Daehler, Horowitz, Wynns, & Flavell, 1969; Saywitz, Geiselman, & Bornstein, 1992), which is similar to that with the Word

Span Task. The Backwards Digit Span task is considered to be more challenging than the Digit Span task as it requires more complex processes including transformations and visual image processing (Reynolds, 1997).

The Child Attention Network Task was used to assess attention in this study. Two variables were used for analysis at both pre-test and post-test: mean reaction time for correct trials and mean accuracy.

Sleep intervention and measures. In order to assign children into their respective sleep groups, a preliminary analysis of baseline sleep data was required. Children were assigned to one of two groups: control group or sleep modified group. Of the 33 children in the study, 17 were assigned in the control group (10 girls, 7 boys) and 16 were assigned in the sleep modified group (9 girls, 7 boys). Six children (3 girls, 3 boys) were placed into the control for reasons including: the child already had a very late bedtime of 11:00 pm (n = 1); the caregiver did not complete the sleep diary for baseline sleep data collection (n = 2); non-compliance with actigraph procedures (n = 1); preliminary analysis indicated average amount of sleep per sleep diary was less than 10 hours (however later analysis via actigraphy data indicated that sleep was okay as the child slept for a daily average of 10 hours, 41 minutes (n = 1)); and baseline data being invalid due to the family being on vacation for part of the time causing the child's bedtime, wake time, and naptime to differ from normal (n = 1).

There exists a discrepancy for the child whose sleep diary data reported less than 10 hours and whose actigraphy data reported 10 hours, 41 minutes, as sleep diary data typically reports more sleep than actigraphy data. This discrepancy is due to the fact that actigraphy data from the first day included an afternoon nap which was not included in the sleep diary, as caregivers were instructed to start collecting sleep diary data beginning at bedtime on the first day. Additionally, the last night of actigraphy data was invalid due to the child not wearing it at night and it was on the last night that, per parent diary, the child slept the least amount, an average of 51 minutes less. It should be noted that per methodology and the study's design, caregivers, if they were placed in the sleep modified group, were given the choice of either delaying their child's bedtime or waking their child up earlier. All caregivers in this study opted to delay bedtime rather than participate in a modified wake schedule.

Sleep data for children in the sleep modified group provided additional information. A total of 16 children were randomly assigned to the sleep modified group. These children experienced no more than 4 days of their modified bedtime (range: 1-4, $M = 3.56$, $SD = .89$). Additionally, per protocol, children's instructed modified bedtimes were no more than one hour ($M = 50.17$ minutes) later than their baseline average as determined by the prior week of baseline data. Caregivers were informed of modified bedtimes that may vary up to an hour past typical bedtime during the phone screening (see Appendix A). Sleep restriction was aimed at restricting sleep one hour; however, if the child was sleeping less than 10.5 hours a day, restriction would only occur to the point where the child would receive no less than 9.5 hours a day as that would place the child below the 25th percentile (National Sleep Foundation, 2004).

Compliance with sleep restriction methodology per sleep diary data. Sleep diary data were provided by each child's caregiver. According to Sadeh (1996), caregivers accurately report schedule related measures (e.g., sleep onset time, sleep duration) in the child's sleep diary. Caregiver provided reports of the child's sleep patterns via sleep diaries over the entirety of the study. During the phone screen, caregivers were informed that if they child was randomly placed in the sleep modified group, they may be asked to delay their child's bedtime up to at most 1 hour and were given a specified amount of time to delay the child's time to bed. Of the 16 children in the sleep modified group, nine children were in full compliance with the new bedtime, four were in compliance for at least 50% of the nights, two were not in compliance for at least 50% of the nights, and one did not return a sleep diary. See Table 6 for the targeted times in bed.

According to sleep diary data, children in the sleep modified group went to bed significantly later than children in the control group during training [t (15) = -6.20, $p < .01$]. Children woke up, on average, at 7:17 during baseline and at 7:22 during training [t (29) = -1.42, p = n.s.]. Children in the sleep modified group woke up, on average, at 7:03 during baseline and at 7:10 during training [t (15) = -1.27, p = n.s.] and children in the control group woke up, on average, at 7:30 during baseline and at 7:36 during training [t (13) = -.84, p = n.s.]. Additionally there were no significant differences between the children in both groups (e.g., control group verses sleep modified group) at baseline or during training for wake times. See Table 7 for sleep diary summary data.

Actigraphy provides continuous motion data using a wristwatch-size microprocessor that senses motion with a piezo-electric beam accelerometer. Mini motionlogger actigraphs (Ambulatory Monitoring, Inc., Ardsley, NY, USA) were set for 1 min epochs and zero-crossing mode. Activity counts range from 0 to 280 each minute, when programmed for sleep analyses (Acebo et al., 1999, 2005). Activity counts were analyzed using the autoscoring program for sleep available in Action4 software (Ambulatory Monitoring, Inc., Ardsley, NY, USA) that yields sleep parameters using Sadeh's algorithm validated for children in this age group (Acebo et al., 1999; Sadeh, Sharkey, & Carskadon, 1994; Tikotsky & Sadeh, 2001). At the end of each week, the actigraphs were downloaded and checked against the sleep diaries.

Table 6

Targeted Times in Bed

Baseline Bedtime	Restriction Amount (in minutes)	Actual Training Average Bedtime
20:30	45	20:59
20:30	45	21:31
21:45	30	22:19
22:00	45	22:29
21:30	60	22:02
21:00	60	22:10
21:00	60	missing (actigraph malfunction)
20:30	60	21:21
20:45	60	21:37
21:45	45	23:04
21:45	45	23:02
20:00	60	21:13
20:00	60	20:58
21:00	60	21:28
20:30	45	21:19
21:15	60	22:18

Table 7

Sleep Diary Summary Data

	Baseline	Training
Bedtime		
All Children	21:26	21:46
Control Group	21:40	21:44
Sleep Modified Group	21:12	21:47
Waketime		
All Children	7:17	7:22
Control Group	7:30	7:36
Sleep Modified Group	7:03	7:10

Baseline data were obtained for 30 of the 33 children. For two girls, baseline data were missing as a result of actigraph malfunction. Baseline data were missing for another girl because her actigraph was taken off in the evenings and put back on during the day. Data obtained from the remaining children provided baseline actigraphy data for two to 11 days ($M = 5.4$, $SD = 1.55$) and three to 12 nights ($M = 6.40$, $SD = 1.55$).

Training sleep data were obtained for 28 of the 33 children. Of the five children missing training sleep data, three (2 girls, 1 boys) were unrecorded as a result of actigraph malfunction. Another boy had missing data as a result of a lost actigraph. Similar to baseline actigraphy data, training sleep data were missing for the same girl who had her actigraph removed in the evenings and placed back on during the day. Data obtained from the remaining children provided training sleep data via actigraphy for up to 12 days ($M = 5.0$, $SD = 2.7$) and up to 13 nights ($M = 6.0$, $SD = 2.7$). One boy who provided data for zero days and one night during the training week had much difficulty wearing his actigraph and refused to wear it; he was willing and able to wear it during his baseline week. Data excluding this boy ($n = 27$) resulted in actigraphy training sleep data for two to 12 days ($M = 5.22$, $SD = 2.5$) and three to 13 nights ($M = 6.2$, $SD = 2.5$).

Actigraphy data were scored according Sadeh's sleep algorithm. It is considered appropriate for younger populations because it was developed using subjects ranging from 10 to 25 years of age (Sadeh, Sharkey, & Carskadon, 1994). Although the study's population included children younger than the targeted population for the Sadeh sleep algorithm, use of the Sadeh sleep algorithm for younger children, including preschoolers and toddlers, has been validated (Acebo, Sadeh, Seifer, Tzischinsky, Hafer & Carskadon, 2005; de Souza, Benedito-Silva, Pires, Poyares, Tufik, & Calil, 2003; Sadeh, Acebo, Seifer, & Carskadon, 1995; Sadeh, Lavie, Scher, Tirosh, & Epstein, 1991; Tikotzky & Sadeh, 2001) and is used in many other studies (Galland, Kennedy, Mitchell, & Taylor, 2012; Lam, Mahone, Mason, & Scharf; 2011; Souders, Mason, Valladares, Bucan, Levy, Mandell, Weaver, & Pinto-Martin, 2009).

Nighttime actigraphy data were analyzed using three different measures: average time the child went to bed, average number of minutes the child was in bed each night, and average number of minutes between actually falling sleep at night and waking up in the morning. Naptime actigraphy data were analyzed using two different measures: average number of minutes the child went down for a nap, and the average number of true nap minutes for each nap. Naptime data were only analyzed for children who took naps.

Compliance with sleep restriction methodology per sleep actigraphy data. From baseline to training, children in the sleep modified group went to bed significantly later [t (13) = -3.16, p < .01], were in bed significantly less [t (13) = 4.00, p < .01], and slept less at night [t (13) = 1.80, p = .095]. These children woke up at the same time during baseline and training [t (13) = 1.01, p = n.s.], had the same number of naps [t (12) = -1.11, p = n.s.], had the same naptime length [t (12) = -1.47, p = n.s.], and slept the same amount during naptime [t (12) = -1.26, p = n.s.]. This demonstrates that caregivers of children in the sleep modified group, on average, were consistent in following through with their modified sleep schedule. There were no significant differences from baseline to training for children in the control group with respect to bedtime, bedtime duration, true nighttime sleep amount, waketime, number of naps, naptime duration, and true naptime sleep amount. This indicates that there was appropriate follow-through at home and at preschool, ensuring that the children in the sleep modified group were not given the opportunity to “catch-up” on lost sleep at night with an extended sleep opportunity.

For children in the control group, there were no gender differences between boys and girls for any of the actigraphy sleep measures at baseline and at training. Similarly, for children in the sleep modified group, there were no gender differences for any of the actigraphy sleep measures at baseline and at training.

Average bedtime indicated that at baseline the children in the sleep modified group went to bed 40 minutes earlier than the control group [t (28) = 3.00, $p < .01$]. It is unclear why this difference exists as the groups were semi-randomly assigned and did not demonstrate any significant differences in age which may have contributed to the sleep modified group going to bed much earlier than the control group. See Table 8 for sleep actigraphy summary data.

Sleep data demonstrated some correlations with child's age, where correlations are denoted as *r*. As preschoolers get older, the amount they sleep, on average, at night decreases at baseline [r (28) = -.47, $p < .01$] and at training [r (26) = -.51, $p < .01$]; and the total amount they truly sleep (including both nighttime sleep and naptime) decreases with age at baseline [r (27) = -.53, $p < .01$] and at training [r (25) = -.60, $p < .01$]. There was also a trend-level correlation indicating that as preschoolers get older, their average bedtime is later at training [r (26) = .34, p = .080].

Table 8

Sleep Actigraphy Summary Data

	Baseline	Training
Bedtime		
All Children	21:41	21:50
Control Group	22:01	21:50
Sleep Modified Group	22:21	21:51
Bedtime Duration (in minutes)		
All Children	585	569
Control Group	575	579
Sleep Modified Group	596	559
True Nighttime Sleep Amount (in minutes)		
All Children	525	520
Control Group	520	524
Sleep Modified Group	531	517
Waketime		
All Children	7:28	7:03
Control Group	7:38	7:29
Sleep Modified Group	7:18	6:40
Naptime Duration (number of naps; length in minutes)		
All Children	3.97; 112	4.39; 115
Control Group	4.20; 115	4.00; 113
Sleep Modified Group	3.73; 110	4.79; 116
True Naptime Sleep Amount (length in minutes)		
All Children	75	78
Control Group	77	77
Sleep Modified Group	73	79

Chapter IV

Results

Question 1

Does an acute sleep restriction affect the training of a preschooler's attention abilities? The attention training program followed a similar design as that used by Rueda, Rothbart, McCandliss, Saccomanno, and Posner (2005). Only one referreed published sleep restriction study, to date, has been documented for the preschool population.

There were no major significant differences on training performance between the control group and the sleep modified group. Sleep modification did not begin until the evening after completing training session one. Therefore, a difference between the control group and sleep modified group for the first two training games (which, for all children, was played during training session one) was not anticipated. As predicted, an independent samples *t*-test indicated no significant difference between the control group and sleep modified group for the first two training games. Within each group, both the control and the sleep modified groups demonstrated that the second game was significantly easier than the first game [t (14) = -4.58, $p > .01$ and t (13) = -3.79, $p < .01$, respectively]. There were no significant training differences within each group between the third and fourth game. The only significant difference occurred within the sleep modified group, which demonstrated significantly poorer performance on the sixth game compared to the fifth game [t (6) = 3.66, $p < .01$]. Both the control group and the sleep modified group demonstrated a 50 percent ($n = 4$ and $n = 4$, respectively) completion rate on the seventh game. A paired samples *t*-test did not indicate a significant difference in performance for the children who completed the seventh game between the control group and the sleep modified group. Overall, these findings indicated no significant training differences between children in the control group and children in the sleep modified group.

Question 2

Do the trained attention skills generalize to attention performance and to other executive function skills, namely inhibition, cognitive flexibility, and working memory, and are there differences between the sleep modified and control groups? No published studies to date have tested whether the training of attention skills also extend to changes in other executive function skills.

Attention performance. Overall findings indicated that children in the sleep modified group demonstrated significant improvements in attention (both in terms of mean accuracy and mean reaction time) from pre-test to post-test compared to children in the control group, who did not show any significant changes from pre-test to post-test. Descriptive data are presented in Table 6. A paired samples *t*-test identified significant improvements for all children from pre-test to post-test for the mean reaction time for correct trials on the Child Attention Network Task [t (26) = 3.01, $p < .01$]. Children in the sleep modified group demonstrated improvements on the Child Attention Network Task mean reaction time [t (15) = 3.54, $p < .01$] and Child Attention Network Task mean accuracy [t (15) = -2.82, $p < .05$] from pre-test to post-test.

Generalization of attention skills to other executive function skills. Results were calculated to determine the proportion correct for both pre-test and post-test for the following tasks: Day/Night, Standard Dimensional Change Card Sort, Simon Says, and Flexible Item Selection Task. For Word Span, Digit Span, and Backwards Digit Span, preliminary analyses were conducted comparing the number achieved (e.g., total score) for each task. Descriptive data for each measure, both pre-test and post-test, are presented in Table 9.

Table 9

Descriptive Data for Pre-test and Post-test Measures

	n		Range		Mean	
Measures	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Day/Night	33	33	1-14	0-14	9.12	11.45
Standard Dimensional Change Card Sort	33	32	7-12	6-12	10.33	10.84
Simon Says	33	32	10-18	10-19	11.14	11.50
Flexible Item Selection Task	33	32	14-30	19-30	22.36	24.44
Word Span	33	32	0-6	2-7	3.97	4.50
Digit Span	33	32	0-6	2-8	4.06	4.62
Backwards Digit Span	16	21	0-6	0-6	2.88	2.76
Child Attention Network Test						
Mean Reaction Time for Correct Trials	28	31	670-1465	835-1308	1140.11	1084.16
Mean Accuracy	33	33	37-96	16-97	69.33	72.00

Children in the sleep modified group showed more improvements from pre-test to post-test than those in the control group. A paired samples *t*-test identified significant improvements from pre-test to post-test measures for all children on the following tasks: Day/Night [$t\ (32) = -2.93$, $p < .01$], Flexible Item Selection Task [$t\ (31) = -2.74$, $p < .01$], Word Span [$t\ (31) = -2.09$, $p < .05$], and Digit Span [$t\ (31) = -2.75$, $p < .05$]. Children in the control group demonstrated significant improvement from pre-test to post-test on the Flexible Item Selection Task [$t\ (15) = -2.41$, $p < .05$]. Children in the sleep modified group improved on more measures from pre-test to post-test; they showed significant improvements on Day/Night [$t\ (15) = -3.33$, $p < .01$], Flexible Item Selection Task [$t\ (15) = -2.65$, $p < .05$], and Digit Span [$t\ (15) = -2.18$, $p < .05$]. Performance data for each group on each measure at pre-test and post-test, are presented in Table 10.

Additional analysis did not indicate any significant differences between amount of training (which included the number of days trained, number of games played, and number of games completed) with the degree of pre-test to post-test improvement for all children. Further analysis also indicated no differences when children were divided into their respective groups (e.g., control versus sleep modified group). Trend-level correlations were found for children in the control group: amount of training with performance on the Standard Dimensional Change Card Sort task [$r\ (17) = .41$, $p = .104$] (i.e., children with more training had better cognitive flexibility), performance on the Simon Says task [$r\ (17) = .45$, $p = .073$] (i.e., children with more training had better inhibition), and performance on the Word Span task [$r\ (17) = .44$, $p = .076$] (i.e., children with more training had better working memory). Similarly, trend-level correlations were found for children in the sleep modified group: amount of training with performance on the Simon Says task [$r\ (16) = -.42$, $p = .107$] (i.e., sleep modified children with more training had

Table 10

Performance Data for Each Group at Pre-test and Post-test

	Control Group		Sleep Modified Group	
Measures	Pre-test	Post-test	Pre-test	Post-test
Day/Night	9.41	10.76	8.81	12.19
Standard Dimensional Change Card Sort	9.82	10.06	10.88	11.63
Simon Says	10.35	10.31	11.98	12.69
Flexible Item Selection Task	22.53	24.38	22.19	24.50
Word Span	3.53	4.00	4.44	5.00
Digit Span	3.59	4.13	4.56	5.13
Backwards Digit Span	2.83	3.25	2.90	2.46
Child Attention Network Test				
Mean Reaction Time for Correct Trials (ms)	1144	1125	1137	1046
Mean Accuracy (percent)	65.0	63.9	73.9	80.6

worse inhibition abilities), and the Flexible Item Selection Task [r (16) = -.51, $p < .05$] (i.e., sleep modified children with more training had worse cognitive flexibility abilities).

Question 3

Are there child gender and age differences in behavior and sleep habits and do such differences exist between groups? Past studies (Blair, Denham, Kochanoff, & Whipple, 2004; Carr, Lemanek, and Armstrong, 1998; and Bournaki, 1997; Buss, Brooker, and Leuty, 2008; Else-Quest, Hyde, Goldsmith, & Van Hulle, 2006; Graves, Blake, & Kim, 2012; Klenberg, Korkman, & Lahti-Nuuttila, 2001; Kochanska, Murray, & Harlan, 2000; Maccoby, 1988; Maccoby & Jacklin, 1974; Raaijmakers, Smidts, Sergeant, Maassen, Posthumus, Van Engeland, & Matthys, 2008) have shown many behavioral differences between boys and girls. Only Owens, Spirito, McGuinn, and Nobile (2000) indicated no gender differences for sleep habits in children and additional studies may be helpful to support this finding.

Behavioral findings. Findings generally indicated significant differences in temperament by gender but no differences by age. Boys' temperaments were seen as lower than girls' on effortful control [t (30) = -2.46, p <.05]. There were no significant gender differences in behavior for the children in the control group. There were, however, significant gender differences for the children in the sleep modified group, as girls demonstrated greater effortful control compared to boys [t (14) = -3.72, $p < .01$]. Older and younger preschoolers did not differ in temperament. Descriptive statistics for each factor and subfactor on the Children's Behavior Questionnaire are presented in Table 11.

Caregivers, on average, reported that problem behaviors infrequently occurred, and that the particular behaviors were not problems for them regardless of gender or age. Additionally, caregivers did not indicate any significant behavioral differences or significant concerns

Table 11

Descriptive Data for Each Factor and Subfactor on the Children's Behavior Questionnaire

Factors	*n*	Range	Mean	SD
Extraversion and Surgency	32	4.06-6.59	4.85	1.02
Activity Level	32	3.00-6.86	4.87	.83
Approach/Positive Anticipation	32	3.83-6.33	5.15	.64
High Intensity Pleasure	32	3.50-6.00	5.01	.70
Impulsivity	32	1.00-7.00	4.26	1.12
Shyness	32	1.17-6.67	4.14	1.23
Smiling and Laughter	32	4.33-7.00	5.93	.72
Negative Affectivity	32	2.45-5.57	4.09	.83
Anger/Frustration	32	1.83-6.67	4.43	1.28
Discomfort	32	2.17-6.83	4.60	1.06
Falling Reactivity/Soothability	32	2.00-6.50	4.75	1.09
Fear	32	2.33-6.00	3.86	1.01
Sadness	32	2.33-5.86	4.30	.99
Effortful Control	32	4.21-6.77	5.42	.57
Attentional Focusing	32	2.00-6.50	4.80	1.13
Inhibitory Control	32	2.83-6.83	4.69	.89
Low Intensity Pleasure	32	4.50-7.00	6.09	.60
Perceptual Sensitivity	32	3.67-7.00	5.57	.79

regarding any behavior problems between genders for each group. Descriptive statistics for each scale on the Eyberg Child Behavior Inventory, including the mean of the statements within each scale, are presented in Table 12.

Sleep habits findings. It is important to note that the normative statistics provided by Owens, Spirito, and McGuinn (2000) are based on a sample consisting of children between the ages of four and ten. Use of this normative statistics for comparison measures is difficult due to younger children suffering from a higher prevalence of sleep difficulties, such as difficulties going to bed and falling asleep, and waking up in the middle of the night or too early in the morning (Goodlin-Jones, Sitnick, Tang, Liu, & Anders, 2008; Sadeh, 2004). Additionally, it is noted that although sleep disordered breathing can be present in younger children, it is less common. (Goodlin-Jones, Sitnick, Tang, Liu, & Anders, 2008). Goodlin-Jones et al. (2008) compiled comparative data for children between the ages of two and five, utilizing analysis that was equivalent to that used by Owens et al. (2000) except for "wets bed" due to this behavior being common for children this age.

On average, caregivers reported their child did not suffer from high sleep disturbance. Although they did not view their child as having difficulty falling asleep, they did endorse that their child resists bedtime. However, caregivers felt that their child slept an appropriate amount at night. They did not indicate that their child had a high level of anxiety when going to sleep. Furthermore, caregivers did not report a high number of night wakings for their child. Caregivers also viewed their child as not experiencing many parasomnias during the night while they slept. Most caregivers did not report sleep disordered breathing for their child. On average, caregivers reported an equal distribution of high and low daytime sleepiness. It is important to note that there are violations for normality in the subscales of Night Waking, Parasomnias, Sleep

Table 12

Descriptive Data for Scales on the Eyberg Child Behavior Inventory

Scale	*N*	Range	Mean	SD
Intensity	32	51-159	104.69	26.08
Mean of Statements	32	1.42-4.42	2.93	.72
Problem	31	0-24	5.23	5.31
Mean of Statements	31	0.00-1.00	.24	.29

Disordered Breathing, and Daytime Sleepiness.

Caregivers did not indicate any significant gender differences on the Total Sleep Disturbance score on the CSHQ. Furthermore, there were no differences between boys and girls on any of the eight subscales on the CSHQ: Bedtime Resistance, Sleep Onset Delay, Sleep Duration, Sleep Anxiety, Night Waking, Parasomnias, Sleep Disordered Breathing, and Daytime Sleepiness.

The CSHQ did not correlate with age (e.g., the Total Sleep Disturbance score). In addition, all eight subscales did not correlate with child's age. Descriptive statistics for each subscale and Total Sleep Disturbance on the Children's Sleep Habits Questionnaire are presented in Table 13, including normative statistics (Owens et al., 2000).

Independent samples *t*-test analysis of the CSHQ indexes for the children in the control group indicated significant differences between genders for daytime sleepiness [t (9) = 2.89, $p < .05$], meaning boys in the control group were more likely to be sleepy during the day, and trend-level differences between genders for night wakings [t (9) = -2.05, $p = .071$] meaning girls in the control group were more likely to wake up in the middle of the night. Children in the sleep modified group demonstrated trend-level differences between genders for sleep anxiety [t (6.139) = 1.81, $p = .119$] meaning boys in the sleep modified group tended to suffer greater sleep anxiety.

Question 4

Are there child gender differences in performance on the attention training on the pre-test and post-test measures? Do such gender differences in performance also exist within groups? Behavioral gender differences have been reported; however, direct evaluations of performance differences with respect to gender have not. The attention training program was designed so that

Table 13

Descriptive Data for Each Subscale on the Children's Sleep Habits Questionnaire

Subscale	*N*	Range	Mean	SD	Owens' Norm Values	Goodlin-Jones et al.'s Values
Bedtime Resistance	22	6-17	9.86	3.48	7.06	9.87
Sleep-Onset Delay	22	1-3	1.55	.74	1.25	1.43
Sleep Duration	22	3-7	4.14	1.21	3.41	3.87
Sleep Anxiety	22	4-10	5.91	2.05	4.89	5.88
Night Wakings	22	3-5	3.82	.85	3.51	4.36
Parasomnias	22	7-13	8.73	1.55	8.11	8.69
Sleep-Disordered Breathing	22	3-5	3.18	.40	3.24	3.36
Daytime Sleepiness	22	8-20	14.32	3.77	9.64	Not Provided
Total Sleep Disturbance	22	34-65	48.32	8.66	38.75	45.98

each subsequent game (and consequently each subsequent training session), would be more difficult than the preceding one.

Attention training. Analysis comparing girls and boys indicated some differences with regard to the game played and the day of training. Overall, girls performed better as indicated by generally achieving a greater proportion correct on the games and being able to complete the game with fewer trials. Detailed information regarding such gender differences are provided in Appendix I.

Pre-test / Post-test measures. Gender comparisons indicated no significant differences between boys and girls for both pre-test and post-test measures. However, there was a trend-level difference on the post-test measures of Day/Night [t (18.495) = -1.85, p = .080], in which girls achieved a greater proportion correct [p = 0.89] compared to boys [p = 0.72], and a trend-level difference on the post-test mean accuracy measure of the Child Attention Network Task [t (31) = -1.801, p = .081], as girls achieved 76.74% correct compared to boys who achieved 65.57% correct.

At pre-test, children in the control group demonstrated a trend-level gender difference on the Child Attention Network Task (mean reaction time) [t (10) = -2.20, p = .052] meaning boys in the control group were faster. There were no significant gender differences for the children in the control group with respect to post-test measures.

At post-test, children in the sleep modified group demonstrated a significant gender difference for the Day/Night task [t (14) = -2.27, $p < .05$] meaning girls in the sleep modified group performed better. There was a significant gender difference for children in the sleep modified group with regard to the Child Attention Network Task (mean accuracy) [t (14) = -3.14, $p < .01$] meaning girls in the sleep modified group were more accurate.

Girls in the control group performed significantly better than boys in the control group with respect to the seventh game [t (9) = -4.89, $p < .01$] and demonstrated a trend-level greater performance than boys on the sixth game [t (4) = -2.15, $p = .098$]. Boys in the sleep modified group demonstrated a trend-level greater performance than girls on the second game [t (8) = 1.73, $p = .122$].

Question 5

Are age differences observed from pre-test to post-test and with respect to the attention training? Executive function skills are rapidly developing during the preschool years, and it is highly possible that an age difference of about 24 months may illustrate differences in performance.

Attention training. None of the individual training games correlated with age.

Pre-test / post-test measures. Several pre-test and post-test measures correlated with age. At pre-test, older preschoolers, compared to younger preschoolers, demonstrated higher levels of cognitive flexibility as indicated on the Standard Dimensional Change Card Sort task [r (31) = .43, $p < .05$]; greater levels of inhibition as indicated on the Simon Says task [r (31) = .55, $p < .05$]; greater working memory abilities as indicated on the Digit Span task [r (31) = .37, $p < .05$]; and heightened levels of mean accuracy as indicated on the Child Attention Network Task [r (31) = .38, $p < .05$]. At post-test, older preschoolers continued to demonstrate higher levels of inhibition as indicated on the Simon Says task [r (30) = .43, $p < .05$].

Chapter V

Discussion

Pre-test and Post-test Group Differences

Children in both the sleep modified and control groups improved in performance from pre-test to post-test.

Inhibition. Children in the sleep modified group exhibited significant improvements in inhibition from pre-test to post-test that were not evident for children in the control group. As expected, inhibition improved from pre-test to post-test on the task that was designed for 4-year-olds (the Day/Night task). It should be noted that the first task in all executive function tasks that were administered was the Day/Night task. It is possible that improvements observed in the Day/Night task may be due to improved rapport between the child and the examiner; however, if this were to be so, then we would expect to also see improvements in the task for children in the control group, which we did not. Furthermore, at pre-test, there were no significant performance differences between children in the control group and children in the sleep modified group. No significant differences were found for the inhibition task designed for 5-year-olds. It appears that children either had difficulty with inhibition for this task or they understood it and were successful. These abilities were consistent from pre-test to post-test, thus indicating no differences in inhibition abilities about one week later. Therefore it is concluded that children in the sleep modified group demonstrated improvements in inhibition.

Cognitive flexibility. Children in both the control group and the sleep modified group demonstrated a significant overall improvement in cognitive flexibility. Although children were administered two different cognitive flexibility tasks (one designed for 4-year-olds and one designed for 5-year-olds), children in both groups showed significant improvement only on the cognitive flexibility task that was designed for 5-year-olds. All children performed well on the cognitive flexibility task designed for 4-year-olds and therefore improvements could not be demonstrated because they initially already did well reaching the ceiling point when they completed the pre-test measure. It should be noted that improvements on the Flexible Item Selection Task, the cognitive flexibility task designed for 5-year-olds, were only seen with the second selection and the total score. This is likely due to the fact that all children performed well with the first selection at pre-test and therefore only limited improvements could be made. Because the total score is based on the sum of the first selection and the second selection, improvements that were observed with the selection would also be reflected in the scores on the total selection. The Flexible Item Selection Task is the most difficult task for assessing cognitive flexibility in this study, and furthermore the second selection is considered to be more challenging than the first selection. Therefore it is concluded that overall cognitive flexibility improved from pre-test to post-test.

Working memory. General findings indicated that the Word Span task was actually slightly more challenging for preschoolers than the Digit Span task. Dempster (1981), Gates and Taylor (1925), and Hurlock and Newmark (1931) all found that 5-year-olds perform slightly better on Digit Span tasks compared to Word Span tasks. As expected, the Backwards Digit Span task was the hardest for preschoolers. In fact, not all preschoolers were able to understand the task as demonstrated during the sample items and thus the test items were not administered. All preschoolers were able to complete both the Word Span task and the Digit Span task at pre-test and at post-test, indicating that preschoolers may have demonstrated an improvement in working memory. Additionally, the number of preschoolers who were able to complete the Backwards

Digit Span task increased indicating that more preschoolers were able to understand the task from pre-test to post-test; however, no significant improvement were demonstrated.

Improvements in working memory were also noted for children in the sleep modified group from pre-test to post-test. These children displayed significant improvements in their Digit Span scores; however, it should be noted that at pre-test, children in the sleep modified group performed significantly better on this task compared to children in the control group. Despite already performing better at this working memory task at pre-test, children in the sleep modified group were able to significantly improve their scores by post-test. Significant improvements in task scores indicate improved working memory abilities. The other two working memory tasks (e.g., Word Span and Backwards Digit Span) did not show any significant improvements from pre-test to post-test. With regard to the Backwards Digit Span task, all children struggled with this task. In fact, only about half the children were able to complete the practice items and of those children, only 75 percent were able to successfully complete one test item. By post-test, five additional children were able to successfully complete the practice items. In general, the Backwards Digit Span task is considered to be harder than the Digit Span task (Gardner, 1981; Beauchamp, Samuels, & Griffore, 1979; Daus & Pratt, 1995; Hurlock & Newmark, 1931; Lee, Lu, & Ko, 2007; Reynolds, 1997; Rosenthal, Riccio, Gsanger, & Jarratt, 2006) and it is possible that this task was generally too hard for children in the age range to successfully complete and possibly demonstrate growth. It was originally believed that of the three working memory tasks, Word Span would be the easiest for children due to the notion that people tend to remember things easier when they are able to make associations (Daneman & Carpenter, 1980; Isen, Johnson, Mertz, & Robinson, 1985; Lewandowsky & Murdock, 1989). Instead, results indicated that children performed similarly on the Word Span task and the Digit Span task at pre-test and at post-test (when children were compared in their respective groups) as all scores were highly and significantly correlated and no significant differences were indicated. Again, researchers (Dempster, 1981; Gates & Taylor, 1925; Hurlock & Newmark, 1931) found that children performed better on Digit Span tasks compared to Word Span tasks, indicating that the Digit Span task is easier. Therefore, it is not surprising that improvements in performance would first be observed in the Digit Span task prior to observing improvements in the Word Span task, unless the performance threshold for Digit Span has already been reached. Findings indicated significant improvements from pre-test to post-test for the Digit Span task for children in the sleep modified group. It would be expected since improvements were observed for one group, improvements would also be demonstrated for the other group, the control group; however, significant improvements were not observed, only a slight trend-level improvement [t (15) = -1.65, p = .120]. It is therefore concluded that children in the sleep modified group generally demonstrated improvements in working memory whereas no differences in performance was indicated for the children in the control group.

Attention. Improvements in performance were also seen with respect to attention. No performance differences were observed from pre-test to post-test for children in the control group; however, significant performance differences were indicated for children in the sleep modified group. These children demonstrated significantly improved reaction times and accuracy on the Child Attention Network Task from pre-test to post-test. This indicates that not only were the children able to answer the prompts faster, they did so with increased accuracy. Increases in reaction time generally decrease accuracy, possibly to due impulsivity and reacting without thinking (Hick, 1952; Schouten & Bekker, 1967; Woodworth, 1899). Similarly, by increasing accuracy, reaction time will often be affected and decrease (Hick, 1952; Schouten & Bekker, 1967; Woodworth, 1899). In this case, however, increases in reaction time did not negatively impact accuracy, as accuracy improved. This was likely due to improvements in attention as the Child Attention Network Task is designed to assess attention abilities. It is unlikely that these improvements are due to learning as Rueda et al. (2005) administered this task 2-3 weeks apart for pre-test and post-test measures, with findings that demonstrated similar increased reaction time and an increase in accuracy. Similarly, not much additional learning can occur with more repetition of task due to the repetitive and basic nature of the task, in general. Therefore, improvement was greater than expected from more than carry-over effects.

Gender differences. Gender comparisons indicated no differences between boys and girls in each group for both pre-test and post-test measures. This is understandable as preschoolers' executive function abilities are developing similarly for both boys and girls at this age (Anderson, 2002). Chelune and Baer (1986), Welsh, Pennington, and Groisser (1991), and Passler, Isaac, and Hynd's (1985) studies also noted that there are no differences in executive function abilities from boys to girls.

Age differences. Although findings indicated some correlations with age and task for children in both groups at pre-test and post-test, all significant correlations were only positively, moderately correlated. This indicates that although there was a relationship between age and task (either at pre-test or post-test), this relationship was not that strong.

Attention Training

Gender differences. Gender comparisons indicated some differences between girls and boys in performance on the attention training games. In general, girls performed better than boys. Girls completed fewer correct trials, which indicated that girls were able to reach ceiling points quicker than boys. As a result, they achieved a greater proportion correct on various training sessions. Parents and teachers of preschoolers report boys having more difficulty with focusing and paying attention and are more easily distractible (Else-Quest, Hyde, Goldsmith, & Van Hulle, 2006) compared to girls. Furthermore, they are more impulsive (Else-Quest, Hyde, Goldsmith, & Van Hulle, 2006) and this can affect their ability to answer questions correctly. These challenges may contribute to the difficulties preschool boys had in playing the attention training games as presented in this study.

Age differences. The individual training games did not demonstrate any correlations with age, thereby demonstrating no linear relationship between the two. Further analysis using a scatter plot showed that a relationship between the ages of the preschoolers in this study and the training games in the attention training program likely does not exist. This may be due to the fact that the attention training program was designed for preschoolers (e.g., children in this study); thus differences would ideally not be evident.

CHAPTER VI

Conclusion

The purpose of this experiment was to study the effects of sleep on the training of attention and generalization of such training to other executive function skills. The attention training program by itself did not appear to help improve attention abilities overall. Nor did the attention training program alone appear to impact the executive function abilities of inhibition, cognitive flexibility, and working memory. This conclusion can be drawn from the fact that children receiving training and no change in sleep (the "control" group) did not demonstrate improvements in attention from pre-test to post-test. They showed no significant performance differences on the Child Attention Network Task. It should be noted that this study's low statistical power may not be adequate enough to establish significance of changes that may be expected from a one-week training program. This study's model hypothesized that improvements made in attention may possibly generalize to improvements in other areas of executive function, as it is believed that attention is a common denominator for executive function. However, no improvements were made in attention abilities nor in the other areas of executive function except for cognitive flexibility. It is possible that the attention training program enhanced cognitive flexibility as improvements in cognitive flexibility were observed in both the control group and the sleep modified group; however, the attention training program was specifically designed to improve attention (Rueda et al., 2005). Therefore, the conclusion that the attention training program enhanced cognitive flexibility is not made. Rather, it is concluded that with this study, the attention training program alone did not improve attention abilities in children.

The finding and conclusion that the attention training program did not improve attention abilities in preschool children conflicts with prior research. This is may be due to the small sample size of this study. Rueda et al.'s (2005) study, which this current experiment was adapted from, utilized a larger sample compared to this current study's sample size. Additionally, the attention training program protocol was not administered in the same manner as other studies. In this study, the attention training was administered on mostly consecutive days over the course of a few days within one week's timeframe. The attention training is typically administered over the course two to three weeks (Rueda et al., 2005). This may help with the training and learning of attention skills due to the ability to consolidate learning over the course of time as distributed sleep is critical in early learning (Kurdziel, Duclos, & Spencer, 2013). On the other hand, because the attention training in the Rueda et al.'s (2005) study took place over the course of several weeks, it is also possible that attention improvements are made due to the natural course of development (Jones, Rothbart, & Posner, 2003). Additionally, Rueda et al. (2005) had children complete the entire attention training protocol, which consisted of five training sessions and nine or 10 games for the children to play. Children in this study completed at most 4 sessions and at most 7 games, with an average completion of 3.2 sessions and 5.4 games. Thus, children in this study obtained less attention training compared to what children in other studies received. Generally, children in this study received a "light" version of the attention training. These several differences in how this study administered the attention training and how it was intended and designed to be administered may be the contributing factors as to why attention abilities did not improve in this study in the group of children whose sleep was not modified.

However, while the control group failed to demonstrate any benefit from attention training, skill improvement did occur for the children in the sleep modified group. All areas of executive function that were addressed in this study showed improvements, including the area of attention. Therefore, it is concluded that the small restriction of nighttime sleep that took place over the course of a few days may have improved response to the skills/trainings. While this result was unanticipated, there are plausible explanations for why a small restriction of nighttime sleep enhanced executive function skills as observed in this study. It is possible that the moderate amount of sleep restriction actually amplified the benefit of the attention training. This hypothesis would appear to be at odds with studies that have found sleep deficits to be detrimental; yet this research differs from the current study in several important respects. Meijer and Van Den Wittenboer (2004) specify that chronic sleep reduction directly affects cognitive performance; however, they also propose a model where the effect of sleep quality may be an indirect factor due to psychosocial factor of eagerness which, in turn, affects performance. Dahl (1996a) also proposed that insufficient sleep can result in low mood and energy which also affects performance. Children in this current study did not suffer from chronic sleep reduction as defined by Dahl (1996a) and Meijer and Van Den Wittenboer (2004) as all children obtained an age-appropriate average amount of sleep per the National Sleep Foundation (2004) and any sleep restriction that they may have experienced as a result of participating in this study would ensure that they remain in the average range for age-appropriate amount of sleep per study's methodology.

In contrast to the studies cited above, children in this study experienced at most a mild sleep reduction over the course of a maximum of four days, subtly altering their established sleep habits. Such restrictions have been shown not to be negatively impactful. Research on college students indicated that performance on memory tasks, including working memory, was not impaired with sleep reduction (Friedmann, Globus, Huntley, Mullaney, Naitoh, & Johnson, 1977). Reaction times in adults are not affected by short-term repeated sleep restriction (Axelsson, Kecklund, Akerstedt, Donofrio, Lekander, & Ingre, 2008). A meta-analysis examining the effects of sleep deprivation and fatigue on medical residents' performance (Samkoff & Jacques, 1991) reported reaction time did not deteriorate after one night's sleep loss. Performance tests on children were not affected by moderate sleep loss (Carskadon, Harvey, & Dement, 1981a; Carskadon, Harvey, & Dement, 1981b; Horn & Dollinger, 1989). Less complex cognitive functions are likewise not affected by when children go to bed (Meijer, Habekothe, & Van Den Wittenboer, 2000). Fallone, Acebo, Arnedt, Seifer, and Carskadon (2001) found that acute sleep restriction did not impair performance on inhibition or sustained attention in children and adolescents.

Far from being negative, or even neutral, the sleep modification practiced in the current study may have introduced a small, short-term amount of stress which improved performance. Ford and Wentz (1984) found that performance on reaction time assessments improved with less sleep. This could be attributed to the mild and temporary increase in the activity of major neuroendocrine stress systems sleep restriction has been shown to produce (Meerlo, Sgoifo, & Suchecki, 2008). Such a stress response which would theoretically help heighten focus during attention training, resulting in improved attention abilities overall. This would also explain why studies with more severe and sustained sleep deprivations exhibited deficits. Research has found curvilinear relationships between stress and performance, with greater amounts of stress becoming less effective and ultimately detrimental over time (Keeley, Zayac, Correia, Christopher, 2008). Subsequently, in accordance with the study's hypothesized model, by improving attention, other areas of executive function, in this case the areas of inhibition, cognitive flexibility, and working memory, were improved. Therefore there is a possible conclusion that the attention training did in fact improve attention abilities, which then generalized to improved abilities in inhibition, cognitive flexibility, and working memory.

While this may explain why sleep-restricted children in the current study demonstrated improvements in attention and executive function, it still does not explain why the control group failed to exhibit any improvement. Previous studies showed that children were able to benefit from the attention training without changes in their sleep habits (Rueda et al., 2005). Similarly, if the attention training improved overall attention abilities, then it would be expected that children in the control group would also benefit from the attention training, even if it were a smaller degree of benefit. Why, then, was no benefit from the attention training was observed?

The answer could be found in the complex relationship among sleep restriction, stress, and attention training. As stated previously, subjects in the current study were given a "light" version of the training, received less training overall with fewer exercises and fewer sessions over the course of a more compressed time frame. It is not known what the exact impact of this reduction might be, nor the precise benefit of each session. Attention training sessions may have a compounding, rather than cumulative, effect. There may likewise exist a training "threshold," a certain, perhaps specific, amount of training that must be administered for the training to have an apparent impact. Children in previous studies (Rueda et al., 2005) benefitted from the attention training due to meeting the necessary threshold. Children in the control group of the current study, in contrast, were unable to meet such a threshold, likely due to receiving a "light" version of the attention training. Just as the precise nature of training and its impact, the influence of sleep restriction on attention training is also not well understood. It could be that such restriction, like training, has a compounding effect on training efficacy. It is likewise possible that sleep deprivation lowers threshold required to make a significant impact. Restricting sleep possibly lowers this threshold, thereby making the attention training more effective with less training required. Further research into the precise impact of individual training sessions, as well as their interaction with sleep restriction and stress, is recommended.

Limitations

Sample size. This study was originally intended to be an extension of Rueda et al.'s (2005) study, which had a sample size of 73 children, which also consisted of 6-year-old children. A total sample size of 49 (control, n = 24; to-be-trained, n = 25) was used for children ages four and five. Therefore, this study initially targeted a sample size of 50 given the sample size Rueda and colleagues (2005) utilized in the experiment and analysis. Ultimately, a final sample size of 33 was achieved for this study, which is about 66.0 percent of the actual desired sample size. This poses implications for adequate statistical power. Even though this study had approximately 50 percent of the participants in each group, much like that of the study conducted by Rueda and colleagues (2005), overall statistical power is low. Further studies would have an increased sample size to account for any of the above, or more, difficulties that might arise.

The sample size was further reduced with the parent questionnaire packet, specifically the Children's Sleep Habits Questionnaire. Due to 10 caregivers not completing the questionnaire to its entirety as some items were skipped and due to one caregiver not returning a parent questionnaire packet, only 22 of the 33 participants had their CSHQ analyzed, thereby further reducing power.

Training differences. This current study attempted to utilize the same training program as Rueda et al.'s (2005) study used. It was originally known that the current study was not going to complete the training protocol as originally designed as intended (Rueda et al., 2005) due to the urgency to collect as much data as possible over a short time frame. Rueda et al. (2005) originally designed protocol for children to complete five days of training over the course of two to three weeks. Children in this study participated in a maximum of four days of training (*M* = 3.15 training days) over the course of a single week. This resulted in a dense amount of training over a few days, without allowing children the possible necessary time to consolidate the training and learning before an additional training session was administered. Therefore, the attention training program was not administered with fidelity as intended by design. It would be ideal if the training protocol was carried out in the manner that it was designed and intended to be used.

Sleep restriction. Children in the sleep modified group experienced varying amounts of sleep restriction, both in terms of number of days they experienced sleep restriction and amount of sleep restriction they underwent each night. Children experienced no more than 4 days of sleep restriction (range: 1-4, *M* = 3.56, *SD* = .89). Children who were not sleep restricted on consecutive days may have had the opportunity to recuperate with previously lost sleep. This recuperation may have helped them make up their possible losses with consolidation of learning. These several different types of inconsistencies in the amount of specific sleep restriction children in the sleep modified group experienced adds another level of variability to the study. It would be helpful if the amount of sleep restriction was uniform across all children in the sleep modified group, both in terms of amount restricted each night and then number of consecutive days the children experience the modified sleep schedule.

Time of sessions. There were many inconsistencies regarding when children participated in the training. Although the majority of children completed the trainings in the morning some children completed some of the trainings in the afternoon after naptime and a few children completed all their trainings in the afternoon after naptime. These differences may have played a role in the consolidation of learning due to differences in opportunities for children to sleep. Individual differences of functioning may also play a role as there exists individual time of day differences for optimal learning. Several studies (Adan, 1991; Anderson, Petros, Beckwith, Mitchell, & Fritz, 1991; Natale & Lorenzetti, 1997; Petros, Beckwith, & Anderson, 1990; Sadeh, Gruber, Raviv, 2002) found that time of day may affect alertness and performance. Additionally, there were inconsistencies with regard to the time of when the pre-test and the post-test were administered as well as the location of administration (e.g., preschool versus home). Therefore, it would be ideal if future studies kept session time consistent for all participants, regardless of whether it was a pre-test or post-test session, or a training session.

Loss of data. Throughout the study, there were various misfortunes with regard to missing or lost data, including incomplete parent questionnaire packets, incomplete sleep diary data during the week of training, child refusal to complete the post-test assessment including the Child Attention Network task, loss of actigraphy data at baseline and at training due to equipment malfunction.

Age. It is possible that there exists significant developmental differences when comparing children from as young as 46-months-old to as old as 68-months-old. As data were being gathered during the summer, older children (e.g., those who were 5-years-old or older as well as those who were almost 5-years-old) would be transitioning to kindergarten and starting kindergarten in the fall, within a few to a couple of months. Therefore, future studies should either account for age differences or separate the children into smaller age groups.

Sleep. Sleep was analyzed using both sleep diary data and actigraphy data. Specific variables that were used for analysis included the time when children were put down for bed or nap and the time that their caregivers reported them getting up. Additionally, to adjust for the fact that children do not fall asleep immediately upon being put to bed, true sleep time was also used for analysis for both nighttime and naptime sleep. Similar to this study, many other studies examine preschoolers' sleep utilizing actigraphy data (Acebo, Sadeh, Siefer, Tzichinsky, Hafer, & Carskadon, 2005; Anders, Iosif, Schwichtenberg, Tang, & Goodlin-Jones, 2012; Christodulu & Durand, 2004; Crosby, LeBourgeois, & Harsh, 2005; Dayyat, Spruyt, Roman, Molfese, & Gozal, 2008; El-Sheikh, Arsiwalla, Staton, Dyer, & Vaughn, 2013; Goodlin-Jones, Tang, Liu, & Anders, 2009; Iwata, Iwata, Iemura, Iwasak, & Matsuishi, 2012; Kushnir & Sadeh, 2011; Lam, Mahone, Mason, & Scharf, 2011; Osborne, Dayyat, Gozal, Molfese, & Molfese, 2008; Sadeh, Alster, Urbach, & Lavie, 1989; Sadeh, Lavie, Scher, Tirosh, & Epstein, 1991; Sitnick, Goodlin-Jones, & Anders, 2008; Souders, Mason, Valladares, Bucan, Levy, Mandell, Weaver, & Pinto-Martin, 2009; Ward, Gay, Anders, Alkon, & Lee, 2008; Ward, Gay, Alkon, Anders, & Lee, 2008; Werner, Molinari, Guyer, & Jenni, 2008). More recently, studies that examine sleep are including neuroimaging data to provide additional information regarding brain activity (Almli, Rivkin, & McKinstry, 2007; Coble, Kupfer, Taska, & Kane, 1984; Dean III, Dirks, O'Muircheartaigh, Walker, Jerskey, Lehman, Han, Waskiewicz, & Deoni, 2014; Nordahl, Simon, Zierhut, Solomon, Rogers, & Amaral, 2008; Redcay, Kennedy, & Courchesne, 2007; Raschle, Zuk, Ortiz-Mantilla, Sliva, Franceschi, Grant, Benasich, & Gaab, 2012; Sanchez, Richards, & Almli, 2012; Wolff & Piven, 2013). Furthermore, Rueda et al.'s (2005) study utilized EEG data to assess children's performance on the attention assay (Child Attention Network test). Other studies required EEG data to further analyze and differentiate sleep behaviors, specifically amount of time in various stages of sleep, including slow-wave sleep (SWS) and rapid-eye-movement (REM) sleep (Griessenberger, Hoedlmoser, Heib, Lechinger, Klimesch, & Schabus, 2012; Groeger & Dijk, 2005; Kwon, Coe, & Seo, 2013; Plihal & Born, 1997; Roffwarg, Muzio, & Dement, 1966; Seigel, 2005; Sheth, 2005; Smith 2005; Smith, 2010; Stickgold, James, & Hobson, 2000; Walker, 2005; Wolfson, 1996). EEG sleep data would be helpful to further analyze bedtime and naptime for potential differences as no differences in this study were found in naptime data via actigraphy and sleep diary. Studies measuring electrical activity have shown differences in nighttime and naptime sleep (Kahn, Fischer, Edwards, & Davis, 1973; Maron, Rechtschaffen, & Wolpert, 1964). Detailed napping data may indicate that napping helped with consolidation of learning (Debarnot, Castellani, Valenza, Sebastiani, & Guillot, 2011; Diekelmann, Wilhelm, & Born, 2009; Koulack, 1997; Ficca, Axelsson, Mollicone, Muto, & Vitiello, 2010; Hupbach, Gomez, Bootzin, & Nadel, 2009; Korman, Doyon, Doljansky, Carrier, Dagan, & Karni, 2007; Lahl, Wispel, Willigens, & Pietrowsky, 2008; Lau, Alger, & Fishbein, 2011; Mednick, Cai, Kanady, & Drummond, 2008; Mednick, Drummond, Arman, & Boynton, 2008; Mednick, Nakayama, & Stickgold, 2003; Milner & Cote, 2009; Milner, Fogel, & Cote, 2006; Nishida & Walker, 2007; Schabus, Hodlmoser, Pecherstorfer, & Klosch, 2005; Schichl, Ziberi, Lahl, & Pietrowsky, 2011; Schoen & Badia, 1984; Tucker & Fishbein, 2008; Tucker, Hirota, Wamsley, Lau, Chaklader, & Fishbein, 2006; Wamsley, Tucker, Payne, & Stickgold, 2010). Further extension of this study could also assess for more detailed sleep data as well as further information and insight regarding brain activity at pre-test and post-test.

Tasks. Pre-test and post-test measures were analyzed via child performance on various tasks. More recently, studies have been utilizing additional methods to further analyze task performance in children, including the use of neuroimaging techniques, such as fMRI (Posner, Rothbart, & Tang, 2013). Such additional data could also be used to further supplement neuroimaging sleep data.

Modified sleep schedule. It would be interesting to investigate the differences for children between having a modified bedtime (e.g., later bedtime for sleep restriction) or a modified wake time (e.g., earlier wake time for sleep restriction). There do not appear to be any studies investigating sleep restriction via a modified wake time for children. This may be due to a possible poorer rate of compliance with a modified wake time compared to a modified bedtime. Participants in this study were given the option to partake in either the modified bedtime or modified wake time if they were randomly placed in the sleep modified group; however, none of the caregivers opted for the modified wake time and all chose to adhere to the modified bedtime procedures instead.

Similarly, future studies could assess for differences/similarities between children with irregular bedtimes and/or sleep scheduled with late bedtimes. Children who experience irregular bedtimes may be more prone to poor sleep and increased sleep difficulties (Iwata, Iwata, Iemura, Iwasaki, & Matsuishi, 2012). Similarly, such children are more likely to demonstrate problematic behaviors during the day (Yokomaku, Misao, Omoto, Yamagishi, Tanaka, Takada, & Kohyama, 2008).

Implications for Future Research

Further research should focus on determining the threshold where sleep restriction becomes detrimental as this study indicates that children benefitted from mild sleep restriction and findings from previous research demonstrate more adverse effects with sleep deprivation. This can be done by varying the amount of sleep restriction, both in terms of minutes/hours per night and number of nights. Preschool and school-age follow-up assessments may be beneficial in determining varying levels of functioning, with respect to executive function and regulation as well as other areas of typical preschool performance. Continued research in the areas of the generalization of skills, in this case, attention, to other executive function abilities in preschoolers would also be helpful. Further studies exploring skills in children of different ages, specifically school-aged children rather than preschool-aged children, can provide information regarding how, when, and if the ability of one skill can generalize into other abilities and other skills.

Previous research has demonstrated success with the training of attention via the attention training program used in this study. Further research assessing sleep and the effects on children with sleep disorders, behavioral disorders, or learning disabilities may supplement our current understanding of the interplays of sleep, training, and learning. Increased knowledge may aid in the development of appropriate and specific interventions targeting a specific areas of weakness or challenge for a child. Ongoing follow-up of these children can further our understanding of the long-term effects and ideally potential benefits for these early targeted interventions.

Summary and Conclusions

The results from the present study have added support to the existing research that implies a relationship between sleep and learning in preschool children. Furthermore, the current research findings indicate that preschoolers who experience mild sleep restriction demonstrate improved attention and improved executive function skills over a short period of time. Therefore, it is informative to recognize that there may be benefits of sleep restriction in preschool children. Findings from this study and other corroborating data warrant future research that clarifies a relationship between sleep restriction and learning.

The relationship between sleep and learning implies that clinicians should also assess for sleep habits and daytime functioning. This will allow clinicians to further determine whether differences in sleep may be impacting a child’s current abilities. Additionally, findings from the current research could be used to assist in the development of future training programs and protocols, whether with attention, executive function, or other areas of development in preschoolers. For example, interventions that target the training of one developmentally appropriate general skill may also provide support for children in other areas. Alternatively, treatment interventions that target sleep patterns and habits may also contribute to the learning of skills. Conversely, interventions that are designed to solely target one area, much like the many interventions that are currently used, may enhance that one specific targeted area. Therefore, it might be important to administer interventions that target general and core areas of functioning so as to obtain the most benefit from such treatment as the targeted skill potentially serves to improve other more defined skills or abilities. However, there might be a need to separately target each specific area, based on each child's individual needs and abilities. Finally, given the complex nature of learning and the intricate relationship between sleep and the training of skills, and various other psychological constructs, interventions that improve specific targeted areas may lead to improvements in overall functioning.

Appendices

Appendix A: Subject Phone Screen

SUBJECT PHONE SCREEN

Note: Every child that returns a consent form must be contacted. It is best to make actual contact with parents on the phone, but if you reach the answering machine, it is okay to leave a message. Give them our lab phone number (812)-855-6961 in case they want to contact us, but always say that you will keep trying to reach them.

Thank you for your interest in this study. This study is being conducted in the lab of Dr. John Bates in the Department of Psychological and Brain Sciences at Indiana University. We are conducting a research study of sleep habits and attention in young children ages 4-6. Before I continue to tell you more about the study, I need to ask you several questions to see if you and your child meet our criteria. This will take about 10 minutes. I would like to ask you questions about you and your child's age, education, medication, psychological problems, development, and sleep patterns and habits. Participation in this interview is completely voluntary. We will not pay you to answer these questions, but if you qualify for the study, your child's preschool or daycare will receive a gift certificate and books to be used in your child's classroom so that every child will benefit from the gifts and your child will receive small age-appropriate gifts over the course of two weeks. The answers to these questions will not be kept after this brief interview and will not be linked to your name unless you are involved in the study. Are you willing to answer these questions?

(IF YES, THEN PROCEED;
IF NO, SAY: *"Thank you for your interest goodbye."*)

	(Check if "Yes")
1. *Are you willing to proceed with the interview?*	☐
2. *Are you the parent or legal guardian of <child's name>?*	☐
3. *Are you able to speak and read English fluently?*	☐
4. *Do you have at least a 6th grade education?*	☐

If the interviewee does <u>not</u> meet criteria (any <u>one</u> of questions 1-4 <u>un</u>checked), say:

I'm sorry, but you do not qualify for this study. We will immediately destroy all of the information you just gave us. Thank you for your time.

If the interview meets *all* of the above criteria, continue.

Now I'm going to ask you some questions about your child.

<u>Background</u>

	(Check if "Yes")
5. *Is <child's name> between the ages of 4 and 6?*	☐
6. *Does <child's name> attend preschool regularly, at least 3-5 days per week?*	☐
7. *Does <child's name> attend preschool during the same time each day?*	☐

8. *Is <child's name>able to speak and understand English?* ☐

If the interviewee does <u>not</u> meet criteria (any <u>one</u> of questions 5-8 <u>un</u>checked), say:

I'm sorry, but you do not qualify for this study. We will immediately destroy all of the information you just gave us. Thank you for your time.

If the interview meets *all* of the above criteria, continue.

<u>Psychology and Development</u>

(Check if "Yes")

9. *Has <child's name> ever been evaluated by a psychologist or psychiatrist?* ☐
10. *Has <child's name> ever been diagnosed with a developmental disability?* ☐
11. *Is <child's name> currently on any medication, not including those for sickness?* ☐

If the interviewee does <u>not</u> meet criteria (any <u>one</u> of questions 9-11 <u>checked</u>), say:

I'm sorry, but you do not qualify for this study. We will immediately destroy all of the information you just gave us. Thank you for your time.

If the interview meets *all* of the above criteria, continue.

<u>Sleep Habits</u>

(Check if "Yes")

12. *Does <child's name> have a past history of sleep problems?* ☐
13. *Does <child's name> currently experience any sleep problems?* ☐
14. *Does <child's name> currently take naps during the day regularly?* ☐

If the interviewee does <u>not</u> meet criteria (any <u>one</u> of questions 12-14 <u>checked</u>), say:

I'm sorry, but you do not qualify for this study. We will immediately destroy all of the information you just gave us. Thank you for your time.

If the interview meets *all* of the above criteria, continue.

<u>Napping Habits</u>

(Check if "Yes")

15. *Does <child's name> currently take naps during the week?* ☐

If the interviewee answers "Yes" to question 15 (question 15 <u>checked</u>), continue to question <u>15A</u>.

If the interviewee answers "No" to question 15 (question 15 unchecked), continue to question 16.

15A. *On average, approximately how many naps does <child's name> take during the week?* ______________________________

If 15A is 4 or more, say:

I'm sorry, but you do not qualify for this study. We will immediately destroy all of the information you just gave us. Thank you for your time.

If 15A is less than 4, continue to question 17.

16. *At what age did<child's name> stop taking regular naps?* ______________________________

Daytime Functioning

(Check if "Yes")

17. *Do you believe that your child functions well during the day with the current amount of sleep he/she is receiving?* ☐

If the interviewee does not meet criteria (question 16 unchecked), say:

I'm sorry, but you do not qualify for this study. We will immediately destroy all of the information you just gave us. Thank you for your time.

If the interview meets *all* of the above criteria, continue.

Sleep Patterns

18. *On average, how much sleep does your child receive each night?* ______________________________

19. *What time does your child typically go to bed during the week?* ______________________________

20. *What time does your child typically get up during the week?* ______________________________

21. *What time does your child typically go to bed on the weekends?* ______________________________

22. *What time does your child typically get up on the weekends?* ______________________________

Calculate

A. (using questions 19 and 20) Amount of sleep each night during the week: __________________

B. (using questions 21 and 22) Amount of sleep each night on the weekends: __________________

C. Difference between sleep during week and on weekends (A-B): __________________

If question A is 10 hours or less, say:

I'm sorry, but you do not qualify for this study. We will immediately destroy all of the information you just gave us. Thank you for your time.

If question A is more than 10 hours, continue.

If difference (question C) is 4 hours or more, say:

I'm sorry, but you do not qualify for this study. We will immediately destroy all of the information you just gave us. Thank you for your time.

If the subject meets our criteria, say:

You and your child qualify for the study; let me give you more details.

Explanation of Study

This study will take place over the course of two weeks. Your child will be asked to wear a wristband that contains an actigraph over the duration of the two weeks. The actigraph records movement, which helps us measure sleep and wake time. Your child will be asked to wear his/her actigraph until he/she completes the final session. During this time, you will be asked to keep record (which will take you approximately 5 minutes a day) of when your child sleeps and wakes as well as information pertaining to these activities.

At the end of the first week, we will provide a bedtime schedule for you to follow during the second week. Some, if not all, the days during the second week will be similar to your child's typical bedtime schedule. There may be nights where your child's bedtime may vary up to an hour past his/her typical bedtime. We ask that your child continue to get up when he/she typically gets up.

During the second week, your child will participate in up to five training sessions that will last between 25 to 30 minutes at your child's preschool. Before the first training session, your child will meet with a researcher for 25 to 30 minutes and ask your child to participate in an assessment of cognitive development. The researcher will also guide your child through a few short tasks designed to explore attention, inhibition, and memory. After the last training session, your child will meet again with a researcher for 25 to 30 minutes and guide your child through a few short tasks designed to explore attention, inhibition, and memory.

You will be asked to complete a packet of four questionnaires which includes family information and information about your child's temperament, typical behaviors, and sleep habits.

All of the information that we collect from you will be kept in strict confidence. No one other than the individuals involved directly with the study will have access to your data, nor will your name be associated with your data in research reports.

Are you still interested in participating?

If yes, then ask and verify:

Parent's Name ________________________________

Parent's Phone ________________________________

Child's Name ________________________________

Child's Birthday ________________________________

Child's Preschool ________________________________

Preschool Attendance

	Monday	Tuesday	Wednesday	Thursday	Friday
Time Attending Preschool					

Appendix B: Sample Copy of Child Sleep Diary

	Child Sleep Diary (Start date-End date)		
FRIDAY NIGHT (Date)			
	Routine		Comments about the ease of bedtime:
	Start Time ___ : ___		___
	☐ Shower	☐ Nightlight	___
	☐ P.J.'s	☐ Music	___
	☐ Story	☐ Teddy Bear	___
	☐ ___________	☐ ___________	___
	☐ ___________	☐ ___________	___
	Nighttime		Reasons for night waking or difficulty sleeping:
	Time in Bed ___ : ___		___
	Night waking 1: ___ : ___	Time Back in bed ___ : ___	___
			___
	Night waking 2: ___ : ___	Time Back in bed ___ : ___	___
			___
	Night waking 3: ___ : ___	Time Back in bed ___ : ___	___
SATURDAY (Date)			
	Morning		Anything unusual about waking:
	Time Awake ___ : ___		___
	☐ Woke Self	☐ Someone Woke Up	___
			___
	Wearing Actigraph		___
	☐ Yes	☐ No (Time on ___ : ___)	___
	Naps		Reason for nap:
	Nap 1 Start Time: ___ : ___	Time Awake ___ : ___	___
			___
	Nap 2 Start Time: ___ : ___	Time Awake ___ : ___	___
	Daytime		Reasons for taking Actigraph off:
	Time Taken Off ___ : ___	Time On ___ : ___	___
			___
	Time Taken Off ___ : ___	Time On ___ : ___	___
			___
	Time Taken Off ___ : ___	Time On ___ : ___	___

Appendix C: Family Demographic Information

Toddler:

Name: __________________ Sex: F M

Parent:

Name: ____________________________________ Sex: F M

Current Age: ____________________________________ Ethnicity: ______________________

Education:

1	2	3	4	5	6
8th Grade or Less	Some High School	GED	High School Diploma	Some College	College Degree: ______

Relation to Child:

1	2	3	4	5
Biological Parent	Step Parent	Adoptive Parent	Foster Parent	Other Specify: _______

Occupation: (job title) ____

(job description) ____

Marital Status:

1	2	3	4	5
Single/ Never Married	Married	Separated	Divorced	Re-Married

Current Parenting Partner (if any):

Name: ____________________________________ Sex: F M

Current Age: ____________________________________ Ethnicity: ______________________

Education:

1	2	3	4	5	6
8th Grade or Less	Some High School	GED	High School Diploma	Some College	College Degree: ______

Relation to Child:

1	2	3	4	5
Biological Parent	Step Parent	Adoptive Parent	Foster Parent	Other Specify: _______

Occupation: (job title) ____

(job description) ____

Marital Status:

1	2	3	4	5
Single/ Never Married	Married	Separated	Divorced	Re-Married

Other Adult Caregivers (if any): **Please exclude any paid professionals**

(1) Name: ____________________________________ Sex: F M

Current Age: ____________________________________ Ethnicity: ______________________

Education:

1	2	3	4	5	6
8th Grade or Less	Some High School	GED	High School Diploma	Some College	College Degree: ______

Relation to Child:

1	2	3	4	5
Biological Parent	Step Parent	Adoptive Parent	Foster Parent	Other Specify: _______

Occupation: (job title) ____

(job description) ____

(2) Name: ______________________ Sex: F M

Current Age: ______________________ Ethnicity: ______________

Education: 1 8th Grade or Less; 2 Some High School; 3 GED; 4 High School Diploma; 5 Some College; 6 College Degree: ______

Relation to Child: 1 Biological Parent; 2 Step Parent; 3 Adoptive Parent; 4 Foster Parent; 5 Other Specify: _______

Occupation: (job title) ______________________

(job description) ______________________

(3) Name: ______________________ Sex: F M

Current Age: ______________________ Ethnicity: ______________

Education: 1 8th Grade or Less; 2 Some High School; 3 GED; 4 High School Diploma; 5 Some College; 6 College Degree: ______

Relation to Child: 1 Biological Parent; 2 Step Parent; 3 Adoptive Parent; 4 Foster Parent; 5 Other Specify: _______

Occupation: (job title) ______________________

(job description) ______________________

Siblings:

Name:	In Home?	When born?	Sex:	Relation to toddler
________	Y / N	(month) (year)	F / M	Full / Half / Step
________	Y / N	(month) (year)	F / M	Full / Half / Step
________	Y / N	(month) (year)	F / M	Full / Half / Step
________	Y / N	(month) (year)	F / M	Full / Half / Step
________	Y / N	(month) (year)	F / M	Full / Half / Step
________	Y / N	(month) (year)	F / M	Full / Half / Step

Which of the above caregivers and siblings live in same home as toddler?

______________________ ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

Appendix D: Sample Items from Rothbart's Children's Behavior Questionnaire (CBQ) (Rothbart, Ahadi, Hershey, & Fisher, 2001)

1	2	3	4	5	6	7	N/A
extremely untrue	quite untrue	slightly untrue	neither true not untrue	slightly true	quite true	extremely true	not applicable

My child:

Seems always in a big hurry to get from one place to another.
1 2 3 4 5 6 7 N/A

Has temper tantrums when s(he) doesn't get what s/he wants.
1 2 3 4 5 6 7 N/A

When picking up toys or other jobs, usually keeps at the task until it's done.
1 2 3 4 5 6 7 N/A

Is not very bothered by pain.
1 2 3 4 5 6 7 N/A

Is not afraid of large dogs and / or other animals.
1 2 3 4 5 6 7 N/A

Likes going down high slides or other adventurous activities.
1 2 3 4 5 6 7 N/A

Usually rushes into an activity without thinking about it.
1 2 3 4 5 6 7 N/A

Can lower his / her voice when asked to do so.
1 2 3 4 5 6 7 N/A

Rarely enjoys just being talked to.
1 2 3 4 5 6 7 N/A

Notices the smoothness or roughness of objects s(h)e touches.
1 2 3 4 5 6 7 N/A

Gets so worked up before an exciting event that s(he) has trouble sitting still.
1 2 3 4 5 6 7 N/A

Cries sadly when a favorite toy gets lost or broken.
1 2 3 4 5 6 7 N/A

Often prefers to watch rather than join other children playing.
1 2 3 4 5 6 7 N/A

Laughs a lot at jokes and silly happenings.
1 2 3 4 5 6 7 N/A

Has a hard time settling down for a nap.
1 2 3 4 5 6 7 N/A

Appendix E: Sample Items from Owens' Children's Sleep Habits Questionnaire (CSHQ) (Owens, Spirito, & McGuinn, 2000)

	3 Usually (5-7x in a week)	2 Sometimes (2-4x in a week)	1 Rarely (0-1x in a week)	Problem?
Child goes to bed at the same time at night	☐	☐	☐	Yes No N/A
Child falls asleep within 20 minutes after going to bed	☐	☐	☐	Yes No N/A
Child sleeps too little	☐	☐	☐	Yes No N/A
Child needs parent in the room to fall asleep	☐	☐	☐	Yes No N/A
Child moves to someone else's bed during the night (parent, brother, sister, etc.)	☐	☐	☐	Yes No N/A
Child wets the bed at night	☐	☐	☐	Yes No N/A
Child snores loudly	☐	☐	☐	Yes No N/A
Child wakes up by him/herself	☐	☐	☐	Yes No N/A

Appendix F: Sample Items from Eyberg Child Behavior Inventory (ECBI)
(Eyberg & Ross, 1978)

	How often does this occur with your child?							Is this a problem for you?	
	Never		Seldom		Sometimes		Often		Always		
Refuses to do chores when asked	1	2	3	4	5	6	7	YES	NO
Whines	1	2	3	4	5	6	7	YES	NO
Dawdles or lingers at mealtime	1	2	3	4	5	6	7	YES	NO
Hits parents	1	2	3	4	5	6	7	YES	NO
Physically fights with brothers and sisters	1	2	3	4	5	6	7	YES	NO

Appendix G: Description of Pre-Test and Post-Test Measures

- Brief cognitive measure (pre-test measure only): Kaufman Brief Intelligence Test (KBIT) (Kaufman & Kaufman, 1990). This test consists of two subtests: Vocabulary and Matrices. Vocabulary measures verbal school-related skills and asks the child to name the object of the picture they are shown. Matrices measures nonverbal skills and asks the child to match a certain picture with one that corresponds with it from set of different pictures or complete a certain picture with one that belongs in the missing part from a set of different pictures. This measure is designed for children ages four and up.
- Day/Night. This measure is based on a task developed by Gerstadt, Hong, and Diamond (1994) and assesses inhibition where children are instructed to say “night” when the experimenter presents the white card with a yellow sun, and to say “day” when the experimenter presents the black card with the moon and stars. Children aged four demonstrate a growth in performance in which, by age five, children typically demonstrate success with this task (Carlson, 2005).
- Standard Dimensional Change Card Sort. This measure is based on a task developed by Frye, Zelazo, and Palfai (1995) and assesses cognitive flexibility where children are instructed to sort a set of cards according to one dimension (pre-switch phase) and then sort another set of cards according to another dimension (post-switch phase). Children aged four demonstrate a growth in performance in which, by age five, children typically demonstrate success with this task (Carlson, 2005).
- Simon Says. This measure is based on a task developed by Strommen (1973) and assesses inhibition where children are instructed to perform an action if the experimenter prefaces the command with “Simon says,” otherwise, the children are to remain perfectly still. Children

aged four are typically unable to perform this task; however, by age five, children demonstrate a growth in performance (Carlson, 2005).

- Flexible Item Selection Task. This measure is based on a task developed by Jacques and Zelazo (2001) and assesses cognitive flexibility where children are instructed to pick two pictures from a set of three that go together (selection 1) and then pick another two pictures from the same set of three that go together (selection 2) (in which one of the pictures would be the same as that picked for selection 1). Children aged four are typically unable to perform this task; however, by age five, children demonstrate a growth in performance (Jacques & Zelazo, 2001).
- Word Span (unrelated nouns, including: car, chair, sun, train, tree, book, grass, dog, fish, frog, grape, ring, ball, bike, juice, pen). This measure is based on a task developed by Thorell and Wahlstedt (2006) and assesses working memory where children are instructed to repeat of list of single-syllable, non-semantically related words. Words will be presented one second apart. The first two trials will consist of two words each. If correct responses are provided on either or both trials, then the next two trials will consist of three words each. List size increases after every two trials (two trials of the same list size equates to a level) until the child gets both trials incorrect at any level, which, at this point, administration will discontinue. All words except for grass, grape, and juice were used in her original protocol. Instead, her original protocol consisted of the words flower, apple, and candy; however, in Swedish (the language in which the task was originally administered), these words are single syllable.
- Digit Span. This measure is based on a task developed by Wechsler (2003) and assesses working memory where children are instructed to repeat a list of numbers (1 through 9).

Numbers will be presented one second apart. The first two trials will consist of two numbers each, if correct responses are provided on either or both trials, then the next two trials will consist of three numbers each. List size increases after every two trials (two trials of the same list size equates to a level) until the child gets both trials incorrect at any level, which, at this point, administration will discontinue.

- Backwards Digit Span. This measure is based on a task developed by Wechsler (2003) and assesses working memory where children are instructed to repeat a list of number (1 through 9) in reverse order. The first four trials will consist of two numbers each. If correct responses on provided on either or both of the first two trials, then the next trial, also consisting of two number each, will be administered. If correct responses are provided on either or both of trial three and/or trial four, then the next two trials will consist of three numbers each. List size increases after every two trials (two trials of the same list size equates to a level) until the child gets both trials incorrect at any level, which, at this point, administration will discontinue.
- Child Attention Network Test. This measure is part of a computer program developed by Rueda et al. (2004) and assesses attention where children are instructed play a computer game and use the two buttons on the mouse and help feed the central fish by pressing the button corresponding to the direction in which the middle fish is swimming. This task is especially important for this study design as Rueda et al. (2005) used this task with the same attention training program and found significant main effects and improvements for reaction time, the number of errors, and conflicts after five days of attention training (similar to this current study design).

Appendix H: Sample Protocol Schedule

- Week 1:
  - Friday: Child receives actigraph and sleep baseline data collection begins.

    Primary caregiver is given parent report measures to fill out.

    Family demographic information (Appendix C).

    Rothbart's Children's Behavior Questionnaire (CBQ) – Short Form (Appendix D).

    Owens' Children's Sleep Habits Questionnaire (CSHQ) (Appendix E).

    Eyberg Child Behavior Inventory (ECBI) (Appendix F).

    Primary caregiver is given a child sleep diary to fill out (Appendix B).
  - Saturday: Continue gathering sleep baseline data.
  - Sunday: Continue gathering sleep baseline data.
  - Monday: Continue gathering sleep baseline data.
  - Tuesday: Continue gathering sleep baseline data.
  - Wednesday: Continue gathering sleep baseline data.
  - Thursday: Pretest measures administered to child.

    Brief Cognitive Measure: Kaufman Brief Intelligence Test.

    Administration will take approximately 10-15 minutes.

    Pre-Test: Day/Night.

    Administration will take approximately 3-5 minutes.

    Pre-Test: Standard Dimensional Change Card Sort.

    Administration will take approximately 3-5 minutes.

    Pre-Test: Simon Says.

Administration will take approximately 3-5 minutes.

Pre-Test: Flexible Item Selection Task.

Administration will take approximately 3-5 minutes.

Pre-Test: Word Span.

Administration will take approximately 3-5 minutes.

Pre-Test: Digit Span.

Administration will take approximately 3-5 minutes.

Pre-Test: Backwards Digit Span.

Administration will take approximately 3-5 minutes.

Baseline data downloaded.

Child randomly assigned to either control group or sleep modified group.

- Friday: Pretest measures administer to child (if not available on Thursday).

  Sleep baseline data downloaded (if not available on Thursday).

  Child randomly assigned to either control group or sleep modified group

- Week 2:
  - Weekend (sometime Friday through Sunday):

    Follow-up phone call in evening to inform parents of modified sleep schedule.

  - Monday: Finish Pre-Test Measure and Training Day 1.

    Pre-Test: Child Attention Network Test.

    Administration will take approximately 15-20 minutes.

    Game 1: Side.

    Administration will take approximately 5-10 minutes.

    Game 2: Chase.

Administration will take approximately 5-10 minutes.

- Tuesday: Training Day 2.

  Game 4: Hole – Visible.

  Administration will take approximately 15 minutes.

  Game 5: Hole – Invisible.

  Administration will take approximately 15 minutes.

- Wednesday: Training Day 3.

  Game 5: Hole –Invisible. (If not completed on Training Day 2).

  Administration will take approximately 15 minutes.

  Game 7: Toybox.

  Administration will take approximately 15 minutes.

  Game 8: Toybox Delay.

  Administration will take approximately 15 minutes.

- Thursday: Training Day 4.

  Game 8: Toybox Delay. (If not completed on Training Day 3).

  Administration will take approximately 15 minutes.

  Game 10: Numbers.

  Administration will take approximately 25 minutes.

  Follow-up phone call in evening.

- Friday: Training Day 5.

  Game 10: Numbers. (If not completed on Training Day 4).

  Administration will take approximately 25 minutes.

  Game 11: Stroop.

Administration will take approximately 10 minutes.

If child is behind, finish games from previous sessions.

Download actigraphy data.

Prepare actigraph and self-report measures for next participant.

Appendix I: Attention Training Gender Differences

There were gender difference with regard to only the seventh game [*t* (10.681) = -3.36, $p < .01$] in that girls achieved a greater proportion correct [$p = 0.94$] compared to boys [$p = 0.80$]. There were significant difference between girls and boys with respect to: the total number of trials played on training session three [*t* (22) = 4.20, $p < .05$] as girls played fewer trials [$n = 40.33$] compared to boys [$n = 57.67$]; the proportion correct on training session three [*t* (22) = -4.02, $p < .05$] as girls achieved a greater proportion correct [$p = 0.91$] compared to boys [$p = 0.78$]; and the total number of trial played on training session four [*t* (10.534) = 3.13, $p < .05$] as girls played fewer trials [$n = 45.73$] compared to boys [$n = 74.00$]. In addition, trend-level data indicated slight differences between girls and boys with respect to: the total number correct on training session two [*t* (29.325) = 1.78, $p = .086$] as girls completed fewer correct trials [$n = 37.16$] compared to boys [$n = 41.64$]; the total number of trials on training session two [*t* (30.275) = 1.86, $p = .073$] as girls completed fewer trails [$n = 37.89$] compared to boys [$n = 42.71$]; and the total number of correct trials on training session four [*t* (12) = 1.63, $p = .129$] as girls completed fewer correct trials [$n = 41.73$] compared to boys [$n = 64.33$].

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ROSANNE W. CHIEN
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EDUCATION

Doctor of Philosophy – August 2014
Indiana University – Bloomington, Indiana (APA accredited; NASP accredited)
Morrison Child and Family Services (APA accredited pre-doctoral internship)
Major: School Psychology
Dissertation: Effects of Sleep Schedule on Training of Executive Function Skills in Preschool-Aged Children
Committee: John E. Bates, Ph.D. (Chair), Jack A. Cummings, Ph.D., Thomas J. Huberty, Ph.D., ABPP, and David B. Estell, Ph.D.
Utilizing: Attention Network Task developed by Michael I. Posner, Ph.D. (University of Oregon), Jin Fan, Ph.D. (Sackler Institute for Developmental Psychobiology), and Bruce D. McCandliss, Ph.D. (Vanderbilt University)
Minor: Counseling
Qualification Paper: Parent-Child Interaction Therapy With Diverse Populations
Minor: Child and Family Studies
Paper: School-Based Interventions for Children of Divorce

Specialist in Education – June 2012
Indiana University – Bloomington, Indiana
Major: School Psychology

Masters of Science in Education – May 2007
Indiana University – Bloomington, Indiana
Major: Educational Psychology

Masters of Science in Education – June 2005
Indiana University – Bloomington, Indiana
Major: Curriculum and Instruction – Secondary Education

Bachelor of Science – June 2004
University of Washington – Seattle, Washington
Major: Psychology

Bachelor of Science – June 2004
University of Washington – Seattle, Washington
Major: Biology – Cellular and Molecular

Bachelor of Arts – June 2004
University of Washington – Seattle, Washington
Major: Chemistry

LICENSES / CERTIFICATIONS

2005 – Indiana State Teaching License: Secondary certification (grades 5-12) in Biology, Chemistry, Physical Science, General Science, Psychology, and Mathematics (with Recognition of Excellence)
(License Number: 936702)

2004 – Washington State Teaching Endorsement: Secondary endorsements in Biology, Chemistry, and General Science

HONORS / AWARDS

2010 – Department of Counseling and Educational Psychology's Trentham Travel Award. *[$300]*

2009 – Counseling and Educational Psychology Research Fellowship. Indiana University: School of Education. *[$750]*

2009 – Department of Counseling and Educational Psychology's Trentham Travel Award. *[$300]*

2006 – Stana Michael Scholarship. Indiana Association of School Psychologists (IASP). *[$1000]*

2005 – Recognition of Excellence. Educational Testing Services

2004 – Paul E. Klinge Scholarship. Indiana University: School of Education *[$1000]*

CLINICAL EXPERIENCE

Mental Health Therapist

Morrison Child and Family Services (Portland, Oregon)

Provide services to children and their families with a variety of behavioral and emotional concerns, specifically focusing on early childhood, grief/loss issues, and trauma recovery. Co-led several groups, including the Incredible Years Parenting Program and the Dina Child Social Skills & Problem Solving Training for Children curriculum both developed by Dr. Carolyn Webster-Stratton.
Supervisor: Joyce Ochsner, Ph.D., Colleen Scott, Psy.D.
August 2011 to Present

Clinical Child Psychology Intern (APA accredited)

Morrison Child and Family Services (Portland, Oregon)

Core placement at a community outpatient mental health clinic with a secondary placement at a children's medical health clinic. Provided services to children and their families with a variety of behavioral and emotional concerns. Developed treatment plans and conducted comprehensive psychological evaluations and provided feedback regarding diagnosis, treatment recommendations, consultation recommendations, and placement recommendations.
Supervisor: Joyce Ochsner, Ph.D.
August 2010 to August 2011

Pediatric Psychology Practicum Student

Riley Hospital for Children (Indianapolis, Indiana)

Completed multidisciplinary integrated pediatric psychological evaluations for families at the Riley Child Development Center three days a week (one to two assessments each day). Initiated and took leadership role of case coordinator on several cases, including that of a non-English speaking client. Participated in seminars dedicated to Leadership Education in Neurodevelopmental Disabilities (LEND) fellows to further my clinical child and pediatric skills.

Supervisor: Steven M. Koch, Ph.D., HSPP.

June 2006 to August 2006

Pediatric Psychology Practicum Student

Indiana University-Purdue University Indianapolis: Pediatrics – Adolescent Medicine (Indianapolis, Indiana)

Completed court ordered psychological evaluations. Collaborated with interdisciplinary teams regarding cases and provided clinical child and pediatric consultation services. Supervised and trained a doctoral-level psychology student in assessment administration and report writing. Conducted research in the areas of juvenile justice and sexually transmitted diseases.

Supervisor: Matthew C. Aalsma, Ph.D.

July 2009 to August 2010

Advanced Assessment Psychology Practicum Student

Institute for School Excellence (Indianapolis, Indiana)

Developed a partnership and form a strong, collaborative relationship between Indiana University's School Psychology program and the Institute for School Excellence. Completed comprehensive psychological evaluations by refining referral questions and designing psychological assessment batteries to address a range of evaluation questions. Provided conceptually informative, insightful reports and gave clear, concise, culturally aware, and clinically useful feedback and recommendations.

Supervisor: Thomas J. Huberty, Ph.D., ABPP.

September 2008 to June 2009

Clinical Psychology Practicum Student *[December 2007 to August 2010]*

Private Practice of Marsha R. McCarty, Ph.D., HSPP, Donald R. Weller, Ph.D., HSPP, & Catholic Charities (Bloomington, Indiana)

Supervised and oversaw new practicum students. Completed psychological evaluations and advocated for children and their families. Led and co-led group counseling sessions, parent and child sessions, and individual counseling sessions. Served as a liaison for all clients seen at Marsha McCarty's private practice clinic and Catholic Charities with those also seen at Stonebelt's Milestones Clinical and Health Resources.

Supervisor: Marsha R. McCarty, Ph.D., HSPP, & Donald R. Weller, Ph.D., HSPP.

Multidisciplinary Clinical Psychology Practicum Student

Stonebelt's Milestones Clinical and Health Resources (Bloomington, Indiana)

Worked with a multidisciplinary clinical team to provide accessible, responsive, comprehensive, integrated community mental health and behavioral support services. Served as a liaison between Stonebelt's Milestones Clinical and Health Resources and a local private practice clinic and non-profit social service organization. Co-led groups using cognitive-behavioral therapy and conduct individual counseling sessions.
Supervisor: Marsha R. McCarty, Ph.D., HSPP., & Debra Mishler, M.S.W., L.C.S.W.
December 2007 to August 2010

Functional Family Therapy Counselor / Practitioner

Indiana University: Center for Human Growth (Bloomington, Indiana)

Counseled court-mandated and self-referred adolescents and their families using the Functional Family Therapy (FFT) model through the Indiana Family Project (IFP) at Indiana University's Center for Human Growth. Participated and completed the national training program for the Indiana Family Project to received ongoing clinical training and practicum supervision with Dr. Thomas L. Sexton, one of the FFT model developers. Carried a caseload of seven families, and supervised new FFT counselors to ensure that model implementation was carried out with fidelity.
Supervisor: Thomas L. Sexton, Ph.D., ABPP.
May 2007 to August 2010

Behavioral Health Technician / Case Coordinator

Centerstone (Bloomington, Indiana) [formerly Center for Behavioral Health (Bloomington, Indiana)]

Organized and conducted weekly group therapy sessions for adult mental health clients. Monitored clients by intervening in crisis situations, providing daily support and guidance, and providing direct support enabling them to overcome obstacles in daily living.
Supervisor: Daniel McNeely, MSW, LCSW
July 2004 to August 2010

Residential Therapist

College Internship Program (Bloomington, Indiana)

Provided direct support and direction as a way to offer individualized post-secondary academic, internship, and independent living experiences for young adults with Asperger's Syndrome and Non-Verbal learning differences. Addressed crisis situations and worked with students to integrate within the community and further develop their social skills in everyday life situations.
Supervisor: Donald R. Weller, Ph.D., HSPP.
August 2006 to December 2009

ABA Therapist

Self Contracted (Bloomington, Indiana)

Provided Applied Behavior Analysis (ABA) therapy to a preschool boy diagnosed with Pervasive Developmental Disorder: Not Otherwise Specified eight hours per week throughout the entire calendar year. Provided consultation services to child's school and daycare centers to enable staff to better meet child's behavioral, social, and academic developmental needs. Utilized additional techniques including video self-monitoring and social stories and worked specifically on ways to improve his communication and social skills and to prepare him academically for elementary school.

Supervisor: Spencer Ramsey, Board Certified Associate Behavior Analyst.

May 2006 to July 2009

Behavioral Clinician Supervisor

Indiana University: Institute for Child Study (Bloomington, Indiana)

Supervised second-year School Psychology practicum students implement behavioral interventions for the Monroe County Community School Corporation through Indiana University's Institute for Child Study (ICS). Ensured that practicum students followed through with their behavioral assessments by providing professional support and utilizing my expertise and experience to help and guide their interventions and assessments. Collaborated with school personnel and provided consultation support to teachers and behavioral clinician interventionists.

Supervisor: Russell J. Skiba, Ph.D.

September 2007 to May 2008

Behavioral Clinician Interventionist

Indiana University: Institute for Child Study (Bloomington, Indiana)

Implemented behavioral interventions for three children interventions for the Monroe County Community School Corporation through Indiana University's Institute for Child Study (ICS). Conducted behavioral assessments through the use of Functional Behavioral Assessments, collaborated with school personnel, and provided consultation support to teachers as well as peer interventionists.

Supervisor: Russell J. Skiba, Ph.D.

January 2007 to May 2007

Residential Counseling Psychology Practicum Student

Damar Services, Inc. (Indianapolis, Indiana)

Worked with a multidisciplinary team at Damar Services, Inc., a residential facility for children with developmental disabilities and behavioral challenges. Completed comprehensive and integrated psychological evaluations and collaborated with teachers and staff. Co-led weekly group therapy sessions for young girls and adolescent girls and prepared children for adoption.

Supervisors: Scott D. Carson, Ph.D., Jim L. Dalton, Psy.D., HSPP, & Thomas J. Huberty, Ph.D., HSPP.

August 2006 to May 2007

Academic Interventionist

Indiana University: Academic Well-Check Program/Response to Intervention (Bloomington, Indiana)

Implemented a reading intervention for early elementary children struggling with reading fluency to assist in Indiana University's Academic Well-Check Program/Response to Intervention (AWCP/RTI) for the Richland Bean Blossom Community School Corporation. Worked with children in small groups, focusing on early literacy and reading skills, and administered and scored Curriculum Based Measurement (CBM) probes for identification, assessment, data analysis, and progress monitoring.
Supervisor: Rebecca S. Martinez, Ph.D., NCSP.
August 2006 to December 2006

Benchmarker

Indiana University: Academic Well-Check Program/Response to Intervention. (Bloomington, Indiana)

Administered reading and mathematics Curriculum Based Measurement (CBM) probes to students in kindergarten through fifth grade during three benchmark sessions each school year in reading fluency, reading comprehension, and mathematics individually and in large groups as part of Indiana
University's Academic Well-Check Program/Response to Intervention (AWCP/RTI) for the Richland Bean Blossom Community School Corporation.
Supervisor: Rebecca S. Martinez, Ph.D., NCSP.
September 2005 October 2006

International Psychology Practicum Student

Agua Viva Children's Home (Chimaltenango, Guatemala, Central America)

Participated in the first cohort to pilot this field-based practicum working at a Pre-Kindergarten to Grade 12 children's home for a two week period. Presented a professional development seminar on the implementation of Montessori practices. Created educational materials based on Montessori principles for use in the school and conducted a large group activity for over 60 students to further develop their social skills and peer interactions. Assisted in completing three evaluations with follow-up case conferences.
Supervisor: Rebecca S. Martinez, Ph.D., NCSP.
June 2006 to August 2006

Response to Intervention School Psychology Practicum Student

Indiana University: Academic Well-Check Program/Response to Intervention (Bloomington, Indiana)

Constructed a Response to Intervention (RTI) toolkit module and trained practitioners throughout Indiana as part of Indiana University's Academic Well-Check Program/Response to Intervention (AWCP/RTI).
Supervisor: Rebecca S. Martinez, Ph.D., NCSP.
May 2006 to June 2006

Educational School Psychology Practicum Student

Metropolitan School District of Perry Township (Indianapolis, Indiana)

Conducted psychological assessments and held case conferences of clients. Utilized a cross-battery assessment approach for thorough evaluation of students.
Supervisor: Bonnie J. Brewer, Ed.S., & Rebecca S. Martinez, Ph.D., NCSP.
January 2006 to May 2006

Educational School Psychology Practicum Student

Bartholomew Consolidated School Corporation (Columbus, Indiana)

Gained experience regarding the role of a School Psychologist in school environments ranging from Preschool to Grade 12, as well as in the areas of special education.
Supervisor: Julia A. Byers, Ph.D., NCSP., & Jack A. Cummings, Ph.D.
September 2005 to December 2005

RESEARCH EXPERIENCE

Leadership Education in Adolescent Healthcare (LEAH) Psychology Fellow

Indiana University-Purdue University Indianapolis: Pediatrics – Adolescent Medicine (Indianapolis, Indiana)

Met weekly with a multidisciplinary clinical team to discuss and collaborate on pediatric cases and attend seminars. Received funding from the Leadership Education in Adolescent Healthcare (LEAH) training grant. Established a student centered health education and promotion project that identifies and addresses an issue affecting students at a local high school.
Supervisor: Matthew C. Aalsma, Ph.D.
July 2009 to August 2010

Graduate Research Assistant

Indiana University: Toddler Sleep Study (Bloomington, Indiana)

Conducted and completed research in Dr. John E. Bates' social development laboratory by analyzing data based upon a coding protocol I developed. Prepared home visit protocols to run second wave of pilot data for grant proposal. Designated as the primary graduate research assistant in running home visit. Trained and oversaw undergraduate research assistants.
Supervisor: John E. Bates, Ph.D.
September 2005 to August 2010

Graduate Assistant

Indiana University: Center for Evaluation and Education Policy (Bloomington, Indiana)

Evaluated Indiana's Reading First Program, a national initiative, by coordinating with schools to ensure that site visits, interviews, observations, and other evaluation means were thoroughly completed. Wrote reports for the Indiana Department of Education based off of evaluation findings to help ensure program fidelity. Completed surveys and report projects for the Indiana Department of Education, wrote grants for education and health policy research, and wrote policy reports that were disseminated across the nation.
Supervisor: Jonathan A. Plucker, Ph.D., Emily C. Rouge, Ph.D., & Amy M. Kemp, Ph.D.
July 2005 to July 2009

Research Assistant

University of Washington: Project 123 Go! (Seattle, Washington)

Assisted in Dr. Liliana J. Lengua's cognitive developmental laboratory (at the Center for Mind, Brain, and Learning) by conducting and running interview sessions with parents and children. Gathered information from sessions for data collection, compilation, and entering. Gained first hand experience in running clinical/community research projects.
Supervisor: Liliana J. Lengua, Ph.D.
April 2002 to June 2003

Research Assistant

University of Washington: Infant Studies (Seattle, Washington)

Assisted in Dr. Andrew N. Meltzoff's cognitive developmental laboratory (at the Center of Human Development and Disability) by preparing client sessions and collecting data.
Supervisor: Andrew N. Meltzoff, Ph.D.
September 2000 to March 2001

OTHER EXPERIENCE

Greeter

Seattle Children's Hospital (Seattle, Washington) [formerly Children's Hospital and Regional Medical Center (Seattle, Washington)]

Patient-Family Support Services: Provided customer service to arriving patients, families, visitors, and staff members. Oversaw assigned guides and volunteers and collaborated with other departments to help establish a positive hospital environment.
August 1999 to June 2004

Resource Coordinator

Seattle Children's Hospital (Seattle, Washington) [formerly Children's Hospital and Regional Medical Center (Seattle, Washington)]

Patient-Family Support Services: Coordinated the organization of the family resource center and the hospital resource center. Provided support to patients, families, visitors, and staff members.
November 2000 to June 2004

Interior Designer

Self and Independently Contracted (Renton, Washington)

Project included new construction for a residential home. Solely responsible for wiring, fixtures, colors, materials, finishes, and appliances to meet the social-psychological and aesthetical goals and requirements of client. Coordinated and collaborated with client and other allied design professionals.

February 2004 to June 2004

PUBLICATIONS

Chien, R. W., Raketich, N., Aalsma, M. (under review). *HIV testing among adjudicated adolescents*.

Chien, R. W., Bodack, K. L., Jackson, R. A., Estell, D. A. (under review). *Teacher, self, and peer perceptions of popularity in new versus continuing students*.

Rouge, E. C., Hansen, J., Muller, P., & **Chien, R.** (2008). *Evaluation of Indiana Reading First program: Interim report: Year five*. Bloomington, Indiana: Indiana University, Center for Evaluation and Education Policy.

Kemp, A., Hansen, J., Muller, P., Kuby, C., Fender, H. R., **Chien, R.**, Bai, S., & Rinkenberger, B. (2008). *Evaluation of Indiana Reading First: Year 4 report.* Bloomington, Indiana: Indiana University, Center for Evaluation and Education Policy.

Chien, R. W., Spradlin, T. E., & Plucker, J. A. (2007). *Indiana's mathematics and science performance: Do we measure up?* Bloomington, Indiana: Indiana University, Center for Evaluation and Education Policy.

Plucker, J. W., Spradlin, T. E., Magaro, M. M., **Chien, R. W.**, & Zapf, J. S. (2007). *Assessing the policy environment for school corporation collaboration, cooperation, and consolidation in Indiana*. Bloomington, Indiana: Indiana University, Center for Evaluation and Education Policy.

Plucker, J. W., Spradlin, T. E., & **Chien, R. W.** (2007). *2006 Public opinion survey on higher education issues in Indiana*. Bloomington, Indiana: Indiana University, Center for Evaluation and Education Policy.

Plucker, J., Spradlin. T., Toutkoushian, R., Michael, B., Hansen, J., Zapf, J., **Chien, R.**, & Edmond, B. (2007). *Special education service delivery in Indiana: Year 2 study*. Bloomington, Indiana: Indiana University, Center for Evaluation and Education Policy.

Plucker, J. A., Spradlin, T. E., Zapf, J. S., & **Chien, R. W**. (2007). *2006 Public opinion survey on education in Indiana*. Bloomington, Indiana: Indiana University, Center for Evaluation and Education Policy.

Plucker, J. A., **Chien, R. W.**, & Zaman, K. (2006). *Enriching the high school curriculum through postsecondary credit-based transition programs*. Bloomington, Indiana: Indiana University, Center for Evaluation and Education Policy.

Plucker, J., Spradlin. T., Eckes, S., Ochoa, T., Toutkoushian, R., Michael, B., Williamson, G., Hansen, J., Trotter, A., Zapf, J., **Chien, R.**, & Jackson, R. (2006). *Special education service delivery in Indiana*. Bloomington, Indiana: Indiana University, Center for Evaluation and Education Policy.

Plucker, J. A., Spradlin, T. E., Zapf, J. S., **Chien, R. W.**, & Jackson, R. A. (2006). *2005 Public opinion survey on education in Indiana*. Bloomington, Indiana: Indiana University, Center for Evaluation and Education Policy.

Plucker, J., Spradlin, T., Zapf, J., McQueen, K., & **Chien, R.** (2005). *Middle school curriculum project*. Bloomington, Indiana: Indiana University, Center for Evaluation and Education Policy.

PRESENTATIONS

Chien, R. W., & Bates, J. E. (2012). *Caregiver reported behaviors relate to child attention performance.* Poster session presentation at Morrison – The Learning Institute: Contemporary Families 2012 in Portland, Oregon.

Peterson, I. T., Staples, A. D., **Chien, R. W.,** Hanrahan, M., & Bates, J. E. (2011). *Language ability predicts development of self-regulation among toddlers*. Poster session presentation at the 2011 biennial meeting of the Society for Research in Child Development (SRCD) in Montreal, Quebec, Canada.

Chien, R. W., & Aalsma, M. C. (2010, April). *HIV testing among adjudicated adolescents*. Poster session presentation at the Society for Adolescent Medicine (SAM) 2010 Annual Meeting in Toronto, Ontario, Canada.

Chien, R. W., Staples, A. D., & Bates, J. E. (2009, April). *Mother-child interaction relates to mother and child sleep.* Poster session presentation at the 2009 biennial meeting of the Society for Research in Child Development (SRCD) in Denver, Colorado.

Chien, R. W., Bodack, K. L., Jackson, R. A., & Estell, D. B. (2009, April). *Teacher, self, and peer perceptions of popularity in new versus continuing students*. Poster session presentation at the 2009 biennial meeting of the Society for Research in Child Development (SRCD) in Denver, Colorado.

Plucker, J. A., Spradlin, T. E., & **Chien, R. W.** (2007, May). *2007 public opinion survey on higher education issues in Indiana*. Presented to the Indiana Commission for Higher Education in Indianapolis, Indiana.

Plucker, J. A., Spradlin, T. E., Zapf, J. S., & **Chien, R. W.** (2007, January). *2006 public opinion survey on education in Indiana*. Presented to the Indiana State Board of Education in Indianapolis, Indiana.

Center for Evaluation and Education Policy. (2006, December). Poster exhibition at the Indiana Youth Institute's (IYI) Kid's Count in Indiana Conference in Indianapolis, Indiana.

Chien, R. W., Prendergast, K. A. (2006, August). *Educación Montessori*. Presented to the staff, faculty, and teachers at Agua Viva Children's Home in Chimaltenango, Guatemala (Central America).

Plucker, J. A., Spradlin, T. E., Zapf, J. S., **Chien, R. W.**, Jackson, R. A. (2006, January). *2005 public opinion survey on education in Indiana*. Presented to the Indiana State Board of Education in Indianapolis, Indiana.

Plucker, J. A., Spradlin, T. E., Zapf, J. S., **Chien, R. W.** (2005, September). *Status of Indiana's highly qualified provisions*. Presentation session at the 2005 Indiana Counsel of Administrators of Special Education (ICASE) Conference in Fort Wayne, Indiana.

CONFERENCES /TRAININGS/ WORKSHOPS ATTENDED

Oregon Department of Human Services. Parent Child Interaction Therapy (PCIT) Training. Salem, Oregon. *[April 7, 2014 – April 9, 2014]*

Oregon Health Authority. "Calming the Storm" with Parent Child Interaction Therapy (PCIT). Salem, Oregon. *[March 12, 2014]*

Morrison – The Learning Institute. Contemporary Families 2013 – Trauma: Theory and Practice. Portland, Oregon. *[August 19, 2013 – August 21, 2013]*

National Association of School Psychologists. NASP 2013 Annual Convention. Seattle, Washington. *[February 12, 2013 – February 14, 2013]*

Morrison – The Learning Institute. Contemporary Families 2012 – Building Blocks to a Better Practice. Portland, Oregon. *[August 6, 2012 – August 8, 2012]*

Multnomah County Department of County Human Services. Child-Parent Psychotherapy (CPP) Training. Portland, Oregon. *[May 17, 2012- May 18, 2012]*

Incredible Years (IY). IY Group Leader Training. Portland, Oregon *[January 12, 2011, January 20, 2011-January 21, 2011].*

Society for Adolescent Medicine (SAM). 2010 Annual Meeting. Toronto, Ontario, Canada. *[April 7, 2010 – April 10, 2010]*

SibShop Facilitator Training. 2010 Sibshop Awareness and Facilitator Training. Indianapolis, Indiana. *[February 26, 2010 – February 27, 2010]*

Cogmed. *"Cogmed Working Memory Training."* Webinar. *[September 30, 2009]*

Pearson. *"WIAT-III Presentation: An Overview of the New WIAT-III."* Webinar. *[September 28, 2009]*

Society for Research in Child Development (SRCD). 2009 Biennial Meeting. Denver, Colorado. *[April 2, 2009 – April 4, 2009]*

ISTC Talking Cure. *"Client Directed Outcome Informed (CDOI) Work for the School Counselor, Psychologist, and Social Worker."* Webinar. *[February 12, 2009]*

University of Wisconsin: Madison. *"Special Topics Seminar in Child and Adolescent Psychopharmocology: New Medication Advances in ADHD Treatment: Progress or Fraud?"* Interactive videoconference with Hugh F. Johnston, MD. *[November 7, 2008]*

Milestones Clinical & Health Resources (a division of Stone Belt). *"Parental Depression and Its Effects on the Family."* Bloomington, Indiana. *[July 17, 2008]*

Psychiatric Solutions, Inc.: Bloomington Meadow's Hospital. "*Using Family Therapy to Address High Risk Behaviors in Teens.*" Bloomington, Indiana. *[February 22, 2008]*

Indiana Resource Center for Autism (Dr. Scott Bellini). *"Building Social Relationships."* Bloomington, Indiana. *[November 7, 2007]*

Indiana Youth Institute. Indianapolis, Indiana. *[December 6, 2006]*

Indiana Association of School Psychologists (IASP) Conference. Indianapolis, Indiana. *[October 16, 2006 – October 17, 2006]*

Lovaas Institute. **"***ABA's Usefulness to a School Aide."* Indianapolis, Indiana. *[September 26, 2006]*

Crisis Intervention (Dr. Bill Pfohl). Bloomington, Indiana. *[April 14, 2006]*

Wechsler Intelligence Scale for Children – Fourth Edition – Integrated (WISC-IV-Integrated). Bloomington, Indiana. *[January 27, 2006]*

Indiana Association of School Psychologists (IASP) Conference. Indianapolis, Indiana. *[October 18, 2005]*

MEMBERSHIP / AFFILIATIONS

Professionally Related Memberships/Affiliations:

American Psychological Association (APA) – Student Affiliate

American Psychological Association (APA), Division 16: School Psychology – Student Affiliate

American Psychological Association (APA), Division 37: Society for Child and Family Policy and Practice – Student Affiliate

American Psychological Association (APA), Division 43: Society for Family Psychology – Student Affiliate

National Association of School Psychologists (NASP) – Student Membership

Indiana Association of School Psychologists (IASP) – Standing Committee: Indiana University Student Liaison

Student Affiliates in School Psychology (SASP) – Indiana University: Secretary, Treasurer, and IASP Student Liaison

PROFESSIONAL REFERENCES

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