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Sleep Deprivation and Brain Function: How does sleep deprivation effects college students' ability to retain information and create memories?

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Abstract: **Specific memory defects and brain function abnormalities are linked to sleep deprivation-a major issue that many experience daily. For instance, inadequate sleep impairs the hippocampus, the major brain structure that is responsible for learning and memory formation. Studies found that there is a great link between sleep, and academic performance, and that sleep deprivation has a negative influence in academic performance and learning. Receiving enough sleep does not only help the brain to function properly, but also has a positive impact on our lifespan and is imperative in maintaining a good health.**

Keywords: **Deprivation, Sleep Impairs, Sleep Deprivation, Negative Influence.**

I. INTRODUCTION

Sleep deprivation is a major problem that affects college students' ability to retain information and create memories. People might only believe that sleep gives your body rest and recharge. However, many are not aware how important sleep is to the brain's ability to learn and function properly. It is true that our body rests while sleeping, but the brain is also busy processing memories. Sleep deprivation severely impairs the hippocampus which in turn decreases the students' ability to perform well in school. The hippocampus is a complex structure that is responsible for forming memories. In addition, insufficient sleep interferes with the biological structures that play critical roles in forming the hippocampus (Ciccarelli, & white, 2013, p.160-165). According to Willingham (2013), Poor quality of sleep causes increase of depression, which is a mood disturbance and affects student's ability to concentrate and learn. When sleep deprived, a person is at risk of developing serious and life threatening problems. Particularly, the person's ability to retain and create memory becomes impaired. Additionally, scientists found that most college students' memory loss was a result of sleep deprivation (Guan, Peng & Feng, 2004, p.38). These factors negatively impact and decrease students' ability to learn new information, retrieve old memories and perform better in their studies.

II. SCIENTIFIC STUDIES

Scientists who studied the importance of sleep have spent a long time to answer what would seem an obvious question: "why do we need to sleep?" (Willingham, 2013, p. 36) Studies reviewed below suggests that inadequate amount of sleep has a wide range of cognitive costs and is a major contributor to most workplace and automobile accidents. According to recent studies that were conducted in the United States, only eight percent of college students reported that they receive optimal amount of sleep, the majority sixty-nine percent reported being sleep deprived (Willingham, 2013, p.37). The sleep deprived students reported being anxious and depressed. This study concludes that lack of sleep represents a challenge to students. However, our society does not acknowledge the effects of sleep deprivation and how it is a major cause of cognitive and memory impairment. Moreover, the experiment identified that sleep and academic performance have strong relationship, and that lack of sleep is associated with poor performance in school (Willingham, 2013, p.37-39). Likewise, numerous other studies were conducted finding the influence of sleep deprivation in learning. The same results were found, indicating that lack of sleep is associated with innumerable cognitive impairments. The brain and its important structures become damaged and consequently, student's learning ability declines drastically.

III. DEPRESSION

Scientists discovered sleep deprivation is associated with a higher rate of depression in college students, which impacts their cognitive performance. However, our society does not yet realize these devastating problems. For example, a sleep deprived student might experience stress and depression as a result of sleep deprivation and end up finding medical treatments or "activating behavioral changes" (Strine, & Chapman, 2005). As a result, the student experiences stress and anxiety that negatively impact their cognitive and mental abilities. It might come to a point when the students find it difficult to concentrate on learning. Recent studies have shown that sleep deprived students are less likely to integrate new materials and perform low on exams as well as a decrease of motivation (Strine & Chapman, 2005; Willingham, 2013, p. 35-39). Besides, researchers reported that there is a negative correlation between insufficient sleep and grade-point average. On the other hand, students who received enough sleep reported getting higher grades and suffer less from depression (Strine & Chapman, D., 2005). It is clear that sleep deprivation has negative impacts on the most important structures of the brain.

IV. HIPPOCAMPUS

The function of the hippocampus had not been identified prior Henry Molaison's case, also known as H.M. (Ciccarelli, & White, 2013, p.165). H.M. suffered severe epileptic seizures and his doctors believed that the hippocampus was responsible for his problems. Doctors recommended for him to undergo brain surgery and remove his hippocampus. Unexpectedly, H.M. could neither learn new information nor could he retrieve his old memories. Experts became curious about the major function of the hippocampus (Ciccarelli, & White, 2013, p.165). After conducting numerous experiments, it was discovered that the hippocampus is responsible for creating new memories as well as retaining old memories. Other cases similar to H.M were investigated to further understand the hippocampus. In one study, the hippocampi of patients with circumscribed memory were studied. The Magnetic resonance imaging (MRI) showed that their hippocampus was smaller in size: "This result suggested that damage to the hippocampus is sufficient to produce clinically significant and long-lasting memory impairment" (Zola-Morgan, & Squire, 1993). Similarly, Sleep deprivation impairs the type of long-term memory that is encoded by the hippocampus.

Even though scientists were proud of discovering the mystery of the hippocampus, they were interested to further explore the specific type of long-term memory that is affected by sleep deprivation. Thus, they started investigating the two parts of long-term memory which are known as declarative and procedural (Ciccarelli & white, 2013, p.164-168). Afterwards, it was found that the hippocampus specifically encodes for the type of long-term memory that is called declarative memory. Declarative memories are memories of fact and are also known as explicit memory (Ciccarelli & white, 2013, p.171). In declarative memory, information can be encoded and stored explicitly. Declarative memory can be divided into two parts, episodic and semantic memories. Episodic memories are memories such as events and personal experience, whereas semantic memories are memory of meaning and general facts such as knowing the meaning of vocabulary words (Ciccarelli & White, 2013, p. 189). In H.M's case, he was incapable of forming his declarative memories. However, he was able to form his procedural memories, the unconscious memory of skills and how to do things such as riding a bike. Afterwards, it becomes clear and understandable that the hippocampal removal affects the type of memory that is responsible for consciously learning and recalling information (Ciccarelli & white, 2013 p.171). Moreover, sleep deprivation detects the proteins and cellular mechanism that play essential role in the hippocampus, which forms, stores and retrieves memories.

V. CELLULAR AND MOLECULAR MECHANISMS

Sleep deprivation alters the most important cellular and molecular mechanism that the hippocampus is dependent on. The hippocampal functioning will be impossible without cell signaling. Cell signaling is a part of a complex system of communication that controls basic cellular activities and coordinates cell action. Signaling is essential in the formation of memory. Damage to the cell signal can be dangerous and can lead to memory mechanisms to malfunction and become impaired (Vecsey. et. al., 2009). Sleep deprivation has been shown to impair the cyclic adenosine monophosphate (cAMP) signaling in the hippocampus. cAMP is used for intracellular signal transduction in various organisms and plays a major role in the cAMP-dependent pathway, or adenylyl cyclase pathway. cAMP is derived from Adenosine triphosphate (ATP), energy currency of life by the enzyme Adenylate cyclase. Using mice, the Vecsey et. al. (2009) experiment showed that the long- term maintenance potentiation was disabled due to decrease cAMP signaling when mice have been sleep deprived. Long-term potentiation is an internal part of the synaptic plasticity and was believed to be basis of learning and memory. According to scientists, a decrease of long-term potentiation reduces the ability to form

memories due to sleep deprivation (Vecsey. et, al.2009). It is clear and is experimentally identified that insufficient sleep has significant effects on the cell-signaling and particularly causes a decrease level of cAMP signaling in many regions of the hippocampus.

VI. COGNITIVE MEMORY

Scientists continued constant researching to discover every problem associated with sleep deprivation. Various studies link unhealthy sleep habits with decreased cognitive performance (Lowery, Dean, & Manders, 2010, p. 17). One study examined the role between sleep and grade-point average (GPA). The researcher administered a survey to undergraduate students on the campus of the University of Minnesota: "six- variables were analyzed from the participants' survey: Sleep quality was assessed by Groningen sleep quality questions, academic success and four different aspects of sleep quantity" (Lowery, Dean, & Manders, 2010, p. 18). These aspects that were measured include number of nights spent with less than five hours of sleep during the last week as well as during an average week. The researcher hypothesized that students who are rarely sleep deprived have higher GPA than compared to students who are mostly sleep deprived (Lowery, Dean & Manders, 2010, p. 18). In addition, the researcher chose participants from various fields, ages, gender as well as different races in order to obtain strong results and reduce errors. These allowed the researcher to control the limiting factors and confounding variables that could impact the results (Lowery, Dean & Manders, 2010, p. 18). Confounding variables are factors that the researcher fails to control and therefore influence the results. This can potentially lead to false interpretation of the relationships between variables. Then, the investigator found that average amount of sleep per night to be significantly correlated with students' GPA. Students who received enough hours tended to obtain better GPA than students who slept less than five hours per night (Lowery, Dean & Manders, 2010, p. 17).). This illustrates that lack of sleep negatively impacts students' academic performance.

VII. ATTENTION AND WORKING MEMORY

Attention and working memory are the two most widely studied cognitive performance domains in most researches about sleep deprivation. It was found that attention and working memory decrease due to sleep deprivation. There are four subsystems of working memory, phonogical loop, visuospatial sketchpad, episodic buffer and central executive (Alhola, &Polo-Kantola, 2007, 553-556). The function of the phonological loop is to temporarily store verbal or acoustic memory also known as echoic memory. Echoic memory is a component of sensory memory that is specific to retaining auditory information. Secondly, visuospatial sketchpad holds visual information or iconic memories. Iconic memory is part of the visual memory and lasts briefly. Third, the episodic buffer integrates information from various parts of brain (Alhola, &Polo-Kantola 2007, 566). The last part of working memory, central executive, "controls these three components" of the working memory (Alhola & Polo-Kantola, 2007). Besides, the central executive working memory plays a major role in certain attentional functions such as sustaining attention Furthermore, the attention and working memory are related to the frontal brain which is sensitive to sleep deprivation and consequently both attentions and working memory become affected during prolonged wakefulness. According to Alhola and Polo-kantola (2007), Sleep deprivation "increases rigid thinking, preservation errors, and difficulties in utilizing new information in complex tasks requiring innovative decision-making". As a result, college students experience decline of their creativity, productivity as well as their thinking and problem solving skills due sleep deprivation

VIII. MEMORY LOSS

Poor quality of sleep significantly causes loss of memory. In fact, many college students experience chronic stress as a result of insufficient sleep and overload of school work. These causes forgetfulness or difficulty retrieving information. This might occur during exams and cause poor performance. Despite the fact, some people may not acknowledge that their lack of sleep decreases their productivity in their learning. (Strine, & Chapman, 2005) A recent study has been conducted to examine whether and how sleep deprivation interferes with the students' capability to retrieve and learn memories. In the experiment, nineteen college students were tested after one trial of normal sleep followed by a night of sleep deprivation. The participants tried to maintain three things over a delay. After a "mention of one to ten seconds," they were asked to report the term and its given location by selecting it on a color wheel (Wee, Asplund &Chee, 2013, p.850).There were significant differences between trials. Students had a better retention on a normal night of sleep than compared to the night of sleep deprivation: "Sleep deprivation selectively reduced the number of integrated representation that can be retrieved after a day, while leaving the precision intact" (Wee, Asplund &Chee, 2013, p.850). In this case, the

precision of retrieval were unaffected even though there was a significant reduction in the students' memory retention in a night of sleep deprivation (Wee, Asplund &Chee, 2013, p.850). It has been proven through experimentations that sleep deprivation negatively impacts college students' overall cognitive performance as well as increases the likelihood of memory loss.

IX. INTERVENTIONS

Scholars have been curious to discover treatments for sleep deprivation. Even though some studies found a drug that can be used to prevents the effects of sleep deprivation, the most agreeable answer has always been to avoid being sleep deprived and get adequate sleep (Vecsey, et al. 2009, Para. 2). It has taken a long time and lots of efforts for researchers trying to explore anything possible that could be the remedy for sleep deprivation. A recent study conducted by Vecsey et. al. (2009) identified a useful drug that treats memory deficits that are associated with sleep deprivation: "With the treatment of inhibitors rescued the sleep deprivation induced cAMP signaling, synaptic plasticity and hippocampus dependent memory" (Vecsey, et al. 2009) Cyclic adenosine monophosphate (cAMP) is essential to many living organisms and it is what mediates different cell responses as well as activates different enzymes and regulates gene expression as stated in the Vecsey et. al. Experiment (2009). Despite the identified treatments, the researchers state that even a brief sleep deprivation can cause problems that interfere with the brain's most critical regions that are responsible on everything that a person does regularly.

X. RECOVERY

A fascinating experiment demonstrates that sleep deprivation and anesthesia share common control mechanism. The study links and specifies that anesthesia and sleep regulatory mechanism support the brain's ability to recover from sleep deprivation (Tung, Bergmann, Cao, & Mendelson, 2004). The experimenter hypothesized that recovery from sleep deprivation also occurs during anesthetized state. Then, an experiment was conducted to test whether the hypothesis is supported. Rats were sleep deprived for twenty-four hours and afterwards some of the rats were allowed six hours of sleep and the other group was anesthetized for six hours. Then, the duration and degree of the recovery were analyzed. The researcher's intention was to examine whether the degree of recovery from unhealthy sleep during sleep is similar to during anesthesia (Tung, Bergmann, Cao, & Mendelson, 2004): "we found that after 24-h of sleep deprivation, recovery sleep behavior in rats for which 6h of ad libitum [natural] sleep was no different from rats subjected to 6-h protolo [under] anesthesia" (Tung, Bergmann, Cao, & Mendelson, 2004).The evidence behind this was found to be that adenosine reuptake inhibitors into the basal forebrain increase during sleep and an increase of "basal forebrain potentiates anesthetic action" (TungBergmann, Herrera, Cao & Mendelson, 2004, 1422). In addition, the extracellular adenosine concentration involves in control mechanism for both sleep and anesthesia (Tung, Bergmann, Cao, & Mendelson.,2004).

XI. CONCLUSION

Thus, the impacts of sleep deprivation on college students' capability to form and retain information are innumerable. Scientists conducted numerous experiments and studies to discover every problem that is associated with inadequate sleep (Lowry, Dean & Manders, 2010; Strine, & Chapman, 20043). Nonetheless, these problems are not acknowledged or recognized in our society. Sleep deprivation impairs the most critical structures of the brain which are essential in learning (Willingham, 2013, p.36). When sleep deprived, the student experiences a decline in their cognitive learning and consequently, perform poorly on their academics. According to scholars, sleep deprivation damages one of the most important brain structures known as the hippocampus. The role of the hippocampus is to form memories as well as retrieve old memories (Ciccarelli, & White, 2013, p.164-166). Additionally, lack of sleep interferes with the important biological structures that are responsible in forming the hippocampus. The importance of the hippocampus was identified after a sixteen-year old; Henry Maloison underwent brain surgery as a result of his epileptic seizures. Doctors believed that the hippocampus caused his illness and Henry was told to have brain surgery (Ciccarelli, & White, 2013, p.165). Surprisingly, the removal of the hippocampus did not relieve the seizures that it was intended to and thus caused Henry to become incapable to form and retrieve memories. Scientists were astonished by the outcome and administered multiple experiments to discover the role of the hippocampus. Afterwards, it becomes clear that declarative memories cannot be formed when the hippocampus is absent or damaged. Declarative memories are memories of facts and knowledge and are divided into episodic and semantic memories. (Ciccarelli, & White, 2013, p.165-172) Episodic memory is part of the long-term memory that involves the recollection of specific events and experiences, whereas semantic memory refers to the memory of meanings, understandings, and other concept-based knowledge such as acquiring knowledge of something (Ciccarelli, & White, 2013, p.173). Moreover, sleep deprivation is a major cause of memory loss in most college students

that suffer from memory loss. A recent study indicates that eight percent of American college student receive enough sleep and sixty-nine percent are sleep deprived (Willingham, 2013, p.35). Furthermore, the sleep deprived students suffer from chronic stress and depression which has a negative impact on their studies. Numerous other researchers tested college students' memory retention after being sleep deprived and indicate there is a significant amount of reduction of memory retention and lack of sleep has a negative correlation with cognitive performance.

REFERENCES

[1] Alhola, P., & Polo-Kantola, P. (2007). Sleep deprivation: Impact on cognitive performance. Neuropsychiatric Disease And Treatment, 3(5), 553-567.

[2] Astur, R., Taylor, L., Mamelak, A., Philpot, L., & Sutherland, R. (2002). Humans with hippocampus damage display severe spatial memory impairments in a virtual Morris water task. Behavioural Brain Research, 132(1), 77-84. Doi: 10.1016/S0166-4328(01)

[3] Ciccarelli, S., & White, N., (2013). Psychology an explore (pp. 163-190). New York: Pearson Education, Inc.

[4] Lowry, M., Dean, K & Manders, K, (2010). The link between Sleep quantity and academic

[5] Performance for the college student. Department of Psychology, University of Minnesota press. (3), 16-1

[6] Strine, T. W., & Chapman, D. P. (2005). Associations of frequent sleep insufficiency with health-related quality of life and health behaviors. Sleep Medicine, 6(1), 23-27. doi:10.1016/j.sleep.2004.06.003

[7] Tung, A., Bergmann, B., Herrera, S., Cao, D., & Mendelson, W. (2004). Recovery from sleep deprivation occurs during propofol anesthesia.Anesthesiology, 100(6), 1419-1426.

[8] Vecsey, C. G., Baillie, G. S., Jaganath, D., Havekes, R., Daniels, A., Wimmer, M., & ... Abel, T. (2009). Sleep deprivation impairs cAMP signaling in the hippocampus. Nature, 461(7267), 1122-1125. doi:10.1038/nature08488.

[9] Wee, N., Asplund, C., & Chee, L. (2013). Sleep deprivation accelerates delay-related loss of visual short-term memories without affecting precision. SLEEP, 36, (6), 849-855

[10] Willingham, D. T. (2013). Are sleepy students learning? American Educator, (4), 35-39.

[11] Zhiwei, G., Xuwen, P., & Jidong, F. (n.d). Research report: Sleep deprivation impairs spatial memory and decreases extracellular signal-regulated kinase phosphorylation in the hippocampus. Brain Research, 101838-47. doi:10.1016/j.brainres.2004.05.032

[12] Zola-Morgan, S & Squire,L. (1993). Neuroanatomy of memory. Annual Review of Neuroscience, 16, 547-563. Retrieved from http://www.neuro.iastate.edu/uploads/squirelr_annrevns93.pdf