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Sleep and Language Development

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SLEEP AND LANGUAGE DEVELOPMENT

by

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Bachelor of Science, Murray State University, 2009

A Research Paper
Submitted in Partial Fulfillment of the Requirements for
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SLEEP AND LANGUAGE Development

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A Research Paper Submitted in Partial

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As adults, without a good night's sleep, daytime functioning and behavior may be altered. Poor sleep may be a result of many aspects: anxiety, underlying medical problems, particular events, among other contributors. Regardless of the cause, the effects are evident. Though changes may be subtle, executive functioning, critical thinking, and speech may be compromised. Lack of energy, decrease in ability to learn new things, and excessive sleepiness may also be evident. Neuroimaging studies have also demonstrated that even short-term sleep deprivation may cause disruptions in verbal fluency, decrease in flexible thinking, memory for temporal order, and inhibition. In order to facilitate better language development, it is necessary to understand the precise role sleep has on language development. Therefore, this is a review of sleep and language development in order to find out if the amount or quality of sleep impacts how children develop language. The goal is to better understand the role sleep plays in language development in order to promote more efficient language development.

Sleep

Sleep, or lack thereof, appears to be an influential factor in children's behavior, cognitive, and language abilities (Fenn et al., 2003; Honaker et al., 2009; Mitchell & Boss, 2009; Ravid et al., 2009). Children, especially young children, are undergoing critical change and development. Sleep is important in neural maturation and synaptic plasticity in early childhood (Key et al., 2009). Lack of sleep may negatively impact developing children's learning, memory, and behavior (Quach et al., 2009). Each of these developmental areas contributes to the language development of children. Sleep problems at an early age not only impact the child in the present, but also impact later developmental outcomes such as behavioral, attention, and emotional problems which could lead to decreased academic performance (Ravid et al., 2009).

As in adults, many factors may contribute to the underlying cause of lack of sleep in a child. Common causes include difficulty falling asleep, night waking, snoring, obstructive sleep apnea, and narcolepsy (The Brown University Child and Adolescent Behavior Letter, 2009; Hamilton, 2009). It is recommended that infants get 14 to 15 hours of sleep a night, toddlers receive 12 to 14 hours

of sleep a night, preschoolers receive 11 to 13 hours a night, and school-aged children receive 10 to 11 hours a night (Lamm, 2006). However, many parents have reported their children receive much less than the recommended amount (Lamm, 2006); possibly due to the aforementioned causes. Sleep is crucial in the development of a child. Without it, deficits are bound to surface.

Children require a much greater amount of sleep than adults (Lamm, 2006). If receiving the appropriate amount of sleep, it may seem that children are asleep more often than they are awake. While children differ in their precise amount of sleep and the times at which they sleep, all children have the ability to sleep through the night (Lamm, 2006). During sleep, a person's body is allowed much needed rest while the brain processes information gathered during the wake cycle; the brain also continues to control heart rate, breathing, muscle control, and other body functions while the person is asleep (American Academy of Sleep Medicine, 2007).

Sleep is divided into stages: N sleep and R sleep. First is N sleep, or non-rapid eye movement (non-REM) (American Academy of Sleep Medicine, 2007). N sleep is the stage an individual enters when first falling asleep. It

accounts for 75% of sleep time in adults and 50% of sleep times in infants. N sleep is further divided into three stages. During stage N1, brain waves change from alpha waves of wakefulness to theta sleep waves. This stage is very light sleep and individuals may easily be wakened. During stage N2, individuals' eyes stop moving and muscles relax more as they move into a time of high amplitude, slow brain wave activity. Stage N3, is a period of deep sleep. Individuals are much harder to awaken during this stage. R sleep, or REM sleep, is the final stage in the sleep cycle. During this stage, eyes tend to move rapidly; arm, face, and leg muscles tend to twitch, and heart rate, breathing, and blood pressure fluctuate. The combination of these stages completes a cycle of sleep. Adults tend to go through four to six 90-100 minute cycles a night. Children's cycles are much shorter, approximately 45 minutes in length, and catch up to that of adults at around age ten (American Academy of Sleep Medicine, 2007).

Between 20% and 30% of children experience sleep disturbances (Hamilton, 2009). These are defined broadly as the interference with the refreshing nature of sleep (The Brown University Child and Adolescent Behavior Letter, 2009). Sleep disturbances may include sleep-disordered

breathing. Sleep-disordered breathing ranges from a mild form, habitual snoring, to a more severe form, obstructive sleep apnea. Habitual snoring has a mean prevalence of approximately 10-12% in children while obstructive sleep apnea appears in 2-3% of children (Honaker, Gozal, Bennet, Sans Capdevilla, & Spruyt, 2009). Both forms may lead to disruptions in attention, concentration memory, and verbal and non verbal intelligence (Honaker, et al., 2009). Other examples of sleep disturbance include but are not limited to childhood insomnia, night terrors, and narcolepsy, among a variety of other disorders (The Brown University Child and Adolescent Behavior Letter, 2009).

Sleep disturbances may be caused by underlying medical conditions such as depression and anxiety disorders or Attention-Deficit/Hyperactivity Disorder (ADHD) (Friedman, 2007). Children with developmental disorders such as Down syndrome, neuromuscular diseases, cerebral palsy, and sickle cell disease may be more apt to have sleep disturbances (Friedman, 2007). Disorders such as sickle cell disease, juvenile rheumatoid arthritis, sleep-related gastroesophageal reflux disease, and nighttime exacerbations of childhood asthma may also contribute to sleep disturbances in children (Hamilton, 2009). Many

childhood sleep problems may be diminished or alleviated by some form of treatment. Options may include behavioral therapy, pharmaceutical, surgical procedures, or a combination of the three (Hamilton, 2009).

Cognition

Cognition plays an important role in an individual's language skills. Cognitive abilities correlate significantly with language abilities. Studies show that lack of sleep or lack of quality sleep directly impacts cognitive abilities in young children (Ravid et al., 2009, Parry-Fielder et al., 2009). Ravid et al. (2009) investigated the role of sleep disturbances in children preparing for school. The study included 148 kindergarten students. Participants underwent a series of tests including the Weschler Preschool and Primary Scale of Intelligence-Revised (WPPSI-R), Conners' Parents Rating Scales-Revised, Technion Sleep Questionnaire, and a 1-week ambulatory actigraph. Results of the cognitive tests confirmed that participants who received less amount of sleep or lower quality sleep had significantly lower WPPSI-R scores than those who received better sleep. Lower scores on the WPPSI-R Performance, Verbal, and Global scores were

associated with children who suggested sleep disturbances such as insomnia and parasomnia.

Contrary to the study by Ravid et al.(2009), Key et al. (2009) argued that sleep does not play a role in cognitive development. Key et al. (2009) investigated the relationship of snoring with sleep, cognition, and psychophysiological characteristics. Thirty-five children between the ages of 5.3 and 7.5 years who were identified as habitual snorers participated in the study. Participants underwent a series of tests including NEPSY, a neuropsychological test for attention, memory, and language abilities, event-related potentials (ERPs) to speech sounds for psychophysiological abilities, and a standard overnight multichannel polysomnographic evaluation. Results of the cognitive portion showed that higher apnea/hypopnea index (AHI) (the number of apneas or hypopneas per hour of total sleep time) did not correlate with NEPSY measures of attention and memory. The discrepancy between Key et al.(2009) and Ravid et al. (2009) might be due to the fewer number of children with severe sleep disordered breathing in the Key et al. (2009) study. Such reasoning might suggest that more severe sleep disordered breathing is associated with impacts on cognitive development as opposed

to mild sleep disordered breathing. Although cognitive deficits were not found by Key et al. (2009), the study did find that even mild forms of sleep disordered breathing may be associated with alterations of brain functioning. Children with higher apnea indexes were found to have greater difficulty regulating attentional commands. Attention is an important factor in the ability to learn language as well as being successful in the academic setting.

Similar to Key et al. (2009), Quach et al. (2010) also suggested that sleep may not be related to cognitive abilities. Quach et al. (2010) investigated the natural history of sleep problems spanning the two year period prior to school entry and the associations of children's health-related quality of life, language, behavior, learning, and nonverbal cognition. Data was drawn from the Longitudinal Study of Australian Children during two waves, one when the children were between four and five years old and one when the children were between six and seven years old. During Wave 1, information was collected from the primary caregiver as to whether or not the child had a sleep problem such as difficulty falling asleep, night waking, snoring, or morning fatigue. At Wave 2, the same

information was collected and participants underwent a series of tests including (a) The Wechsler Intelligence Scale for Children IV (WISC-IV) for nonverbal cognition and verbal cognition, (b) subscales of the parent-reported Child Communication Checklist 2 (CCC-2) for speech, syntax, semantics, and coherence, (c) the Pediatric Quality of Life Inventory 4.0, (d) the parent-reported and teacher-reported Strengths and Difficulties Questionnaire to assess behavior, and (e) the teacher-reported language and literacy and the mathematical thinking subscales of the academic rating scale from the Early Childhood Longitudinal Study to assess learning. Results of the cognitive portion suggested that cognition was largely preserved despite varying degrees of severity of sleep problems. While the study does not suggest that sleep has an impact on cognition at this age, much of it was based on parent report rather than objective measures. Children with sleep disturbances often go undiagnosed and such cases may have impacted the validity of Quach et al.(2009).

Parry-Fielder et al. (2008) suggested that epileptiform activity identified via electroencephalogram (EEG) during sleep is consistent with lower cognitive ability. Parry-Fielder et al. (2008) investigated children

with severe developmental speech-language disorder (DSL_D) and the frequency of epileptiform EEG (epEEG) because they believed that children with severe DSL_D and epEEG would show unique speech-language or cognitive profiles. A control group of 45 language-normal children and an experimental group of 54 children with a diagnosis of DSL_D participated in the study. Participants were between the ages of 4 years and 9 years-11 months. Participants underwent interviews, neurological examination, speech-language examination, cognitive assessment, and sleep EEGs. Results of the cognitive tests showed significant association between epEEGs and lower performance in cognitive areas. Results suggest that interference of normal brain wave function during sleep might result in lower cognitive scores.

Research on the role of sleep in cognitive development is controversial. Although two of the studies suggested that sleep does not correlate with cognitive development, two also suggested that sleep and cognitive development do correlate. It is not possible to say for certain which is fact. Continued study will allow more significant conclusions in this area.

Language

Sleep is believed to affect all areas of development including language. The first few years of life are critical in this development. Negative influences on development during this time of life may have lasting negative influences on an individual's language. Although the impacts of sleep on cognitive development are controversial, the influence of lack of amount or quality of sleep may still have negative impacts on language development.

Semantics and Syntax

Word finding problems have been found to be associated with sleep deprivation in adults (Harrison & Horne, 1998). The study looked at 50 subjects with a mean age of 22.8 years of age. The participants were sleep deprived for 34 hours then completed the Haylings Sentence Completion task and completed a word generation task where they had to generate orally as many verbs directly associated with a given prompt. Results indicated that participants had a difficult time with the word associations task. However, they were often able to successfully complete a sentence. Such results indicate that adults, with a more mature and

developed brain than children, have difficulty with some semantic tasks when deprived of sleep. The study was limited in that it did not address the impact sleep deprivation has on children. Further research in this area is necessary in order to fully understand the impacts of sleep on semantic and syntactical aspects of language.

Although Harrison & Horne (2008) did not include children in their study, other studies confirm semantic difficulties in children with sleep disturbances. Honaker et al. (2009) investigated the verbal skills of children with sleep-disordered breathing because they believed that children with more severe sleep disordered breathing would be more likely to have limited verbal skills. Participants in the study included 228 children with a mean age of 6.68 who were enrolled in the 1-3 grades. Participants underwent a test battery including the School-Age or Preschool Form of the Differential Ability Scales, the NEPSY, the Peabody Picture Vocabulary Test, 3rd edition, and the Expressive Vocabulary Test. Participants also underwent an overnight multichannel polysomnographic evaluation. Results indicated that those with sleep disordered breathing, both habitual snoring and obstructive sleep apnea, exhibited lower levels of vocabulary development, though they were within the

normal range. Children with obstructive sleep apnea also demonstrated significantly lower levels of auditory comprehension as compared to their otherwise healthy peers. As verbal instructions became semantically and syntactically more complex, the participants had increasing difficulty. Children with more severe respiratory problems displayed more significant deficits than their typically developing peers.

Both studies agree that sleep has an impact on the semantic and syntactic abilities of adults and children. These studies are an interesting comparison to the studies of cognition and sleep. If semantic and syntactic abilities are impaired, the same deficit could occur in the verbal portion of cognitive assessments. Although the vocabulary deficits of children with sleep disturbances was not severely impacted, their ability to comprehend semantically and syntactically complex utterances was impaired which could pose a problem in tests of cognition as well.

The aforementioned investigations looked at the role of nocturnal sleep and language. Gomez et al. (2006) investigated the impact of naps on abstract language learning in infants. Gomez et al., (2006) investigated 48 healthy 15-month-olds in order to determine if napping

after language exposure would enhance the learning of abstract language. They believed that language abstraction is important because abstraction is an important part of language and learning. Participants were assigned to either nap, no-nap, or nap-control conditions. For the study, a nap was defined as 30 minutes or more of uninterrupted sleep during the time between familiarization and test. Familiarization consisted of the participants listening to strings of their training language multiple times. After 4 hrs, each group was tested. The head turn preference procedure was used to determine if the infant oriented to the test stimulus. Test stimulus consisted of words from familiarization in different strings. Results showed that infants who napped oriented to new strings of the words from familiarization more than those who did not, indicating that sleep in the form of naps facilitates language abstraction in infants. Abstraction is an important part of language and learning. Ensuring a child takes adequate naps may enhance abstract learning and language.

Phonology and Morphology

In the study conducted by Parry-Fielder et al. (2009) with children with epEEG and DSLD, language testing was also conducted. Results indicated that the most common subtype of DSLD in children with epEEGs was phonological syntactic, a subtype of DSLD characterized by lower lexical diversity and shorter length of utterances. This subtype appeared nearly twice as often as compared with other subtypes. Children within this subtype accounted for 71% of the epEEGs. Phonological syntactic subtype of DSLD accounted for only 38% of those with normal EEGs. We can infer from the epEEG that these children received lower quality of sleep than those with normal EEGs. It is possible that this lower quality of sleep is a factor in the increased amount of phonological syntactic subtype of DSLD. However, more research is needed to confirm such ideas.

Sleep contributes to phonological development and consolidation in children. Lack of quality sleep may contribute to disturbances in a child's phonological development (Parry-Fielder et al., 2009). Fenn et al. (2003) also supported this idea. Fenn et al. (2003) investigated the role of sleep on individuals'

consolidation of perceptual learning of spoken language during sleep. Participants included 84 persons with a mean age of 20.3 years old who were divided into two groups. Each group listened to a series of computer-generated monosyllabic consonant-vowel-consonant words and responded by typing each word; listeners never heard the same word twice. Both groups were given a pre-test before the training and post-test 12 hours after the training. One group was allowed sleep during the 12 hours while the other group was denied sleep. Results from the post-test showed significant improvement in the group that slept as compared to the group that did not. This study indicates that sleep plays a role in the consolidation and learning of phonological structures. Though this study investigated only adults, it would be interesting to see the results of young children who are at a prime time in language development and are acquiring phonological structures.

Children with sleep-disordered breathing often do not get the recommended amount of sleep and often the sleep that they do have, is not of high quality. A common cause of sleep-disordered breathing is adenotonsillar hypertrophy (Lundeborg, et al. 2009). Lundeborg, et al. (2009) explored the impact of adenotonsillay hypertrophy in children with

sleep-disordered breathing on their phonological development. The study investigated 67 Swedish children between the ages of 50 and 65 months with adenotonsillar hypertrophy. A control group of 70 typically developing peers were also included. Prior to receiving surgery and again afterwards, participants underwent a Swedish phonology test. Oral motor examinations were also administered. Results indicated that after surgery there were phonological improvements in the experimental group. Results also indicated no relationship between the results of the oral motor examination and the phonological development. This indicates that after surgery, the severity of the sleep disturbances due to respiratory problems was either diminished or alleviated causing a direct impact on the children's phonological growth.

Pragmatics and Behavior

During this critical developmental time frame, children must learn appropriate social language and behavior. Lack of amount or quality of sleep has been associated with children's language, spontaneity, social behaviors, and ability to control emotions (Quach et al., 2009). In the Quach et al. (2009) study, results indicated

that overall language use in children was poorer in those with persistent sleep disturbances. The study also suggested that children with persistent sleep disorders had poorer parent-reported and teacher-reported behavior. The question comes into play as to whether parent and teacher reports are reliable. Parent reports of children's behaviors were more reliable than that of the teacher though both were factual (Paavonen et al., 2009).

There is much agreement in the research community that sleep disturbances directly affect children's behavior (Mitchell & Boss, 2009; Paavonen et al., 2009; Quach et al., 2009; & Velten-Schurian et al., 2010). Paavonen et al., (2009) investigated sleep difficulties and behavioral symptoms in children because they believed that limited sleep and sleeping difficulties are associated with inattention, internalizing, and externalizing symptoms and tiredness. They investigated 297 families of 5-6 year old children. Parents completed a questionnaire with questions regarding their child's sleeping behaviors and questions about the child's behavior and mental health. Background and demographic information was also included in the survey. Results showed that short sleep duration was very closely related to psychiatric symptoms such as attention,

and internalizing and externalizing symptoms. Such psychiatric symptoms were also related to sleeping difficulties. Therefore, limited sleep as well as sleeping difficulties appear to be related to children's behavior.

Similar to Lundeborg et al.(2009), Mitchell & Boss (2009) also investigated the affect of surgery on children with sleep disordered breathing and its impacts on their development. However, the focus of this study was behavior instead of phonological development. Mitchell & Boss (2009) investigated quality of life and behavioral deficits in children with obstructive sleep apnea, and the impact of adenotonsillectomy. Eighty-nine children between the ages of 3 and 17.1 with a apnea-hypopnea index greater than or equal to two were included in the study. Obese and normal-weight children were included. Participants underwent polysomnography. Caregivers completed the OSA-18 Quality of Life survey and the Behavioral Assessment Survey for Children (BASC) before and 3-6 months after surgery. Results indicated improvement in both quality of life and behavior deficits after the surgery. This study shows that children with obstructive sleep apnea had poorer behavior. The study did not clarify, however, whether the

improvements were due to better sleep after surgery, or improved respiration.

Velten-Schurian et al. (2010) investigated sleep behaviors to analyze the association between sleep behaviors in children with insomnia and daytime functioning. They also wanted to determine whether the variables of frequency of night waking and wake time after sleep onset provided any additional information in the prediction of daytime functioning in this population. The study included 34 children between the ages of 5.2 and 10.9 who were diagnosed with behavior related to insomnia according to the International Classification of Sleep Disorders, 2nd edition (ICSD-II). Of the 34 children, 25 presented with behavioral insomnia of childhood, six had inadequate sleep hygiene, two had psychophysiological insomnia, and one had an adjustment sleep disorder. The participants' caregivers completed the following: a questionnaire about their child's development and the history of their sleep problems, a two week sleep log of their child, an interview about their child's sleep, and additional questionnaires addressing their child's sleep patterns, daytime sleepiness, and daytime problem behaviors. Main results of the analysis of the data found

that reduced total sleep time was associated with more delinquent behavior and more concentration problems. Also, longer wake time was linked to more profound daytime sleepiness which in turn correlated with social problems. The Velten-Schurian et al. investigation again confirms that lack of sleep and lack of quality of sleep is directly linked to behavior and social behavior of children.

Learning and School Readiness

Every moment is an opportunity to learn. Young children are constantly experiencing new situations and learning from such experiences. Sleep enhances such opportunistic learning. Sleep consolidates memories and protects them from further interference or decay and also recovers and restores memories (Fenn et al., 2003). In the study conducted by Fenn et al. (2003), sleep was found to stabilize memories so that the rest of the wake cycle did not cause regression of learning the following evening.

Sleep has been seen to cause problems with attention, behavior, learning, and language which may limit academic success. Students at the elementary level are expected to behave appropriately, sustain adequate attention, and learn in a language-rich environment. Deficits in such areas are

bound to surface and hinder the learning environment. Children who perform better in school tend to go to bed earlier, sleep more, and have more regular sleep/wake rhythms (Paavonen et al., 2009). Ravid et al. (2009) found that children who did not qualify for first grade after a year in kindergarten had much lower sleep quality and shorter sleep duration than those children who did qualify. Sleep problems were more common in these children and they were often fatigued, had low energy, and were sleepy during the day. Addressing sleep problems before the start of school could encourage better academic performance in children with sleep disturbances or sleep disorders (Paavonen et al., 2009).

Intervention

Various interventions are available for sleep disorders depending on the cause of the sleep disorder or sleep disturbances. Most common are surgery, pharmaceuticals, and behavioral therapy. Sleep-disordered breathing, obstructive sleep apnea, and habitual snoring, may be alleviated or entirely diminished by surgery such as adenotonsillectomy, the use of continuous positive airway

pressure (CPAP), while overweight or obese children may benefit from weight loss (American Academy of Sleep Medicine, 2006; Friedman, 2007; & Hamilton, 2009).

Pharmaceuticals may be used to lessen disorders of anxiety or stress that may cause forms of insomnia (Hamilton, 2009). However, pharmaceuticals are not recommended for use to treat sleep problems. Sleep hygiene and behavioral therapy is considered be the best method to treat behavioral sleep disorders (Hamilton, 2009). Such intervention includes setting a firm bedtime, creating a comfortable sleeping environment, helping the child wind down from the day, and minimizing caffeine and energy supplements throughout the day.

Further Investigations

Much research is still needed in the area of sleep and language development. Few studies have been conducted to determine the specific link between sleep and language development. While aspects of language have been studied, a broader picture is lacking. Studies have focused on phonological development and vocabulary development. Future investigations should look at language as a whole and how it develops in children with sleep disturbances.

Several studies have considered the role of sleep in adults or school-age children. However, there are few studies focused on infants and toddlers. Sleep patterns of younger children in the birth to three population should be investigated to determine how significant the link between the two is. Also, the majority of the current investigations focus on children with specific sleep disorders. Future investigations should also look at the sleep patterns of children with delayed or impaired language development who are otherwise healthy.

Conclusions

Sleep has an impact on children's language development. When a child does not receive an appropriate amount of sleep or efficient quality of sleep, the effects are seen within the child's development. Semantics, syntax, phonology, morphology, and pragmatics are all impaired when sleep disturbances are present. Lack of sleep or lack of quality of sleep also causes deficits in children's behavior, attention, and emotional stability. Such deficits contribute to decreased performance in the academic setting and may have long term effects.

Intervention in a timely and efficient manner may reduce such deficits. Educating current parents as well as soon-to-be parents on the importance of sleep for their child's development may be a beneficial method of prevention. Education on different sleep disorders and disturbances as well as good sleep hygiene for their child might decrease sleep problems and in turn enhance the child's growth and development.

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