Negative Outcomes Brought by Poor Sleeping Quality concerning Emotion, Reaction, and Memory

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Abstract: The present study experimentally investigated the potential effects caused by low sleeping quality in emotion, reaction speed, and memorizing ability among students over high school(mainly college students over 20 in age). The method was to assign samples (N=34) into two groups according to their scores in the PSQI(Pittsburgh Sleeping Quality Index), and they were asked to complete another depression index questionnaire and tasks designed in the reaction and memorizing test. Measurements of their mood condition and memorizing capacity were achieved by counting final scores, while reaction speed was quantitative by calculating the total time spent finishing those tasks. The results obtained in this work showed that participants who acquire higher sleeping quality(getting marks <5) tend to behave better in the memorizing test. However, no obvious evidence is revealed that poor sleeping quality or sleeping deprivation(with marks =>5) is responsible for longer reaction time and a more vulnerable mental state.

1 INTRODUCTION

1.1 Background

Before this study was conducted, some research about existing conclusions on the role of sleeping in daily routine, the association between sleeping quality and depression, memorizing level, and reaction time were conducted. Followings are results found in journal articles, textbooks, and official reports.

1.1.1 Importance of Healthy Sleep

It is beyond dispute that sleeping is a crucial stage in mammals' living routine. We humankind spend approximately one-third time of our lives asleep. Sleep is an essential biological function with significant roles in recovery, energy conservation, and survival. In rats, total sleep deprivation can cause death within three weeks (Rechtschaffen et al. 1989).

In the dimension of neuroscience, one hypothesis for sleep-related rhymes is that they help the brain disconnect the cortex from sensory input. A night filled with sleep in bed for up to 8 hours might allow the body to recover from physical exertion, while a negative mood would probably occur the next day if enough sleep is not obtained (Bear et al. 2020). Another hypothesis shows that metabolic wastes during wakefulness are cleared from the brain during sleep (Purves et al. 2018).

Sleep also appears to be essential for multiple vital processes, such as brain development, learning, memory, heart regulation, cellular detoxification, and regulating emotional, cardiovascular, and metabolic functions (Mukherjee et al. 2015).

For the psychologist, sleep functions to recognize information received in the daytime under some logic. Research discovers that compared with staying awake, proper sleep could improve the ability to solve problems significantly (Wagner et al. 2004). Therefore, a good sleeping habit should play an essential role in developing students' learning abilities.

All those researches convince people that sleep is closely linked to a human's ability to memorize and recognize. Projects like how sleep routine affects learning, memorizing, and emotion have attracted the attention of scientists from different fields.

1.1.2 Concerning Situation

Currently, it has raised social concerns that sleep disturbance spreads out gradually as a common

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phenomenon among Chinese college students in the wake of the accumulating study stress and diverse ways of entertainment. One research where 112939 university students were included found that the overall pooled prevalence of sleep disturbances was 25.7%, the percentages of students dissatisfied with sleep quality and those suffering from insomnia symptoms were 20.3% and 23.6%, respectively (Li et al. 2018).

However, the evil sleep habits of Chinese young people can date back to their experience in middle school. Burdened with tons of homework, they were always forced to work until midnight and wake up early in the morning, leading to severe sleep deprivation. Even worse, the prohibition of entertainment can give rise to revenge consumption of Internet games and addiction to virtual competitions, which are to blame for sleep disorders.

Furthermore, the suicide rate has increased constantly in recent years. 2.8% prevalence of suicide attempts and more than 600,000 suicide attempters among college students indicate that suicide attempt among college students is a significant public health problem in China (Yang et al. 2015).

1.2 Question and Exploration

Unfortunately, it is well recognized that sleep disturbance is prevalent among adolescents, especially those suffering from the population suffering from mental disorders like depression. A survey indicates that depressed adolescents usually underwent longer sleep onset, had more wake after sleep onset and had lower sleep efficiency than those who were non-clinical or had relief (Lovato and Gradisar 2014). However, their samples were mainly adolescents ranging from 12-20 years, so the results might differ from those drawn in this study.

As for the impact of sleep deprivation on memory consolidation, how sleep quality can affect non-declarative memory is hugely controversial; Giuditta raised Dual-Process Hypothesis, that whether the REM (Rapid Eye Movement)stage of NREM(non-rapid eye movement)stage functions depends on which kind of memory is formed (Giuditta 2014). While Barrett insisted Sequential Hypothesis that the alternation between REM-NREM plays a dominant role in the efficiency of memory consolidation (Barrett and Ekstrand 1972).

Therefore, this study will explore the effect of sleep quality on the accuracy and reaction time of declarative memory recognition with tasks including remembering irregular number sequences, phrase combination, and face recognition to investigate

whether two groups with different sleep qualities would have discrepancies in performance.

2 GOAL AND HYPOTHESIS

2.1 Goals of This Study

This study was expected to demonstrate the adverse effects of poor sleep quality on several aspects, including those indicators relevant to learning ability and depression or frustration. Besides the awareness of the importance of healthy sleep, a solution is expected to be introduced to improve the living quality of college students.

2.2 Hypothesis

If college students over 20 frequently undergo poor quality sleep in the last month, they are more vulnerable to gloomy moods, react more slowly, and harder to produce and store declarative memories.

3 METHODS AND EXPERIMENTAL PROCEDURES

3.1 Samples

The subjects were 40 Chinese college students with their average age = 21.5±2.5, including 19 males and 21 females. Each participant received a package containing detailed instructions, a PSQI survey, a depression index survey, a reaction test, and a memorizing test via e-mail, and they were asked to respond to the mail with their answers attached, then their scores were counted respectively. Finally, 34 of them finished all of the materials, so 34 valid data groups were collected.

All participants were selected from students around researchers, had finished or undergoing higher education. Each of them volunteered to participate in this study that rewards of any means were not offered.

3.2 Materials

3.2.1 Sleep Quality Survey

In order to ensure participants' sleeping conditions, they were asked to finish PSQI(Pittsburgh Sleep Quality Index), which made it possible to recognize

their sleep habits and sleep quality in the last month. This index was compiled by Professor Buysse et al. from the University of Pittsburgh in 1989. In 1996, the Chinese version was produced by Xianchen Liu et al. The reliability and validity for the Chinese population were also proved by their researches involving ordinary people, patients diagnosed with insomnia, depressive disorder, and schizophrenia. (α value=0.84).

This index consists of 7 dimensions, including subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction (Buysse et al. 1989). The PSQI includes a scoring key for calculating a patient's seven subscores, each of which can range from 0 to 3. The subscores are tallied, yielding a "global" score that can range from 0 to 21. A global score of 5 or more indicates poor sleep quality; the higher the score, the worse the quality (Carole A, n.d.).

3.2.2 Depression Index

The mood survey tested participants' moods. Questions were asking their mood in the past couple of weeks, their take on life. Furthermore, they asked if they had been experiencing any physical changes. The standard is as follows:

Depression Severity: 0-10 none, 11-21 mild, 22-32 moderate, 33-43 moderately severe, 44-60severe.

3.2.3 Reaction Test

In this test, three parts of tasks were designed. The first one is to find all allocated numbers in the following sequence: all ten numbers with three among 48 sequences. Moreover, the second one is to find all Chinese characters with one shared structure from all the characters shown on the screen. The final task is graph recognition, for instance, to find all four equilateral triangles from all assigned graphs. Once the participants finished all the tasks, the time spent would be measured.

3.2.4 Memory Test

Based on the Clinical Memory Scale(CMS) published in 1986, a simplified version of the memory test was constructed to improve the experimental procedure, including three sections: association learning, random number sequences recalling(instead of meaningless graph recognition in CMS), and face-associated features recognition (Xu and Wu 1986). In the first part, in total, 18 pairs of Chinese phrases were shown

to participants. Half of them were connected logically(e.g., apple-fruit in English), while the other half were meaninglessly linked or even belonged to different parts of speech(e.g., light-following). Participants were given 20 seconds to memorize all those combinations and would have 1 minute to fill the blank with only one of the phrases were shown on the screen. Such a kind task is repeated twice in the first part in the same way but with different phrases (eighteen sets of meaningful words and eighteen sets of meaningless ones in total). For the second part, participants were asked to remember random number sequences within 1.5 seconds and write them correctly in 3 seconds(eight sequences with seven numbers, one sequence with five numbers, one with six numbers, one with eight numbers, one with nine numbers). The final task is to repeat the three lines of personal information in 15 seconds after being shown features connected with faces, including nationality, occupation, and age, for 5 seconds. Three faces with nine lines of features were arranged in one task, and four tasks would be conducted in total(including Western male and female faces & Eastern male and female faces).

The followings are the scale for this test:

First section: Three scores were assigned for one meaningful set, six scores for meaningless sets.

Second section: One score was assigned for the sequence with five numbers, two scores for the sequence with six numbers, three scores for sequences with seven numbers, four scores for the sequence with eight numbers, five scores for the sequence with nine numbers.

Third section: One score was assigned for one feature associated with an Eastern face and two for those associated with a Western face.

With 252 scores in total, participants getting scores higher than 110 would be considered to have performed well, while those ending up 110 scores or less would be judged as poor.

3.3 Tools

3.3.1 Document Retrieval

The digital database of document retrieval applied in this paper includes Web of Science, PubMed, and Google Scholar. The keywords researched includes "sleep", "REM", "memory consolidation", "depression", "reaction", "declarative memory" and "Chinese student suicide rate".

3.3.2 Data Analysis

IBM SPSS statistics 23 was used in this study to conduct correlation analysis.

4 RESULTS

4.1 Statistics

Table 1: Pearson Test.

Correlations

		SleepingQuality	DepressionIndex	reaction time	MemorizingIndex
SleepingQuality	Pearson Correlation	1	.135	-.031	.374*
	Sig. (2-tailed)		.445	.863	.029
	N		34	34	34
DepressionIndex	Pearson Correlation	.135	1	-.341*	-.227
	Sig. (2-tailed)	.445		.049	.197
	N	34		34	34
reaction time	Pearson Correlation	-.031	-.341*	1	.336
	Sig. (2-tailed)	.863	.049		.052
	N	34	34		34
MemorizingIndex	Pearson Correlation	.374*	-.227	.336	1
	Sig. (2-tailed)	.029	.197	.052	
	N	34	34	34	34

*. Correlation is significant at the 0.05 level (2-tailed).

Table 2: Regression Test.

Model Summary

Model	R	R Square	Adjusted R Square	Std. The error of the Estimate	Durbin-Watson
1	.374[a]	.140	.113	31.466	1.405

a. Predictors: (Constant), SleepingQuality

b. Dependent Variable: MemorizingIndex

Table 3: Coefficients.

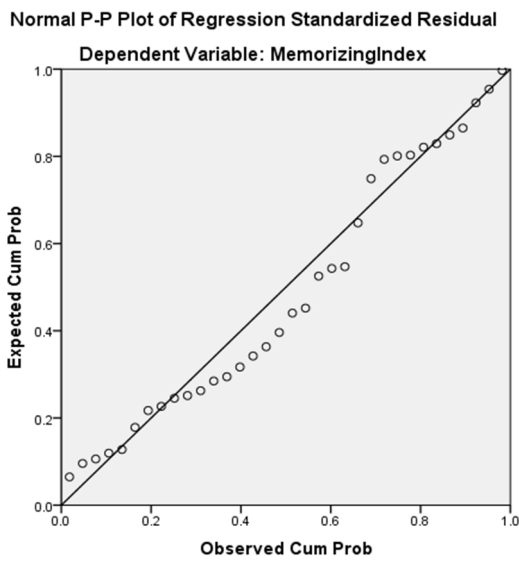| Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	85.288	9.360		9.112	.000		
	SleepingQuality	4.903	2.149	.374	2.281	.029	1.000	1.000

Figure 1 Normal Distribution Analysis.

4.2 Analysis

4.2.1 Pearson Test

Table 1 shows the result of the Pearson test. According to the Pearson test, correlation is significant if p-value <0.05. Unfortunately, no significant correlation between sleep quality, depression index, and reaction time were found. Meanwhile, R-value can indicate the degree to which two variables are associated. It is a value ranging from -1 to 1. The greater its absolute value is, the stronger correlation the two variables have. As for sleeping quality and memory ability, the data indicated that higher PSQI scores(poorer sleeping quality) could lead to lower memory levels.

4.2.2 Regression Test

In order to explore the detailed connection between sleeping quality and memory, linear regression analysis was decided to be conducted with results shown in Table 2 and Table 3. According to the R square value, sleeping quality contributes to about 14% of memory scores, which is a dominant factor in statistics. Table 3 suggests the value of constant and coefficient, for which the equation involving memory scores and sleeping index can even be deduced: $Memory\ Index = Sleep\ Index * 4.903 + 85.288.$

4.2.3 Test of Normality

Figure 1 shows the condition of the normal distribution of the memorizing index data. The condition of the distribution of the dots fits the line closely, so the scores acquired are distributed normally.

5 CONCLUSIONS

Three experiments were conducted in order to discover the relationship between sleep quality and three other variables. The result shows a positive correlation between sleep quality and short-term declarative memory storage(*p value=0.029<0.05, R value=0.374, two tail, Table 4.1.1.1*). This result testifies that people undergoing a healthy sleep the last night tend to memorize tasks better. While there is no significant correlation between sleep quality and depression index or reaction speed. Because the p values of them are 0.445 and 0.863, all bigger than 0.05. These statistics disprove the hypothesis, meaning that better sleep quality results in better emotional states or faster reactions. However, they could be attributed to the limitations demonstrated below.

6 LIMITATIONS

6.1 Samples

Due to the financial limitation, it was challenging to offer rewards to participants in this study, for which reason samples from classmates or friends closely around were most available, which was likely to cause convenient bias. For example, all of the participants were experiencing or had finished higher education. In addition, the sample amount was not very broad(N=34), so fortuity could not be excluded. Furthermore, the time delay was unavoidable through internet interviews. An inaccurate time report could be produced for this reason.

6.2 Materials

It is worth noticing that some of the surveys mentioned above were self-designed. Although quite a quantity of documents was referred to, there was no evidence that all the materials applied could discover the exact condition. Take the depression survey, for instance. Inaccurate results could be achieved by a

survey limited to 9 questions.

6.3 Equipment

Although PSQI is widely recognized as an efficient survey to release the sleep quality of participants, a brain wave recorder is required if the research on the sleep stage, brain wave features, and eye movement features need to be conducted, which helps to confirm the effect of different sleep stages on memory formation.

7 FUTURE DIRECTIONS

7.1 Study Accuracy

In the future, the study is expected to be clarified in three aspects. First, tests on more participants must be conducted, which leads to more accurate data and statistics analysis, and the correlation of sleep quality and other variables can be confirmed. Second, applied materials require upgrading to fit into different groups of participants and rule out irrelevant variables like nationality, gender, age, and family background. Finally, the access to technological equipment to finish the further study is wished to come true.

7.2 Study Function on Society

This study hopes that people could realize the critical role healthy sleep plays in people's daily routine. In modern society, staying up late or sleeping disorders have become ordinary phenomena. A revolution to such a problem on the way of studying and working is also expected. College students, especially, should keep a good habit of sleeping.

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