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The Relationship Between Teenagers' Sleep Length and Short-term Visual Memory

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Abstract: Sleep is an essential factor that influences people's regular life. People sometimes feel frustrated in their work or studies the next day when they did not sleep well the night before. It is an issue bothering people, and therefore, finding out the principles of how sleep affects body regulation is significant work scientists nowadays are doing. Studies have shown the potential relationship between sleep, memory, and cognitive functions. This paper aims to find the possible relationship between sleep length and cognitive functions, specifically visual short-term memory. In this research, the author designed a visual-short-term-memory test to identify the impact of sleep length on adolescents aged between 16 to 18 years old's memory performances. The participants showed their degree of short-term visual memory by identifying emotions and locations of faces on the screen that appears in only 15ms. The test results showed that sleep length and participants' visual short-term memory is related but not significant, and the relationship between sleep length and recognition of each emotion is not substantial.

Keywords: Teenagers, sleep, cognitive functions, emotions, visual short-term memory

1. Introduction

Sleep is a significant factor in people's lives. Most people think it determines their performance in a day. Lack of sleep or too much sleep often makes people feel tired working through events in the day. Studies about sleep, how it affects brain functions, and how people think are ongoing throughout the year. Debate continues over sleep-dependent studying, memory, and attention-focusing processes [1].

Studies conducted by Gradisar, Terrill, Johnston, and Douglas in 2008 [2] showed that adolescents who reported insufficient sleep performed poorly in the working memory test, including the job of letter-number sequencing and operation, compared with those who said good and borderline sleepers. This proved that short-term memory is related to people's sleep length.

Brain images show that the prefrontal cortex plays an essential role in working memory [3]—the prefrontal cortex functions in decision-making and cognition. However, the prefrontal cortex was also found to participate in cognitive functions. Recent single-cell and imaging investigations and lesion studies suggest that the prefrontal cortex plays a non-mnemonic role in sensory processing, information integration from several domains, stimulus selection, and memory monitoring [4]. Other studies have shown that in the creation and control of emotion, the prefrontal cortex (PFC) is essential [5]. Therefore, the author could conclude that there must be a potential relationship between emotion and cognitive functions like visual short-term memory. Sleeping lengths can affect 16 to 18-year-old

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adolescents' cognitive functions, which is reflected in participating poorly in recognizing emotions in an emotion-based visual short-term memory test.

2. Method

2.1. Participants

Thirty high school students aged 16 to 18 from the High school affiliated with Shanghai Jiaotong University, the Academy of Our Lady of Peace, and the High School Affiliated with Renmin University of China.

2.2. Procedure

The participants need to complete a visual short-term memory task. They must point out where and what faces with different facial expressions appear on the screen after the faces flash. The participants are shown a 3x3 grid with nine locations on the screen, but the looks on each slide will be placed in only eight positions, where position number five has a cross that will help the participants to focus. Four faces with different facial expressions are shown to the participants, which include "happy," "sad," "angry," and "neutral." Each slide is shown for 15 ms and then jumps to a plain slide, where the participants are required to give out their answers of emotions and locations immediately in the format like "1a2s3h4n". A practice session is given to the participants, 1-neutral, 4-happy, 8-angry, 9-sad. There are ninety trials involved in this test. Online meeting programs (Zoom and Wechat Meeting) are used to collect data. The participants record their answers on paper and directly send their answers sheets to the recorder. There is a grading system for this test: 720 points in total, including 4 points for recalling the location correctly and 4 points for identifying the facial expressions correctly for each trial, and 90 points for each emotion, which the participants must answer both the facial expressions and the location precisely to get the point. The independent variable of the test is the participants' average sleeping length within two days, and the dependent variable of this test is the participants' performances while doing the trial, which is indicated by the total grade and the grades for four different emotions. This test involves an intra-group comparison.

3. Results

The author collected the participants' gender, age, and average sleep length two days before the day that they took the test. The data collected after the test are total, location, and emotion scores.

The results of the Shapiro-Wilk normality test on "average sleep" are W=0.9229, p-value=0.0282 (see Figure 1).

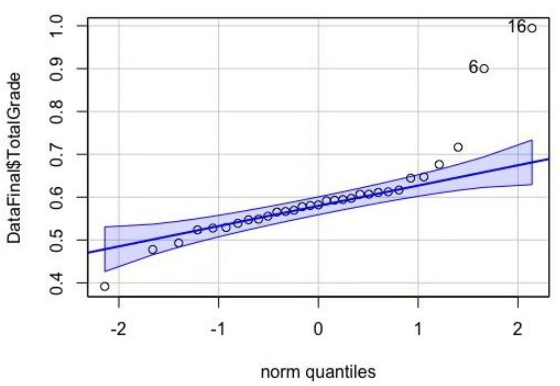

Figure 1: qqPlot graph of the distribution of average sleep.

The results of the Shapiro-Wilk normality test on “TotalGrade” are W=0.79208, p-value=3.695e-05 (see Figure 2).

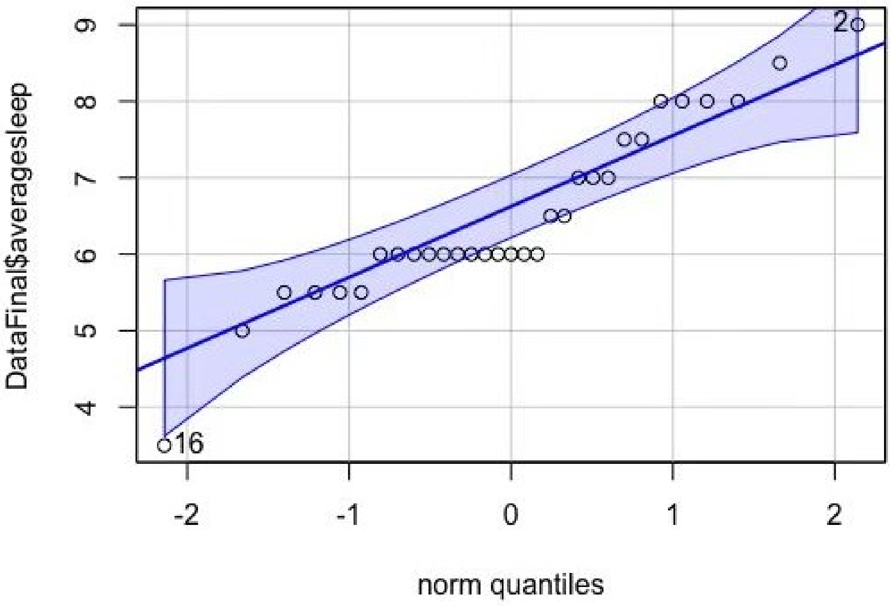

Figure 2: qqPlot graph of the distribution of total grade.

The results of Spearman’s rank correlation rho between “average sleep” and “TotalGrade” are S=4152.1, p-value= 0.3813, alternative hypothesis: true rho is not equal to 0, sample estimates: rho 0.1628833 (see Figure 3 and Figure 4).

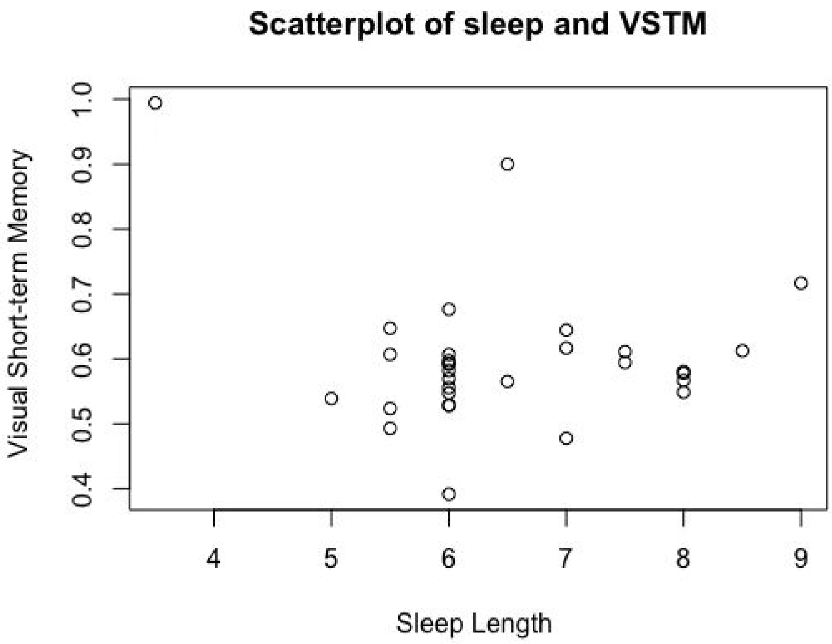

Figure 3: Scatterplot of sleep and visual short-term memory.

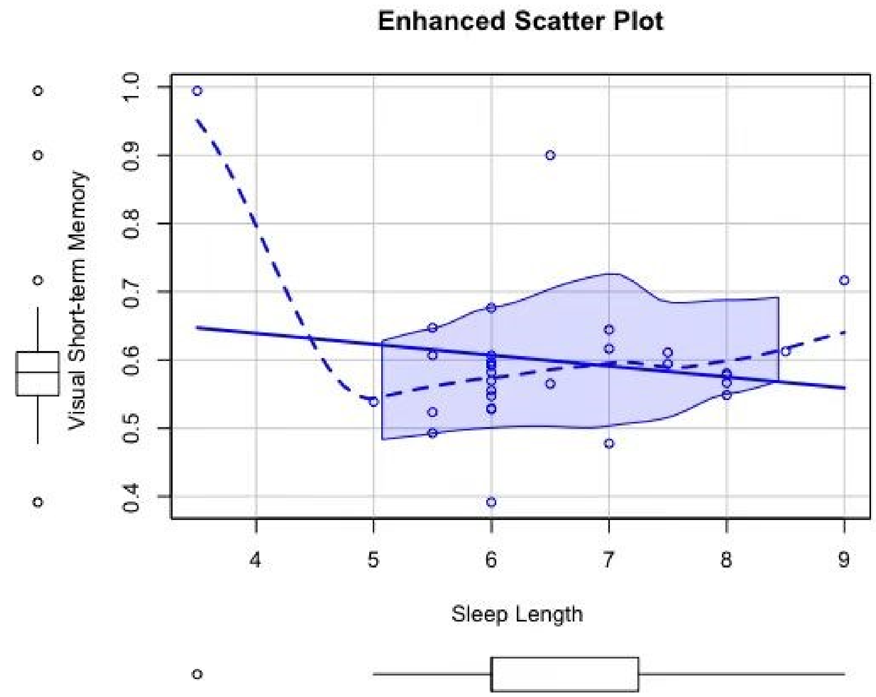

Figure 4: Enhanced Scatter Plot of sleep length and visual short-term memory.

The results of Spearman's rank correlation rho between "average sleep" and "HappyProportion" are S = 5677.6, p-value = 0.4375, alternative hypothesis: true rho is not equal to 0, sample estimates: rho -0.1446725.

The results of Spearman's rank correlation rho between "average sleep" and "SadProportion" are S = 4746.1, p-value = 0.8178, alternative hypothesis: true rho is not equal to 0, sample estimates: rho 0.04312052.

The results of Spearman's rank correlation rho between "average sleep" and "NeutralProportion" are S = 4483.7, p-value = 0.6074, alternative hypothesis: true rho is not equal to 0, sample estimates: rho 0.09602201.

The results of Spearman's rank correlation rho between "average sleep" and "NeutralProportion" are S = 4740.8, p-value = 0.8134, alternative hypothesis: true rho is not equal to 0, sample estimates: rho 0.04419775.

4. Conclusion

The Shapiro-Wilk normality test verifies that the data conform to normal distribution. Based on the results of the Shapiro-Wilk normality test on "average sleep" (W=0.9229, p-value=0.0282<0.05), the data of average sleep is not normally distributed; the data are skewed. The data of "TotalGrade" (W=0.79208, p-value=3.695e-05<0.05) is also unevenly distributed. The variable of average sleep and total grade is not normal distributions. Spearman's rank correlation rho measures the nonlinear relationship between two variables. The Spearman's rank correlation rho results of correlation between average sleep and total grade (p-value= 0.3813>0.05, rho 0.1628833), average sleep and happy proportion (p-value = 0.4375>0.05, rho -0.1446725), average sleep and sad balance (p-value = 0.8178>0.05, rho 0.04312052), average rest and neutral proportion (p-value = 0.6074>0.05, rho 0.09602201), and average sleep and angry ratio (p-value = 0.8134>0.05, rho 0.04419775), which shows that although there are relations between the variables, the correlation between these variables is not significant.

This research has potential limitations. There are several reasons for constraints that exist in this research. The sample size of the test is only around 30 students aged 16 to 18, and this is not a massive number of participants participating. Furthermore, most participants involved have an average amount of sleep. Therefore there are not much extreme data collected from the participants. Since most participants joined the test online, technical issues like internet connection cause online tests' unstableness and doubt the facticity of the test scores. The test was also designed to include one positive emotion and two negative emotions in each trial. Therefore the author cannot analyze the participants' performances in identifying positive or negative emotions.

For further directions of the research, I expect to do experiments in a lab that strictly controls participants' sleep and records their actual sleep length and quality. Apart from that, I would like to reduce the space and time limit and test the participants face-to-face and simultaneously. Increasing the sample size and including other influential factors that could cause the participants to participate differently in my analysis will also be a measure in my future studies. I will redesign the test to include the same number of emotions, from positive and negative, and make the test more rigorous. Future studies of participants' participation over positive or negative emotions will be conducted, and intragroup tests, which will show the impact of sleep on recognizing different faces more clearly, will be involved in the research.

References

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