

The Relationship Between Sleep Duration and Short-Term Memory Performance Among High School Students

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Abstract. Sleep constitutes an essential component of human health and daily life, being vital to learning, skill acquisition, and holistic physical and mental well-being. It exerts a significant influence on individuals' memory consolidation, learning competence, academic achievements, and neurobehavioral functioning. The present study is intended to investigate the correlation between sleep duration and memory consolidation among high school students. In this study, a total of 34 samples were used. During the data cleaning process, the author employed Pandas to identify and address missing values and outliers. For instance, the extreme data from respondents who claimed to sleep for more than 12 hours or less than 4 hours per day were removed from the dataset. Correlation analysis was conducted using Excel to explore the association between sleep duration and memory performance. The findings indicate a weak positive correlation between the two variables, suggesting that longer sleep duration is generally associated with better memory retention for high school students.

Keywords: Sleep, time for sleep, memory retention, students

1. Introduction

It is observed that many students nowadays have severely insufficient sleep. According to the 2022 China National Health Sleep White Paper, the average sleep duration for high school students is only 6.5 hours. Moreover, high school students face the greatest academic pressure. Therefore, it is hoped that research and investigation will determine whether the duration of sleep has an impact on memory and learning, and whether sacrificing sleep hours to dedicate more time to academic studies can contribute to higher performance of high school students in the college entrance examination.

These results delineate a systematic shift in the neural representation of an acquired motor sequence subsequent to a night's sleep. This form of overnight neuroplasticity, linked to sleep-dependent memory processing, bears significant relevance to the acquisition of numerous real-world motor skills [1].

This study completed many statistical research through online questionnaire and correlation analysis of the relationship between sleep duration and memory. This research has made contributions to the field of sleep and education, enabling researchers to empirically examine the correlation between sleep and memory within the real-life contexts of contemporary high school

students. This has served as a warning and reflection for schools, such as reducing students' burden and allowing them to have more sleep time to improve memory and efficiency.

2. Literature review

Many high school students cannot concentrate on their studies and classes after staying up late to study the previous night. Additionally, they cannot memory context clearly. For example, some students cannot remind the context of knowledge although they stay up late to remember it the last night.

Sleep is important for everyone. Sleep helps the brain "organize and digest" the information learned during the day and form long-term memory. On top of that, Inadequate sleep may result in impaired attentional focus and diminished short-term memory capacity.

Some studies have found that the more adequate the sleep is, the better the learning content can be retained. Additionally, research has shown that increased daytime sleepiness, a direct consequence of poor sleep quality, can severely impair students' cognitive processes and behavioral functioning.. Studies involving children with sleep-breathing disorders or obesity have also suggested a link between academic achievement and sleep habits or the degree of daytime sleepiness. Ultimately, experimental manipulations of children's sleep amount and quality have confirmed that suboptimal or fragmented sleep is associated with behavioral and cognitive difficulties, as well as reduced academic success and learning efficacy [2].

Other studies have discovered that excessive sleep time is not always better; the key lies in "high-quality sleep." Sweileh et al., in a study involving 400 Palestinian students, ascertained that academic achievement bore no association with sleep quality. Another investigation focusing on 189 Pakistani medical students similarly found no significant linkage between inadequate sleep and academic test performance. In this context, students may be susceptible to sleep disorders—a factor that has been proposed as a potential contributor to subpar academic outcomes, though no clear elucidation has been provided. Separately, one study identified daytime sleepiness (rather than sleep quality or duration) as an independent prognostic factor for academic success. A comparable study further revealed that sleep onset latency and wake-up time (not total sleep duration) were associated with academic achievement, whereas total sleep amount showed no correlation with academic performance among adolescents with active cognitive functioning. In contrast to these studies highlighting weak or non-existent associations, other research has observed an inverse relationship between sleep disturbances and academic attainment. For instance, a study on first-, second-, and third-year medical students documented correlations between academic performance, nighttime sleep duration, and daytime sleepiness. Another study of medical students noted that nighttime sleep insufficiency, delayed bedtime, and daytime sleepiness exerted adverse effects on students' academic outcomes. Notably, sleep disturbances are apt to exert a negative impact on academic performance, thereby perpetuating a vicious cycle [3].

Still, some research indicates that different sleep stages (rapid eye movement period and non-rapid eye movement period) have different effects on the types of memory. Research conducted on humans has compared how sleep periods with different ratios of SWS and REM sleep influence memory consolidation. In the human nocturnal sleep cycle, SWS is most prominent in the early stages, while REM sleep dominates the later phases. Consistently, early sleep high in SWS benefits the consolidation of declarative memories, whereas REM-rich sleep supports nondeclarative memory (i.e., the procedural and emotional aspects of memory). These results are congruent with the dual-process hypothesis, which assumes that SWS facilitates declarative memory dependent on the hippocampus, and REM sleep sustains nondeclarative memory independent of the hippocampus.

Nevertheless, other studies have indicated that SWS can also enhance procedural (nondeclarative) memory, and REM sleep may improve declarative memory as well. While these divergent findings might reflect the use of memory task stimuli that often do not conform to a single memory system, they align with the sequential hypothesis. This hypothesis argues that the maximum benefits of sleep for consolidating both declarative and nondeclarative memory are achieved when SWS and REM sleep occur in sequence. For example, overnight gains in visual texture discrimination correlated with both the amount of SWS in the first 25% of sleep and REM sleep in the last 25%. Texture discrimination also improved after a short midday nap of 60–90 minutes that included only SWS, but the effect was stronger when the nap contained both SWS and REM sleep. Furthermore, memory consolidation seems to be compromised when the natural SWS–REM sleep cycle is disrupted, even if the total time spent in these sleep stages remains unaltered [4].

3. Case study

3.1. Research question

This study investigates whether there is a relationship between sleep duration and short-term memory performance among high school students. The hypothesis is that students who sleep for longer durations are expected to perform better in short-term memory tests and delayed recall tests than those who sleep for shorter durations [5].

3.2. Research design

The independent variable in this study is the average sleep duration per night, measured in hours. For analysis purposes, it can be treated as a continuous variable or classified into three groups: ≤ 6 hours, 6–8 hours, and ≥ 8 hours. The dependent variable is the memory performance score, which includes both immediate recall and delayed recall results.

Data were collected through a self-reported questionnaire distributed among high school students. The questionnaire was composed by 6 simple questions regarding the students' sleep time and test scores. A total of 34 questionnaires were initially collected. After screening for missing or invalid responses, 29 valid questionnaires were retained for analysis. Students were requested to indicate their mean sleep duration over the preceding seven days (in hours) and their recent quiz scores from the same week. The collected data were organized and processed using Microsoft Excel.

3.3. Result

To explore the association between sleep duration and memory performance, three analytical methods were employed: descriptive statistics, group comparison, and correlation analysis. All data processing and analysis were conducted using Microsoft Excel.

3.3.1. Descriptive analysis

The average sleep duration among participants was 6.58 hours ($SD = 0.6$), indicating that most students slept slightly less than the generally recommended 7–8 hours per night. The average quiz score across all valid responses was 82.9, reflecting an overall moderate to high level of academic performance.

3.3.2. Group comparison

To further explore potential differences among students with varying sleep durations, participants were divided into three sleep-duration groups: short-sleep (≤ 6 hours), medium-sleep (7 hours), and long-sleep (≥ 8 hours). As shown in Figure 1, the short-sleep group had an average immediate recall score of 1.8, the medium-sleep group averaged 1.825, and the long-sleep group achieved 2.0. This gradual increase in recall performance suggests that longer sleep duration may be associated with improved short-term memory.

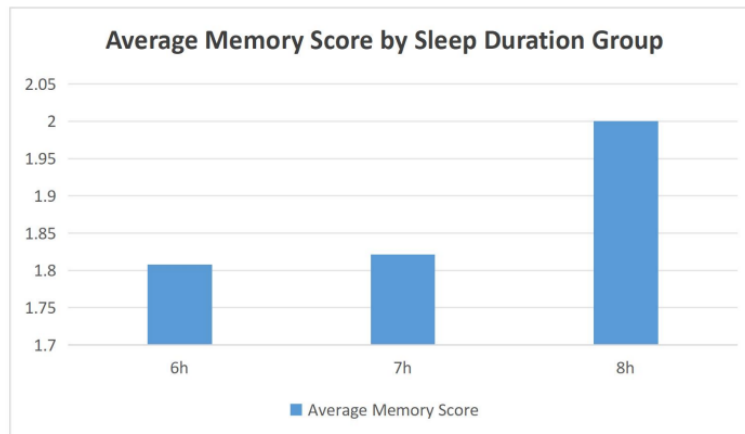


Figure 1. Average memory score by sleep duration group

3.3.3. Correlation analysis

For a deeper exploration of the association between sleep duration and memory outcomes, a correlation analysis was carried out using Microsoft Excel. The results showed a correlation coefficient of $r = 0.3$ between sleep duration and immediate recall score, indicating a moderate positive correlation. This suggests that students who reported longer average sleep durations tended to achieve higher immediate recall scores. According to the established coefficient range (see Table 1), this level of correlation reflects a meaningful, though not strong, positive association between the two variables.

Table 1. Correlation coefficient range and meaning indicated

Correlation coefficient range	Meaning
0.7 ~ 1.0	Strong positive
0.3 ~ 0.7	Moderate positive
0.1 ~ 0.3	Weak positive
0	No correlation
-0.1 ~ -0.3	Weak negative
-0.3 ~ -0.7	Moderate negative
-0.7 ~ -1.0	Strong negative

4. Conclusion

The analysis revealed that students who sleep for a longer duration perform better in memory tests, which supports the initial hypothesis that A positive correlation trend is observed between sleep duration and short-term memory performance.

This study adds to the existing literature by supplying empirical data on the association between sleep duration and memory retention among high school students. It extends previous studies by offering quantitative support for the idea that sufficient sleep serves a pivotal function in facilitating learning and cognitive performance. This study also helps address the limited number of empirical investigations on sleep and memory within the adolescent population.

The present research is constrained by a modest sample size, which may compromise the generalizability of the conclusions. Another potential limitation is that there are some uncontrolled factors such as review sessions and caffeine intake, which could be addressed in future research.

Future study could focus on external factors that may have an impact, such as caffeine intake and study duration.

Overall, this study provides new insights into the association between sleep duration and memory, and highlights the importance of sleep for students.

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