ISSN 2663-8169 Vol. 6, Issue 10: 66-71, DOI: 10.25236/IJNDE.2024.061011

A Case Study on the Effect of Napping on Verbal Memory of High School Students in Foshan, China

Wei Lu[1,a,*]

[1]*Guangdong Country Garden School, Foshan, China*
[a]*winniespace@icloud.com*
[*]*Corresponding author*

Abstract: *Memory is known to be related to sleep, and napping has been proven to have all sorts of long-term benefits. However, the exact impact of naps on short-term memory still remains unclear. We accessed the memory level through a test based on English words and their corresponding Chinese meaning in a high school in southern China. Then, we compared the performance of the participants who were randomized to either nap or no nap groups. The results suggested that the performance of napping groups may not have significant differences in statistics, compared to the no-nap groups, which means that napping might not affect verbal memory to a great extent.*

Keywords: *Adolescent, Napping, Short-time memory, Verbal memory*

1. Introduction

Sleep, which takes up nearly one-third of our day, plays an important role in our physical and mental health. However, a growing body of research shows that a large proportion of people are suffering from insufficient sleep. According to a study in Finland, sleeping difficulties are common: about one-third of the general population suffers from temporary insomnia, while about one-tenth from severe or chronic insomnia [1].

When it comes to adolescents, a sample study focused on American high school students found that the majority of students slept less than 8 hours during school nights, while research in Iceland discovered that the majority of Icelandic adolescents aged 15–16 years do not get the recommended 8–10 h of sleep each night, especially on school nights [2-3].

Previous research has pointed out that there are many factors affecting the sleep length and quality of adolescents, such as general delay of the circadian rhythm of adolescents, increased academic pressure, Internet use, caffeine and alcohol consumption, and even relationships with family and friends [4-7].

Insufficient sleep will increase the frequency of nodding off in class and reduce students' concentration, as well as recognition ability, which will lead to negative outcomes, such as low learning efficiency and unsatisfactory academic performance [8]. Existing research has shown that deficient sleep has been associated with inferior academic performance (GPA) [9].

In order to cope with sleep deprivation, some people consume caffeine drinks, while others choose to have short sleep (usually naps) at other times of the day. A study published in 2003 shows that not only do naps improve experience-dependent perceptual degradation, but they also enhance the performance of participants on the visual texture discrimination task [10]. This finding suggests that a nap has a similar effect on academic performance as a full night's sleep. Subsequent studies have confirmed that daytime naps can consistently improve memory in laboratory circumstances [11]. More research in the field of brain science has verified that a regular sleep schedule involving a nap during daytime may not only ease learning disabilities associated with inadequate nighttime sleep but also benefit sleep-dependent memory by encoding and consolidating declarative memories [12,13].

A great proportion of prevailing studies focus on the long-term benefits, and the experiments are mostly conducted in Western countries. China, in comparison, has far less data and research on high school students. In the work, we hoped to fill the existing gaps in this scientific subject, mainly in two ways: to provide data on Chinese high school students on napping and to investigate the short-term benefits of napping in the daytime.

ISSN 2663-8169 Vol. 6, Issue 10: 66-71, DOI: 10.25236/IJNDE.2024.061011

2. Literature Review

In recent years, more researchers have begun to test the effect of daytime naps in daily education circumstances. A Singapore research group claimed that when learning knowledge about ecology and biology, the learning performance of participants who took a nap was better than that of other individuals who utilized the same period to cram the information[14]. Another study found that teenagers who took a nap about thirty minutes to two hours after class generally scored better on later tests, compared to their counterparts who had conventional schedules of school days without nap hours [15,16]. A recently published review of studies on napping behavior in adolescents pointed out that daytime naps facilitated achieving optimal levels of alertness and function during the day [17]. Thus, it is highly recommended that teenagers take naps in the afternoon without affecting the duration of nocturnal sleep.

All of these studies reveal the benefits of daytime naps. In most cases, people nap during the day to compensate for their lack of nocturnal sleep. However, do daytime naps likewise benefit those individuals who already get enough sleep at night? The experiment conducted by Cousins, Leong, Jamaluddin (2021) et al. provided us with the answer [18]. The researchers recruited 112 teenagers from a boarding secondary school and assigned two stimulated learning weeks on amphibians for them. They could sleep either 8 or 6.5 hours a day, depending on to which group they belonged. The volunteers were divided into four groups with different sleeping patterns: 8 hours of continuous sleep, 8 hours of splitting sleep (1.5 hours at noon, 6.5 hours at night), 6.5 hours of continuous sleep, and 6.5 hours of splitting sleep (1.5 hours at noon, 5 hours at night). The judgment and memory levels of participants under four sleeping modes were assessed using picture coding and factual knowledge tasks. The study revealed that regardless of different total sleep durations, splitting sleep significantly enhanced the performance in the picture encoding and the factual knowledge tasks. Furthermore, splitting sleep had no negative effect on judgment and memory performance in the morning, and at the same time, substantially enhanced those abilities in the afternoon. These findings suggested that the advantages of napping still apply to students who sleep well at night. Without a doubt, daytime napping was indeed more beneficial to those who did not have adequate sleep at night.

Researchers from the University of Hong Kong studied the relationship between napping and nonverbal memory [19]. The experiment contained three parts: recalling and writing down the stories that were told by the researchers, matching words with limited cues, and the Rey Auditory Speech Learning Test. These approaches focused on demonstrating the effect of napping on auditory memory. After a week, the researchers found out that napping significantly improved declarative memory and alleviated a decline in alertness. However, the majority of the participants recruited were female, and the study failed to compare the performance of male participants with that of female participants. Given that it is still uncertain whether different genders have differentiated memory levels and nap quality, researchers should consider gender as a variable, and try to compare the results between two biological sexes.

All of these studies have focused on the impact of napping on long-term memory, but the exact effect of napping on memories in the short term (over a day) remains unknown. Does napping improve people's memory of what they have learned in the short term, even within a day? If so, is the improvement significant? This study was designed to explore these questions. Also, it is a common phenomenon that students choose to sacrifice their sleep before exams to cram and review what they have learned. However, it is known that sleep deficiency can impair attention and cause harm to students' grades. Therefore, we hoped to find out if naps helped students better memorize the information they received in the short term (within one day). If that were the case, students could be provided with a more efficient schedule containing a nap for revision.

3. Study Design

3.1 Experimental Materials

Two different kinds of word lists were prepared in advance: one is for the memory task in the morning, and the other kind is used to access the memory levels. Words on the lists were chosen from the GRE vocabulary, to ensure that it was the first time the participants learned the words. There were 15 words in each word list, arranged from the shortest (includes 3 letters) to the longest (includes 15 letters). Each list was different from the other to prevent participants from discussing it with each other. The lists used for memorizing also included the Chinese meaning of each word. There were only

ISSN 2663-8169 Vol. 6, Issue 10: 66-71, DOI: 10.25236/IJNDE.2024.061011

English words on the word lists for the retrieving task where participants needed to write down the Chinese meaning according to the English words.

3.2 Procedure

Permission to experiment was obtained from school officials before carrying on the experiment. All participants were entirely voluntary to join the experiment. Each participant was given a word list and instructed to memorize the Chinese meanings of the words on the lists for 10 minutes in the morning, at around 9:30 AM. During memorizing, they were allowed to adopt any personal habits to enhance their memory. Although spelling the words on paper was allowed during the time period, these notes were prohibited from being taken away after the experiment, and participants were not allowed to review the words after the 10-minute memorizing time period. Plus, no conversations of any form were permitted during the task.

The test was around 8:30 PM in the evening, on the same day. The schoolday routine of the participants was not disturbed, as they followed their class schedules as usual. The test took part in an empty classroom. The participants were asked to write down the Chinese meanings of the English words they memorized on the word lists, with the English words provided. They were not allowed to access the internet or any other resources, and they were prohibited from asking for help from other people. After they finished, they were asked to fill in a questionnaire about whether they napped and how long they napped.

3.3 Participants

A convenience sample of 69 students in 9^{th} and 10^{th} grade was selected for this study. Of the sample, 34.8 percent (N=24) of the students were from the 9^{th} grade, and 65.2 percent (N=45) of them were from the 10^{th} grade. Among the same sample, 69.6 percent (N=48) of the students were from the high-level English classes, while 30.4 percent (N=21) of them were from the low-level English classes. Students in high-level classes were defined as having superior English learning ability, compared to those in low level classes.

4. Results

Seventy four participants were determined to be eligible for the study and provided informed consent. Of those who consented, five participants withdrew from the study prior to the test. It resulted in a final sample of 69 participants for whom memory performance data were obtained. The results were analyzed through the chi-square test of independence, and the calculated p-value would be compared to the standard p-value to see if the two variables were associated.

There were four sets of associations in the chart (Table 1). The first set was used to determine the association between naps and the level of words recalled among experimental participants. High accuracy refers to students who achieved at least five correct answers in the test. The nap groups were compared to the non-nap groups, to reveal if napping resulted in higher scores in the word test, by calculating the p-value of the 4 data: the number of participants who achieved high accuracy in the nap group and the non-nap group, and the number of participants who achieved low accuracy in the nap group and the non-nap group. The p-value is 0.313208, greater than 0.05, which meant that the null hypothesis could not be rejected. There were no significant differences in statistics, and thus these two factors were independent.

The second pair showed whether the gender difference influenced the performance in the test. The number of male and female who reached high accuracy respectively, and the number of males and females who reached low accuracy respectively were used. The p-value was 0.17175, which was higher than 0.05, so the null hypothesis needed to be accepted, and thus these two factors were not related.

Table 1: Chi-square Test between checked variables.

Variable A	Variable B	Chi-square Value	P-value
Level of words recalled	Nap	1.0171	0.313208
Level of words recalled	Gender	1.8676	0.17175
Level of words recalled	Class	0.4874	0.485071
Level of words recalled	Grade	0.0956	0.757212

The third one was to test the association between the ability to learn English and the level of words

ISSN 2663-8169 Vol. 6, Issue 10: 66-71, DOI: 10.25236/IJNDE.2024.061011

recalled. The number of students in high-level classes and low-level classes whose test accuracy is high, and the number of students in high-level classes and low-level classes who have low test accuracy were analyzed. The p-value was 0.485071, higher than 0.05, so the null hypothesis that these two elements were independent needed to be accepted, while our initial hypothesis was invalid.

The last analysis was conducted to test the relationship between grade and accuracy in the word test. We speculated that the students in eleventh grade would outperform those students in tenth grade. However, with the p-value of 0.757212, not less than 0.05, our expectation was not acceptable, because there were no significant differences in the set of data. As a result, the grades of participants could not affect their performance in the word test.

5. Discussion

The results of this study indicated that the variables were independent. It meant that having or not having naps was not associated with short-term memory of words. However, similar studies conducted before seemed to have different outcomes. A study in 2015 discovered that a postprandial nap for thirty minutes was able to alleviate post-lunch dip and thus restore alertness, while a study in 2017 compared the impacts of napping on adolescents with that on older adults, finding that although naps increased memory reactivation in teenagers, older adults did not show any improvement in episodic memory [20, 21]. Additionally, research drew a closer look at the impact of naps on other types of memory, by utilizing two blocks of memory tasks: one block consisted of easy trials, and the other contained difficult trials [22]. The experiment concluded that a short afternoon nap (about 30 minutes) contributed to procedural memory consolidation. However, declarative memory was found to be unrelated to naps in the experiment. Additionally, to learn more about the habit of napping, a study declared that an afternoon nap was beneficial for long-term memory even if one did not habitually nap [23]. Furthermore, napping was especially beneficial for habitual nappers to perform short-term topographical memory tasks, as napping restored the decline that would otherwise have been incurred.

Due to the limited time and restricted resources, several limitations in our study might jeopardize the accuracy of this experiment, hindering us from discovering the true effect of napping. In the first place, the sample size of experiment participants was not large enough and all participants were from a single high school, which could contribute to lack of viability and lead to biased and invalid results. In the second place, it was highly possible that the participants in the experiment might have failed to express their real situation in our questionnaire on napping since it was hard for them to gauge the exact duration of their naps when they were slumberous. Plus, a proportion of volunteers could not confirm whether they actually fell asleep or just nodded off. These problems made the self-reporting questionnaire less objective, which would exert negative impacts on further analysis. Consequently, future studies should rely on professional tools, such as sleep meters that convey sleep quality and duration, in order to achieve high objectivity, instead of depending on highly subjective questionnaires. Also, the attitude of the participants could affect the experiment outcome to a great extent, because memorizing words was rather demanding and required high concentration, and the participants were expected to try their best in the task. What's more, we did not manage the nocturnal sleep duration of the participants. Yet it is known that sleep deprivation could harm students' recognition ability and concentration, affecting the results of the memory task. Lastly, due to the time schedule of the school, most participants only rested for less than 30 minutes. In comparison, most of the relevant research mentioned above assigned thirty to ninety minutes for nap time in the experiment. According to the experiment conducted by Slama, H., Deliens (2015) et al., the participants in the study were in bed for 30 minutes and achieved an average of 13.2±10.1 minutes of sleep. Thus, the participants in our research are likely to sleep even for a shorter time, suggesting that the duration of napping might as well be responsible for the difference in the outcomes because the napping time could be too short to be effective. Thus, future studies should take control of irrelevant variables discreetly, and ensure that there are as little disturbances to the experiment.

6. Conclusion

This study was among the first to examine the effect of napping on short-term memory of one day. Based on our experimental data, we found out that napping was unrelated, or not significantly related, to short-term memory. However, we believed that this conclusion might not truly discover the relationship between napping and short-term memory due to the uncertainties and limitations of this study. Further studies were expected to explore the effect of napping further and other relevant

ISSN 2663-8169 Vol. 6, Issue 10: 66-71, DOI: 10.25236/IJNDE.2024.061011

variables related to napping, including the optimal length of napping and different types of memory that take advantage of napping behavior. In order to improve the reliability of the experiment and obtain qualified data, more professional devices shall be adopted to measure the nap length and quality, and multiple scientific methods shall be utilized to ensure the full participation of participants.

Acknowledgment

Our gratitude goes to Dr. Xueqin He, for her full support in our research. We likewise appreciate the anonymous participants involved in our experiment and other volunteers help to collect the questionnaire and analyze the data.

Compliance with ethical standards

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

Research involving human participants

All participants had signed informed consent, and this experiment did not interfere with their routines as high school students.

References

[1] Hublin, C., Kaprio, J., Partinen, M., & Koskenvuo, M. (2001). Insufficient sleep—a population-based study in adults. Sleep, 24(4), 392-400.
[2] Ming, X., Koransky, R., Kang, V., Buchman, S., Sarris, C. E., & Wagner, G. C. (2011). Sleep insufficiency, sleep health problems and performance in high school students. Clinical Medicine Insights: Circulatory, Respiratory and Pulmonary Medicine, 5, CCRPM-S7955.
[3] Rognvaldsdottir, V., Gudmundsdottir, S. L., Brychta, R. J., Hrafnkelsdottir, S. M., Gestsdottir, S., Arngrimsson, S. A., ... & Johannsson, E. (2017). Sleep deficiency on school days in Icelandic youth, as assessed by wrist accelerometry. Sleep medicine, 33, 103-108.
[4] Tarokh, L., Short, M., Crowley, S. J., Fontanellaz-Castiglione, C. E., & Carskadon, M. A. (2019). Sleep and circadian rhythms in adolescence. Current sleep medicine reports, 5, 181-192.
[5] Power, S., Taylor, C., & Horton, K. (2017). Sleepless in school? The social dimensions of young people's bedtime rest and routines. Journal of Youth Studies, 20(8), 945-958.
[6] Bartel, K. A., Gradisar, M., & Williamson, P. (2015). Protective and risk factors for adolescent sleep: a meta-analytic review. Sleep medicine reviews, 21, 72-85.
[7] Delaruelle, K., Dierckens, M., Vandendriessche, A., Deforche, B., & Poppe, L. (2021). Adolescents' sleep quality in relation to peer, family and school factors: Findings from the 2017/2018 HBSC study in Flanders. Quality of Life Research, 30, 55-65.
[8] Taras, H., & Potts-Datema, W. (2005). Sleep and student performance at school. Journal of school health, 75(7), 248-254.
[9] Wolfson, A. R., & Carskadon, M. A. (2003). Understanding adolescent's sleep patterns and school performance: a critical appraisal. Sleep medicine reviews, 7(6), 491-506.
[10] Mednick, S., Nakayama, K., & Stickgold, R. (2003). Sleep-dependent learning: a nap is as good as a night. Nature neuroscience, 6(7), 697-698.
[11] Alger, S. E., Lau, H., & Fishbein, W. (2012). Slow wave sleep during a daytime nap is necessary for protection from subsequent interference and long-term retention. Neurobiology of learning and memory, 98(2), 188-196.
[12] Ong, J. L., Lau, T. Y., Lee, X. K., van Rijn, E., & Chee, M. W. (2020). A daytime nap restores hippocampal function and improves declarative learning. Sleep, 43(9), zsaa058.
[13] Cellini, N., Torre, J., Stegagno, L., & Sarlo, M. (2016). Sleep before and after learning promotes the consolidation of both neutral and emotional information regardless of REM presence. Neurobiology of learning and memory, 133, 136-144.
[14] Cousins, J. N., Wong, K. F., Raghunath, B. L., Look, C., & Chee, M. W. (2019). The long-term memory benefits of a daytime nap compared with cramming. Sleep, 42(1), zsy207.
[15] Lemos, N., Weissheimer, J., & Ribeiro, S. (2014). Naps in school can enhance the duration of declarative memories learned by adolescents. Frontiers in Systems Neuroscience, 8, 103.
[16] Cabral, T., Mota, N. B., Fraga, L., Copelli, M., McDaniel, M. A., & Ribeiro, S. (2018). Post-class

ISSN 2663-8169 Vol. 6, Issue 10: 66-71, DOI: 10.25236/IJNDE.2024.061011

naps boost declarative learning in a naturalistic school setting. npj Science of Learning, 3(1), 14.
[17] Santos, J. S., Beijamini, F., & Louzada, F. M. (2021). Napping behavior in adolescents: consensus, dissents, and recommendations. Sleep and Vigilance, 5, 189-196.
[18] Cousins, J. N., Leong, R. L., Jamaluddin, S. A., Ng, A. S., Ong, J. L., & Chee, M. W. (2021). Splitting sleep between the night and a daytime nap reduces homeostatic sleep pressure and enhances long-term memory. Scientific Reports, 11(1), 5275.
[19] Lau, E. Y. Y., McAteer, S., Leung, C. N. W., Tucker, M. A., & Li, C. (2018). Beneficial effects of a daytime nap on verbal memory in adolescents. Journal of adolescence, 67, 77-84.
[20] Slama, H., Deliens, G., Schmitz, R., Peigneux, P., & Leproult, R. (2015). Afternoon nap and bright light exposure improve cognitive flexibility post lunch. PLoS One, 10(5), e0125359.
[21] Scullin, M. K., Fairley, J., Decker, M. J., & Bliwise, D. L. (2017). The effects of an afternoon nap on episodic memory in young and older adults. Sleep, 40(5), zsx035.
[22] Qian, L., Ru, T., He, M., Li, S., & Zhou, G. (2022). Effects of a brief afternoon nap on declarative and procedural memory. Neurobiology of Learning and Memory, 194, 107662.
[23] Leong, R. L., Yu, N., Ong, J. L., Ng, A. S., Jamaluddin, S. A., Cousins, J. N., ... & Chee, M. W. (2021). Memory performance following napping in habitual and non-habitual nappers. sleep, 44(6), zsaa277.