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Sleep Deprivation Affects Memory and Attention

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ABSTRACT
Numerous researches suggest that sleep and memory have been an important part of people's lives and are positively correlated. The present study aims to explore this topic further by providing short-term memory experiments and a discussion of sleep of memory and attention. Two different age groups were compared and reviewed on the differences between memory and attention with sleep as another factor. Twenty participants aged 18-22 and 42-47 were randomly selected in two groups and were asked to do a memory and a attention task after recoding their sleep hours for seven days. However, contrary to predictions, the result shows that the sum of sleep time and memory tasks are negatively related and there is not a significant relationship between sleep and attention, which are also different from previous researches. These results may be caused by some biases in this experiment and it also raised some doubt on the generalization of the benefits of sleep on memory. The results and biases of this experiment are discussed.

Keywords: *Sleep, Exercise, Attention, Memory, Deprivation*

1. INTRODUCTION

Sleep is one of the most important factors that influence the daily behavior of a person. Numerous researches have concluded that the quantity and quality of sleep positively influence memory[1-3]. Enough sleep prepares the brain for encoding new memories and provides an opportunity to consolidate and integrate recently learned information[4]. Moreover, sleep makes the memory more stable, and thus memory more resistant to interference and decay[5]. On the other hand, sleep can also harm the brain when it is insufficient. The deprivation of sleep causes the frontal lobe, which is the area of short term and long term memory, to deactivate, and hence leads to reduced brain activation[5]. The next background information is obtained from the 104 responses collected in the survey that was handed out to people aged 18-22, and the survey questions were set up to demonstrate their daily routine and lifestyle, so the experiment results can be better explained. Figure 1 is bar chart for the average performance rated on the scale 1-5, and more than half of were rated at 4. And Figure 2 is the bar chart for the performance the participants rated after pulling an all-nighter before an exam or due, and the majority shifted to 3, which means they realize they performed worse and had worse memory on a cognitive task without sleeping at all.

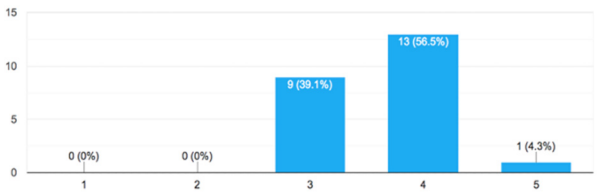

Figure 1. The performance the participants rated normally

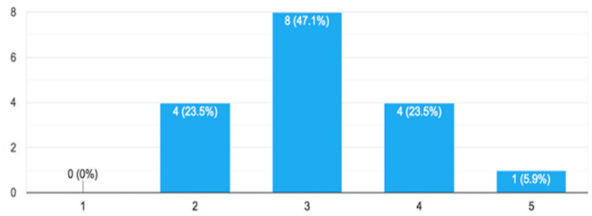

Figure 2. The performance the participants rated after pulling an all-nighter

What triggers the researchers to conduct this research is the interest in comparing different age groups and study the differences between memory and attention with sleep as another factor.

The purpose of this study is to test whether sleep affects short term memory and attention of different age groups in the same way or not. Specifically, a hypothesis is developed that sleep has a positive correlation with attention and short term memory for different age groups according to the literature reviews.

2. METHODS

2.1. Participants

A total of 20 participants were chosen to do the experiment. This study designed to divide them into two groups based on their ages, which were “young group” and “old group”. 12 people in the “young group” were between 18 and 22 while 8 people in the “old group” were between 42 and 47. All the participants gave consent to be studied in the experiment and were given debriefing after the study was concluded.

2.2. Design and Procedure

Participants were required to collect their sleep data for 7 days by using a sleep app called “Sleep Cycle”. This study mainly used this app to measure participants’ actual sleep time. The principle of this app is to use the accelerometer to detect movements when people sleep, which could have slight errors but it was the best way for measuring sleep in a remote experiment. The participants only needed to turn on the app and put their phones near their pillows every night before they slept.

After recording down their 7-day sleep time, they moved into the interview part of this study where the researchers asked questions about their sleep quality in the past week.

Then, the participants were required to do one memory task and one attention task via Zoom interviews. The memory task was to measure their short-term memory and the attention task was to measure their attention focusing. For the memory task there were 20 words that the participants need to memorize(the same category - fruit: coconut, grape, kiwi, watermelon, strawberry, pear, tangerine, guava, cherry, peach, lime, plum, blueberry, raspberry, apple, avocado, banana, durian, lemon, orange) for one minute, then they were asked to recall immediately and were recorded how many words they can remember within two minutes and the percentage of recalled words out of twenty were calculated. For the attention task, the participants were asked to complete the “Same or Different” task from Happyneuron(Figure 3)[6]. This attention task had eight trails of graphic patterns in two columns. It required them to circle the different patterns between the left and right columns. Their performance would be the time they took to finish and their accuracy.

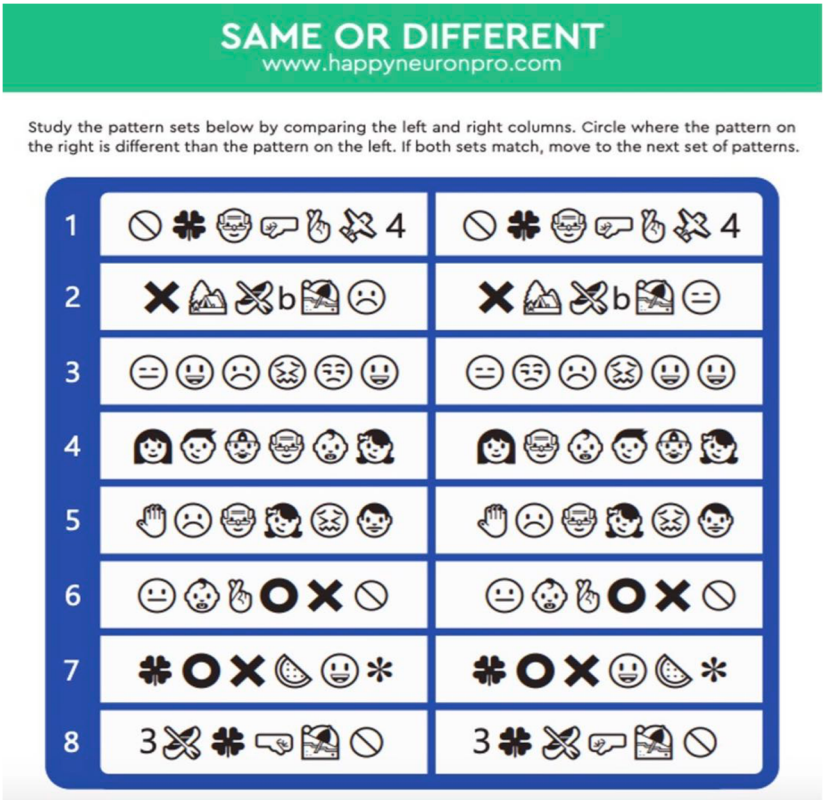

Figure 3. The same or different test

3. RESULTS

3.1. Data Analysis

The scatter plots for each group of experiments were drawn from the data collected in the procedure. Shapiro-Wilk normality test was run to check if the data fit a standard normal distribution before doing the following test. Finally, the Pearson's product-moment correlation test was done to compare different variables and to measure their relationship.

3.2. Young Group

For Young Group, the t equaled to -2.28 while the p-value was 0.04615<0.05 in the memory test associate with sleep (Figure 4). This meant that this data was statistically significant. The 95 percent confidence interval was -0.87 to -0.015. The correlation coefficient was -0.584. For the accuracy and sum of sleep, t=0.16359, p-value=0.8733 ns, 95 percent confidence interval was -0.5382 to 0.060755, and the correlation coefficient was 0.05166. For time used in attention task and sum of sleep (Figure 5), t=0.007267, p-value=0.9943 ns, 95% confidence interval was -0.5724 to 0.5754, and correlation coefficient was 0.002298.

3.3. Old Group

In Old Group, for the accuracy in attention task, t=-0.7835, p-value=0.4631, 95% interval was -0.8309 to 0.5093, and the correlation coefficient was -0.3047. For the time/sleep, the t=0.9506, p-value=0.3785, 95% confidence interval was -0.4602 to 0.8498, and correlation coefficient for this one was 0.3617. For the memory task (Figure 6), the t=-0.7995, p-value=0.4545, 95% confidence interval was -0.8328 to 0.5047, and correlation coefficient was approximately -0.3103.

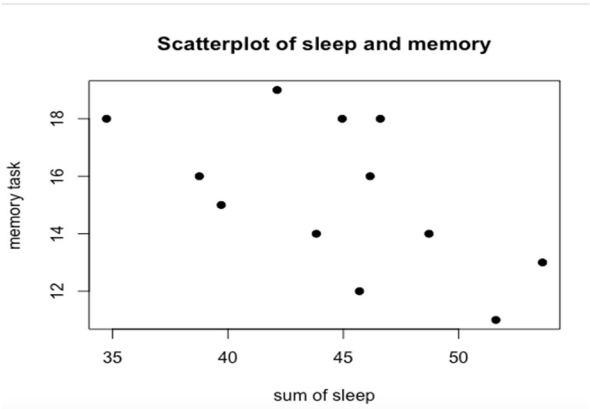

Figure 4. The relationship between the score participants get in the memory task and the sum of sleep hours of participants in Young Group

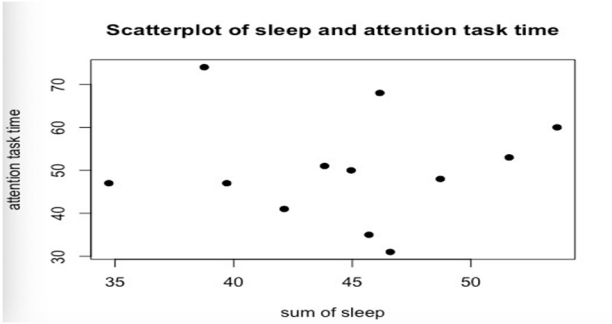

Figure 5. The relationship between time participants used in attention task and sum of sleep in Young Group.

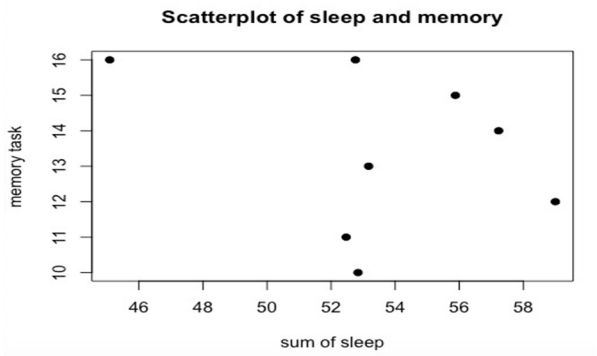

Figure 6. The relationship between the score participants get in the memory task and the sum of sleep hours of participants in Old Group.

3.4. Young Group & Old Group

For the young group, the average of sleep within the past 7 days was 44.7 hours. The average number of words they could recall in the memory task was 15.3. The average time they took to finish the attention task was 50.4 seconds. And the average accuracy rate they had on the attention task was 99.3%.

For the old group, the average of sleep within the past 7 days was 53.5hours. The average number of words they could recall in the memory task was 13.4. The average time they took to finish the attention task was 88 seconds. And the average accuracy rate they had on the attention task was 89.8%.

4. CONCLUSION AND DISCUSSION

Based on the previous results, there is a negative relationship between sum of sleep and memory in Young Group, which is also the only statistically significant value in this experiment. Also, the scatter plot of this group of experiment confirms that there is a negative relationship between sleep and memory, which means the longer the sleep hours are, the lower the scores are in the memory task. All other groups of experiments do not have statistically significant results. The only conclusion in this study contradicts with the original hypothesis.

There are two findings while comparing Young Group with Old Group. On average, elder people sleep more than younger people that Old Group had an average of 53.5 hours of sleep in 7 days while Young Group only had an average of 44.7 hours. On average, younger people have much better performance on the attention task than elder people that they spent less time and had higher accuracy. Young Group spent an average of 52 seconds finishing the attention task while Old Group spent an average of 88 seconds. Moreover, young Group's accuracy rate of the attention task was 10% higher than Old Group.

There are a few limitations in the study since it was conducted remotely. Technical difficulty is the biggest challenge of the study, therefore, slight errors could occur for measurements. The next is individual differences, circadian rhythm and gender are very important factors that cause problems in internal validity[7]. For instance, one could be drowsy and performed worse while another coule be full of energy at the same time of the day they were interviewed. Additionally, self-reported survey could trigger problems like social desirability and self-promotion of the participants. And last but not least, the sample size for the experiment was rather small.

Shifting gears on some future directions. As mentioned ealier, the research is better to apply more professional and accurate measurements while replicating the experiment, such as Electroencephalogram (EEG)[8]. Moreover, it is better to do a within-subject experiment instead of between-subject to best eliminate personal differences in memory and attention levels such as gender[7]. For instance, designing an experiment that requires participants to receive both treatments, geting enough sleep and insufficient sleep. And then testing them to see whether they have different performance on memory and attention tasks. In addition with counterbalancing, some people do enough sleep first while others do insufficient sleep first, which improves the reliability of the results. Lastly, there might be a positive correlation between workout and memory/attention based on the literature reviews [9-12]. Whether doing aerobics increases memory capacity and decreases retention or not could be a potential direction. All the future directions are valuable for later replications or new studies.

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