

Why You Can't Remember Where Your Keys Are: The Effects of Sleep Deprivation on Visual Short-Term Memory

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ABSTRACT: This study examines the effects of sleep deprivation on young adults' short-term memory. High school students between ages 16-18 from Turkey and the United Kingdom (n= 106) were asked to fill out a survey, play a short-term memory game and watch a video that showed 20 photos to them for 20 seconds. I predicted that the young adults who slept less than six hours the other day would have worse short-term memory, take more time to complete the short-term memory game, and would not be able to recall the images as well as the ones who slept more than six hours. In addition to this, I predicted that the young adults who slept less would be prone to remember the negative emotions triggering images better than other images and created a memory test to examine it. Recent findings demonstrate that sleep deprivation is linked with short-term memory loss and causes the brain to focus more on negative aspects throughout the day. This study supports recent findings and offers evidence that the sleep deprived young adults experience impaired visual short-term memory and have an altered perception of the world.

KEYWORDS: Sleep; sleep deprivation; perception; memory consolidation; short-term memory.

■ Introduction

Many people find it hard to remember a name they just heard, a question someone asked, or even where their keys are. Short-term memory loss is often associated with brain tissue damage caused by diseases and certain conditions.¹ Yet, do insufficient sleep and chronic sleep deprivation also have serious effects on the short-term memory capacity of the human brain? Do people who didn't get adequate sleep the other day tend to remember more negative images than positive ones?

Previous research conducted by using repetitive transcranial magnetic stimulation (rTMS) shows that two mechanisms attributable to sleep deprivation have a great impact on short-term memory: perceptual processing and basic attention.² Basic attention provides two-channelled receiving functionality by specifically filtering the information for new processes, ultimately leading to perception. The process of choosing, arranging, and evaluating information is known as perception. Perceiving chosen inputs that enter through the sensory filtration, are arranged in established frameworks, and are derived from existing knowledge is what this process entails.³ Another study concluded that sleep-deprived animals have longer reaction times, and the formation of short-term memory is delayed.⁴ Yet, sleep deprivation does not only affect the short-term memory of an individual, but it also causes irritability and lowers the mood.⁵ The amygdala, the brain's central processing unit for scary and angry inputs, and the prefrontal cortex, a brain unit important for decision making, executive function, attention, impulsive behaviour, memory, cognitive control, and social behaviour regulation, normally have a balanced relationship. But in a sleepless brain, the amygdala is found to dominate over the prefrontal cortex, which causes a sleep-deprived individual to experience more negative emotions.⁶ For instance, in his book "Why We Sleep"

Matthew Walker explains that the participants in a study, who normally had the capacity to reset REM sleep at night, but were left without sleep this time, lapsed into a fear-containing bias in a setting where they regarded soft and friendly-looking faces as threatening. The surroundings had become an unjustifiably more terrifying and unpleasant place for them as a result of the brain's lack of REM sleep, a phase of sleep where the eyes move rapidly and randomly. In the perspective of sleep-deprived brains, the actual and perceived reality were not the same anymore.⁷

In accordance with research conducted by many neuroscientists, most of the literature so far demonstrates that sleep deprivation impairs short-term memory consolidation and causes the brain to perceive the world in a negative way.⁸ Still, there is hardly any research conducted that precisely examines the sleep deprivation's effects on young adults' visual short-term memory. The purpose of this paper is to offer findings that might give some insight into it, as visual short-term memory is a vital cognitive function for young adults.

The current study aims to help acknowledge the serious influence of inadequate sleep on the human brain's ability to form short-term memories. Specifically, young participants who slept less than others were expected to need a longer time to finish a memory game and likely remember images that evoke negative emotions. This was assessed with the help of a survey.

Firstly, the method of the study and general information about the topic are introduced and are followed by the examination of the results gathered from the memory game and a short-term memory test. The research paper then continues with addressing strengths and weaknesses, meaning of the study, unanswered questions, and future study as well as previous studies and ends with the presentation of the study as a whole.

■ Methodology

Participants:

The study group consisted of young adults. They had to: (i) be aged between 16-18, (ii) live in Turkey or the United Kingdom, (iii) have no sleep disorders, (iv) have no memory disorders, (v) have no vision problems. 106 persons participated in this study. 41.5% of the participants were eighteen, 39.6% seventeen, and 18.9% sixteen years old. 52.8% of those surveyed were female and 47.2% male. All participant young adults were volunteers.

Materials:

A Google Form was created and sent to young adults. The form was divided into three parts: personal information, a memory game, and short-term memory test. The memory game was created using a website called “interacty” and was based on matching ten paired images. The number of minutes each participant spent playing the game was measured by a chronometer. For the short-term memory test, a YouTube video was created. The video showed 20 images for 20 seconds and then required the participants to answer a question. Scores were gathered and then evaluated using various charts.

Procedure:

At the beginning of the survey, the participants were given information about the aim as well as the duration of the survey. Each form could be filled only one time and it was compulsory to fill each question. The survey was sent to young adults in Turkey and the United Kingdom via WhatsApp by me and they needed to fill out the survey at 12 p.m. precisely. They needed to fulfill the participation criteria in order to take the survey. The responses were anonymous so the subjects knew their results on the memory game and the short-term memory test couldn't be traced back to them. After the survey was completed, all the submissions were assessed, and then scatter plots and column charts were created. With the help of suitable charts, the correlation between sleep deprivation and impaired short-term memory was determined. The evaluation process comprised comparing the sleep-deprived participants' memory game durations with others and the type of images (negative or positive emotions triggering) they were able to recall in the short-term memory test. In addition, whether their short-term memory capacity was affected to a certain extent by each decreasing number of hours slept was taken into consideration.

■ Results and Discussion

Principal Findings:

The purpose of this study was to test whether sleep deprivation had a negative impact on short-term memory consolidation and sleepless young adults were more likely to remember negative images better. I predicted that the longer young adults slept the previous day, the less time they would spend on the memory game (Figure 1 and 2), and the more positive emotions triggering words they would recall on the short-term memory test.⁹ The average hours the young adults slept the other day was 6.2 hours. 46.22% of them slept less than 6 hours and 6.6% slept less than 4 hours the other day. The hypothesis was fully supported for both the memory

game and the short-term memory test. The participants who slept less than six hours the other day spent more time on the memory game and remembered more negative emotions triggering images.

Memory Game:

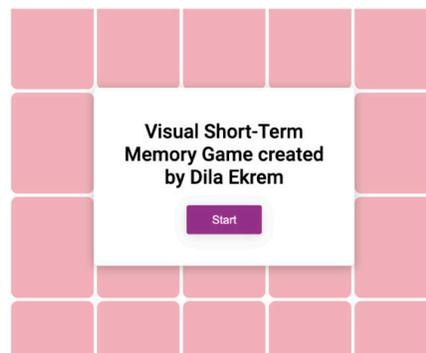


Figure 1: The memory game.

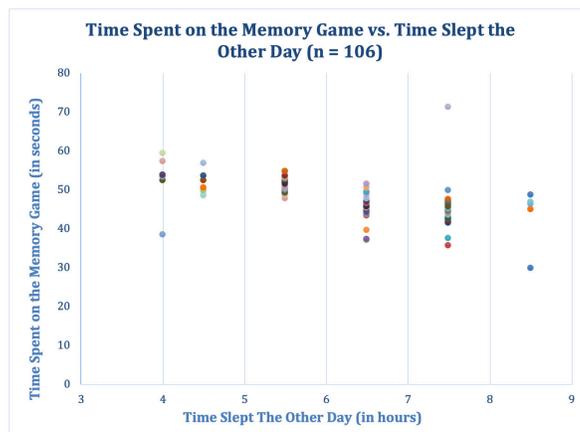


Figure 2: The memory game.

On average, the participants spent around 48.13 seconds on the memory game. The participants who stated having slept more than six hours the other day ($n=57$) spent an average of 45.21 seconds on the game, while the participants who stated having slept less than six hours the other day ($n=49$) spent an average of 51.52 seconds. The participants who slept approximately 8-9 hours the other day ($n=5$) spent 43.34 on the memory game on average, indicating that the more the participants slept the less time they spent on the memory game. (Table 1)

Short-Term Memory Test:

Table 1: Results.



The participants who slept less than six hours the other day were 74.3% more likely to recall negative emotions evoking images such as the thunder, angry fire, fighting kids, and depressive girl. Around 92.3% of them were able to recall the fighting kids and 88.6% of them recalled the thunder. However, the participants who slept more than six hours the other day were able to recall the fighting kids only 23.4% of the time and the thunder 42.7%. These findings prove that when young adults are sleep-deprived, their amygdala is in control, which explains why they remember negative images better.

Strengths and Weaknesses of the Study:

Strengths and Weaknesses of the Study:

As the study examines the correlation between sleep deprivation and short-term memory loss, the results gathered from the survey strongly support the study's hypothesis. At the same time, as there were 106 participants in total, the results can be generalized to young adults aged between 16-18, who are currently enrolled at a high school and don't have any sleep or memory disorders. In terms of cost-effectiveness, the study was conducted without any costs. The self-compiled survey offered a free method to obtain a huge quantity of data in a short period of time and gather information on a variety of aspects such as personal information, memory/sleep disorders, and sleep habits details. However, if the study was to examine sleep deprivation's effects on short-term memory using neuroimaging techniques, it would be highly costly.

The participants of the survey were requested to fill out the survey at 12 p.m. in order to avoid false results due to the time the survey was taken. Still, the timing might have influenced the results. People can be categorized into three groups when it comes to sleep cycles: morning birds, night owls, and those who identify themselves as both. As 40% of the world population consist of morning birds and 30% of night owls, it can be concluded that 30% of the participants ($n \approx 31$) of the survey were disadvantaged in the sense of executive cognition compared with others.

Previous Studies:

Lisa Y. M. Chuah and Michael W. L. Chee were one of those who studied sleep deprivation's negative effects on short-term memory. Their 2008 research study demonstrates that the reason why short-term memory gets impaired as a consequence of sleep deprivation is that visual attention and visual processing are influenced by it.¹⁰ Their assumptions seem to be plausible when approached with the results of this study.

The findings of this study are also consistent with those of Li, Yu, and Guo's, where they support that sleep deprivation induces a severe deficiency in hippocampus' plasticity in the course of memory formation leading to impaired short-term memory consolidation.¹¹

In their cutting-edge paper of 2013, Wee, Asplund, and Chee discovered an impact that is aggravated by sleep deprivation: when short-term memory models are retained over a longer delay, they are more prone to failure.¹² Their results indicate that, if the images on the short-term memory

Meaning of the Study:

Taken together, this study's findings suggest that sleep plays a vital role in the formation of short-term memories among young adults and provides evidence of how sleeplessness can influence the brain's significant functions. The next decade is likely to see many other research studies on sleep deprivation's effects and this study adds substantially to our understanding of the correlation between sleep deprivation and short-term memory capacity.

Unanswered Questions and Future Research:

While the majority of the sleep-deprived participants yielded anticipated results, there were a couple of outliers. For instance, there was in particular a 17-year-old girl who reported having slept less than four hours the other day but spent only 35.6 seconds on the memory game, doing better than most of the participants. This could perhaps indicate that sleep deprivation doesn't necessarily affect young adults' short-term memories in the same way. As in many other aspects of sleep deprivation, whether the short-term memory gets impaired or not might depend on the person. A young adult who had a healthy and quality sleep the other day might show worse short-term memory performance than someone who didn't get sufficient sleep.

Research on sleep's effect on short-term memory and perception of the world could go in various ways. Firstly, studies could explore whether the deprivation of two sleep stages (REM and NREM) has unlike consequences in terms of short-term memory formation. Secondly, the effects of longer sleep-deprivation terms, especially pulling all-nighters, on short-term could be examined. Is there a tipping point, when the brain stops forming short-term memories? Lastly, sleep researchers and neuroscientists could design devices to improve short-term memory formation even when sleep-deprived.

■ Conclusion

I predicted that the participants who slept less than six hours the other day would spend more time on the memory game and would remember more negative emotions triggering images on the short-term memory test. The findings of this study demonstrate my hypothesis through the survey's results, and I found a significant negative correlation between the amount of time slept and the time spent on the memory game. The results of this study have further strengthened my confidence in sleep deprivation's devastating effects on visual short-term memory and perception.

There are numerous examples of sleep deprivation's negative effects on young adults' brains. Taking the results of this study into consideration, the importance of sufficient sleep should be taken more seriously, as the education young adults aged 16-18 get, plays a big role in the formation of their futures, and without adequate sleep, the education they obtain cannot even be useful short-term, let alone long-term. This study, as well as future studies, will add to our understanding of the adverse effects— and potential chronic disorders that can occur — of not getting enough sleep. I hope that this paper successfully highlighted the importance of getting sufficient sleep and will encourage young adults to establish healthy sleep habits to

promote their visual short-term memory. Finally, with the results of this study, it can be concluded that the reason why most people cannot remember where they put their keys is probably that they didn't get enough sleep at night.

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