EFFECTS OF SLEEP DEPRIVATION AND LANGUAGE ON WORKING MEMORY

Effects of Sleep Deprivation and Language on Working Memory

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Abstract

Research was limited on the relation of sleep deprivation and the number of languages spoken by individuals and how it affects working memory. The goal of this study is to examine if these two factors are related as well as if it affects recall in working memory. Fifty eight college students, ages 18-30, performed the same task in which they memorized ten non-sense words and were asked to recall these words on a provided answer sheet. There were no significant results found, however, participants who were not sleep deprived as well as bilingual speakers performed quite well. The data suggests that sleep deprivation and monolingual speakers have lower working memory.
Effects of Sleep Deprivation and Language on Working Memory

Sleep deprivation effected decision making for everyday life. Sleep deprivation is a problem for more than 50% of American workers (National Sleep Foundation, 2000). Insufficient sleep may lead people to be faced with a myriad of decision. Sleep-deprived people generally select the least demanding options that may negatively affect their safety which can possibly result in serious, perhaps life threatening consequences (Engle-Friedman, Riela, Golan, Ventuneac, Davis, Jefferson, & Major, 2003). Therefore, it is important to investigate the impacts of sleep deprivation on working memory because of its influence on social domains, especially in school and the workplace.

Aside from sleep deprivation, languages learned by individuals also have an effect on one’s memory. Until recently, research has not compared bilingual and monolingual individuals and how this affects one’s working memory (Ransdell, Barbier, & Niit, 2006). Due to the diversity in America, it is important to learn how and why bilingual speakers remember more than monolingual speakers.

Identifying the involvement of working memory on everyday cognitive activities has been an interest for many researchers. Working memory includes temporary processing, storage of information, reasoning, language comprehension, long-term learning, and mental arithmetic. In recent years, there has been a considerable interest in the contribution of the effect of working memory to sleep deprivation and language. Past research performed over the year show a clear correlation with working memory and language processing. WM is necessary for regulating learning and memory in individuals (Ransdell, Barbier & Niit, 2006).
Working memory (WM) has been decreased by 38% after sleep deprivation (Turner, Drummond, Salamat, & Brown, 2007). However, there was a significantly difference in the measure of the three components processes of WM: attention, WM span, and efficiency of encoding into episodic memory were found in response to 42 hr of total sleep deprivation (TSD). Sleep deprivation was strongly correlated with declines in attention and WM span. However, episodic memory encoding was found to be weak. Therefore, these findings show that not all component of WM are equally affected by 42 hr of TSD. Additionally, individual-level differences in response to 42 hr of TSD were also found. Majority studies of sleep deprivation suggested that some perform well after sleep deprivation, whereas others show impairment on cognitive process. Therefore, individuals can be found to be resilient on one component of WM process while they show vulnerability effect on other (Turner et al., 2007). The resilient individuals had a small impact on one model parameter, while the vulnerable individuals experienced the most affect.

Decrements in cognitive functioning such as alertness, reaction time, attention, and vigilance have been associated with sleep deprivation (Killgore, Balkin, & Wesenten, 2006). In addition, the declines in WM performance were associated with 20 or more hr of total sleep deprivation (Polzella, 1975). There was a significant difference among individuals under rested conditions and those under sleep-deprived condition when they were measured on WM by the sensitivity parameter (d’). Participants who are under rested conditions were more likely to respond to the items correctly, thus, indicating that sleep loss affected decrement in WM (Polzella, 1975). This evidence was also supported by previous study in which the researchers found that sleep periods chronically limited to
4 hr and 6 hr per night reduced the effectiveness of psychomotor vigilance performance, working memory performance and cognitive throughout performance (Dongen, Maislin, Mullington, & Dinges, 2003).

The effects of sleep loss on memory are also associated with words recalled and picture recognition (Williams, Gieseking, & Lubin, 1966). The participants’ words recalled were dropped by one and a half words after one night of sleep deprivation and about four words after two nights without sleep. Therefore, the effects on nights of sleep loss proved detrimental to immediate memory. For picture recognition task, the participants were show pictures for 10 sec and after 24 hr were asked to recognize those pictures. There were significant differences under sleep-deprived conditions and normal conditions. Sleep-deprived individuals were not easily to recognize pictures than when they were under normal conditions (Williams et al., 1966).

Sleep loss is also associated with effort and reduction in tasks (Engle-Friedman, Riela, Golan, Ventuneac, Davis, Jefferson, & Major, 2003). In non-sleep-loss conditions, the participants selected problems that are more challenging and more demanding than those selected under sleep loss conditions. Those who selected the simplest tasks were associated with being most sleepy, most fatigued, and had the longest reaction times. In addition, the non-sleep-deprived group out performed the sleep-deprived group on task that required level of difficulty and accuracy. The participants reported that the routine behaviors that required effort has been reduced after a night of sleep loss. For example, the participants dress less neatly and less fashionably. With regard to school-related activities, participants reported shorter attention spans and they read less for school
following a night of sleep loss. In relations, their WM are not as effective as when they are fully awake.

Response inhibition is effected by sleep deprivation. The automatic response in sleep-deprived individuals is slower than usual and their ability to withhold an appropriate response was impaired (Drummond, Paulus, & Tapert, 2006). The prevention of an automatic response is due to the attention of incoming stimuli that related to the cognitive components. Like WM, after a single night of recovery sleep, these individuals were able to perform the task without any difficulty.

Ransdell, Barbier & Niit (2006) researched individuals who were bilinguals and monolinguals and how this affects their working memory. College students, both bilingual and monolingual, volunteered in this experiment which was given in English. Participants read through sentences without stopping until they reached the end. Participants tried to remember all the last words in each sentence. In any particular order, they can write down the words. Monolingual students did not perform as well as the bilingual students on the task. Therefore, the researchers concluded that bilingual students have better working memory compared with monolingual students (Ransdell et al., 2006).

Previous researched had showed that bilingual speakers would be able to give more correct answers to questions asked in the same language in which the information was originally learned in (Marian & Fausley, 2006). A group of bilingual students, who spoke both English and Spanish, participated in this research. Students were able to remember new information better in Spanish, their more proficient language, compared to English (Marian & Fausley, 2006). In addition, another study looked at the memory
skills of a group of Mandarin-English speakers (Marian & Kaushanskaya, 2007). When the researchers asked the participants to choose a question in either English or Mandarin, the participants typically choose to answer in relation to that language’s culture. The researchers then asked the participants to name a person with its arm raised while looking into the distance. When this question was asked in English, most would say that it is the Statue of Liberty, however, when it was asked in Mandarin, most would say that it is the Statue of Mao. Therefore, the researchers concluded that the participants rely on the information that was learned from a specific culture and connect that information with the language that is spoken from that culture (Marian & Kaushanskaya, 2007). When the participants learn a new piece of information and are asked in a certain language, an individual’s working memory separates the information that is closely connected with that language’s culture (Marian & Kaushanskaya, 2007).

Both sleep deprivation and bilingualism have an effect on one’s working memory. Individuals are able to function better in memory with an adequate amount of sleep, as well as benefits from the knowledge of more than one language. A person who is able to sleep more is more likely to concentrate on newly learned information compared to those who do not get enough sleep. Research has not yet provided answers to why bilingual individuals have better working memory compared to monolinguals. Research on the relationship between working memory and bilingualism was very limited.

Method

Participants

This experiment will consist of 60 San Jose State University college students, ranging from the ages 18-24. Participants will include both monolingual and bilingual
speakers. Participants will vary in the amount of sleep they self-reported. Researchers will recruit participants from classrooms.

Materials

The researchers will provide four lists of 10 non-sense words (see appendix A 1-4) on power point via a laptop. Most of the words will be five letters long. The words will range from five to seven letters in length. The reason for using non-sense words is because they are more difficult to remember compared with real words. Using real words will allow participants to use different strategies to remember those words (e.g. using the words in a sentence, rhyming the words, real words may be more memorable by certain participants than others, etc.) Background questionnaires will also be given to participants. The questionnaire will ask participants about their sleeping pattern as well as their number of languages spoken and how fluent they are in each language. The questionnaire will also ask for the gender, age, major and G.P.A.

Procedure

As participants arrive, the consent form will be handed out for them to read and sign. Participants will go through four trials to test whether sleep deprivation and languages spoken affects working memory. Each participant will be asked to study the words appearing on the power point slide for 30 seconds. The participants will then be asked to recall the words show to them in one minute from the first slide onto answer sheets provided by the researchers. Researchers will collect answer sheets. Trials, two, three and four will be conducted in the exact procedure as trial one but with a different set of non-sense words for each trail. Participants will then fill out the background questionnaire. All experimental conditions will be conducted in similar settings.
Design and Analysis

This study will use a mixed subjects design and will include four experimental conditions. Each experimental condition will include approximately 15 participants. Languages spoken and sleep deprivation is the independent variables which consist of monolingual/bilingual speakers and students that receive less than/more than five hours of sleep. After completion of trials one through four, researchers will analyze response compared with background information. Researchers will tally number of correct answers of non-sense word with average hours of sleep received and languages spoken. Working memory, the dependent variable, will be measured by the number of successfully recalled non-sense words. This experiment will assess the effects of sleep deprivation and languages spoken on working memory.

Results

This study evaluated the effects of total sleep deprivation and number of languages spoken on working memory.

Effects of Total Sleep Deprivation

Participants who slept more than 5 hours recall nonsense words better (M = 3.6, SD = 1.85) than participants who slept less than 5 hours (M = 3.36, SD = 1.33). This effect was not very significant, $F(1, 56) < 1$. Participants with more than 5 hours of sleep answered, on average, 24% more of the nonsense words correctly.

Effects of Number of Languages Spoken

Participants who spoke more than one languages recall nonsense word better (M = 3.6, SD = 1.6) than participants who spoke only one language (M = 3.1, SD = 1.5). This
effect was not statistically significant, $F(1, 56) < 1$. This result was not the expected outcome.

*Interactions of Total Sleep Deprivation and Number of Languages Spoken*

The interaction of total sleep deprivation and number of languages spoken was not significant $F(1, 56) < 1$, for the current data set. The difference between total sleep deprivation and number of languages spoken was not the same for both groups. The highest average was for the condition of more than 5 hours of sleep and more than 1 languages spoken ($M = 3.6, SD = 1.85$). The lowest average was for the condition of less than 5 hours of sleep and spoke only 1 language ($M = 3.1, SD = 1.5$).

**Discussion**

This study investigated the possible connections between the number of hours of sleep that individuals receive and the number of languages spoken by these individuals and how that affects working memory. Past research has acknowledged that the amount of sleep has a dramatic effect on one’s ability to improve recall (Turner, Drummond, Salamat, & Brown, 2007). Although studies have shown that bilingual speakers recall words better than monolingual speakers, no reason has been found for this effect (Ransdell, Barbier & Niit, 2006). The present study was performed with non-sense words to test the effects of how sleep deprivation and the number of languages spoken by individuals on recall.

More sleep did not prove extremely significant in working memory. In contrast, these results do not support previous research on sleep and working memory. Sleep deprivation has a major impact on working memory due to the inability to engage on the task (Polzella, 1975). When averaging the number of hours slept, the researchers used
only Monday-Thursdays because most college students do not have class on Fridays and the weekend. However, for those who work or have class those days, this was not accounted for. The repetition of the trials seemed to cause participants to lose interest. In addition, non-sense words were used to decrease bias of prior knowledge in relation to the word. Non-sense words made it more difficult for participants to recall due to inability to pronounce the word mentally as a recognition tool (Engle-Friedman et al., 2003).

The result for bilingual speakers’ ability to recall non-sense words more than monolingual speakers was also not significantly. This result is also inconsistent with prior research. Prior research indicates that bilingual speakers tend to perform better than monolingual speakers in working memory (Ransdell, Barbier & Niit, 2006). These results are likely due to the fact that the researchers had more bilingual speakers than monolingual speakers. Out of 60 participants, 46 were bilingual and only 14 were monolingual. Due to the discrepancy in participants, it is difficult to measure how the number of languages an individual knows has an effect on working memory.

The interaction of total sleep deprivation and number of languages spoken was not significant. In the present study, sleep deprivation and languages spoken by individuals were independent variables not related to one another. Instructions were not made clear, which caused inconsistency in the methods therefore lowering the number of correct answers. When participants were filling out the background questionnaire, participants may have not been able to give correct number of hours slept. Participants may have also reported speaking more than one language although not fluent in it. Participants were given a time constraint which may have negatively influences
participants’ scores on the task. This finding is consistent with previous study in which the researchers reported that people who are under low-pressure conditions performed better than those who are under high-pressure on working memory (Beilock & DeCaro, 2007). Due to the added time constraint, the participants who are already stressed may have an additional stressor that have an influence on their scores. The researcher’s presence may have influenced participants’ scores due to anxiety. In addition, the participants may have feel uncomfortable because of the small room that they were in. Although results for both sleep deprivation and the number of languages spoken by college students did not prove significant, it was found that those who received more than five hours of sleep and those who are bilingual speakers performed better on recalling non-sense words. The difference between total sleep deprivation and number of languages spoken was not the same for both groups.

This study investigated how sleep deprivation and the number of languages spoken by individuals impact the way individuals recall information. Future research can focus on methods and how the experiment is carried out. Participants can be given an easier task to do. College students would benefit from future studies due to the lack of sleep and different languages spoken on campus. Future research can stress the importance of getting adequate amount of sleep and learning more languages at a young age to improve working memory not only in college, but as well as the workplace.
References


Appendix A-1: Nonsense Word List

Drogle
Kinmo
Farzy
Manog
Himax
Jeplo
Nupis
Pubit
Yavon
Slint
Appendix A-2: Nonsense Word List

Massan
Kazoompa
Nahdija
Fiaquita
Uffđa
Ock
Sente
Jilion
Mard
Rone
Appendix A-3: Nonsense Word List

Yarf
Junjub
Mofe
Vorphaln
Slithy
Brirlig
Tulhey
Mimsy
Manxhome
Wabeg
Appendix A-4: Nonsense Word List

Awitic
Blegen
Ouffish
Preni
Gilmu
Zhaba
Tuyf
Jivard
Mofdu
Gimek