

# The Effect of Sleep Deprivation on Cognitive Performance in University Students

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## ABSTRACT

This study explores the impact of sleep deprivation on cognitive performance, specifically focusing on attention and memory, in university students. A group of 50 undergraduate students will undergo cognitive testing following both a normal sleep cycle and a sleep deprivation condition. It is hypothesized that sleep deprivation will significantly impair cognitive performance, especially in tasks involving memory recall and sustained attention. The results could inform future strategies for improving student performance and mental health in academic settings.

**Keywords:** sleep deprivation, cognitive performance, attention, memory, university students

## INTRODUCTION

Although not fully understood, sleep is accepted as a vital and organized sequence of events that follows a regular cyclic program each night to ensure the human body can perform at its optimum. A lack of sleep, or sleep deprivation (SD), is a widespread phenomenon that can induce adverse changes in cognitive performance.

Sleep deprivation has become a growing concern in college students due to academic pressures and social activities. Research has shown that sleep plays a critical role in cognitive functions such as attention, memory, and decision-making. However, there is a lack of understanding of how these cognitive impairments specifically manifest in students who experience chronic sleep deprivation. This study aims to fill that gap by examining the cognitive effects of sleep deprivation on university students.

Sleep deprivation (SD) can be divided in partial and total SD. Partial SD refers to a night of reduced or interrupted sleep, and total SD to no sleep for at least one night during the normal sleep/wake cycle. Total SD is frequently studied, which could be due to the easier monitoring of brain activity as longer periods of SD cause increased impaired cognitive functioning. Studies show that consistently restricting sleep overtime is more harmful in comparison to a single night of total SD.

When sleeping, an individual experiences 3 NREM (non-rapid eye movement) and one REM (rapid eye movement) sleep phases. REM SD appears to have a notable effect on exciting neurons, which is vital for assessing possible danger as well as processing reactions to stimuli associated with threats. The NREM sleep deprivation reduces the normal release of specific neurotransmitters, which can affect the ability of the receptors to refresh and restore sensitivity. Without these stages of sleep, the result is reduced cognition.

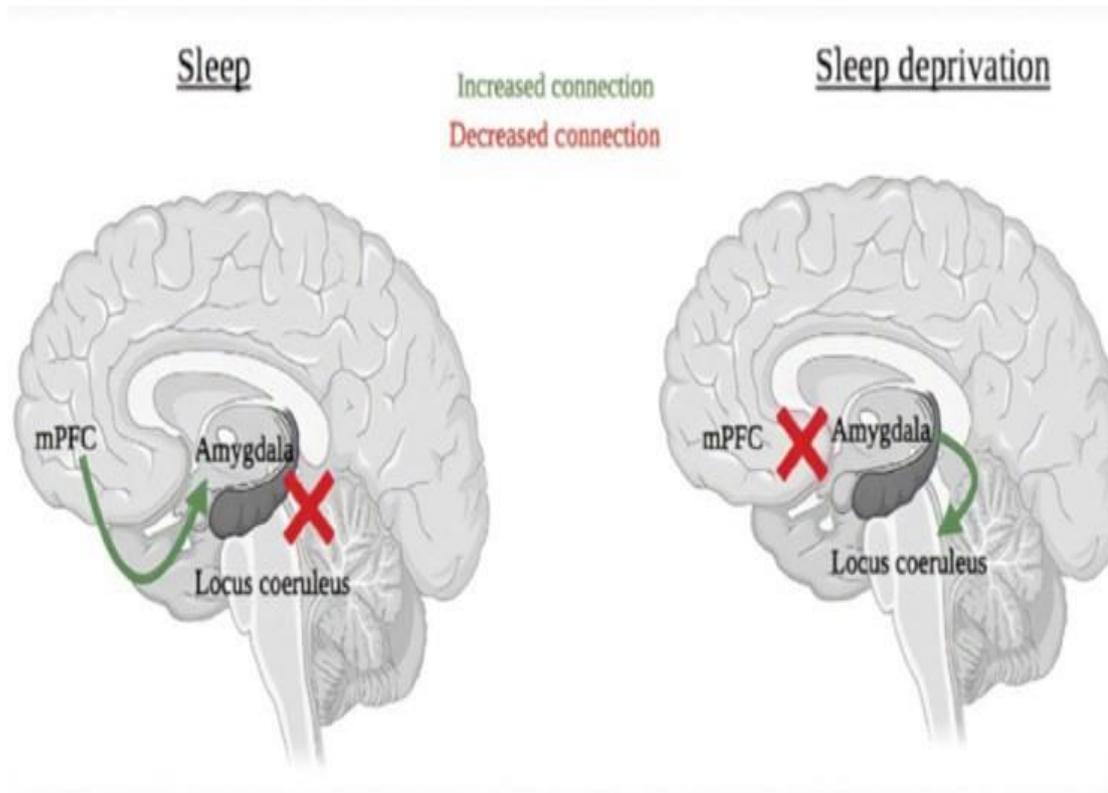
Two processes that affect the amount of sleep obtained are the circadian and homeostatic processes. The circadian process theory proposes a regulating internal circadian clock, which causes the onset and offset of sleep incidents. This facilitates the control wake and sleep cycles as well as the secretion of different hormones. The homeostatic process depends on the wakeful and sleep periods, and the sleep requirements increase with inadequate sleeping hours. As SD increases, the homeostatic functions of the brain become

increasingly impaired. The brain attempts to counter this by secreting hormones in a wave-like manner to prompt wakefulness or sleep. The interaction of the 2 processes regulates the sleep/wake cycle.

### The SD effects on judgment and decision- making

Individuals with SD lose the functional connectivity between the amygdala and the medial prefrontal cortex (mPFC), a region known for exhibiting strong inhibitory projections to the amygdala. In addition, a higher connective relationship occurs in the autonomic areas of the locus coeruleus and the amygdala ( [Figure 1](#) ).

**Figure 1.**



- Comparison of the connections between the mPFC and amygdala, as well as the amygdala and the locus coeruleus, during normal sleep vs. SD. SD - Sleep deprivation, mPFC - medial prefrontal cortex.

With a lack of sleep, an increased amygdala hyperlimbic reaction occurs, resulting in stimuli with negative emotional connotations. This varying level of amygdala activity is linked to a loss of mPFC functional connectivity when sleep deprived, suggesting a decrease in prefrontal lobe inhibition signals. SD results in missing a corrective brain reset reactivity due to the dysfunctional integrity of the mPFC-amygdala circuit, causing inappropriate behavioral responses, such as making rational decisions and social judgments. A study examining moral judgment in individuals with SD reported that SD causes longer response latencies, suggesting a higher level of difficulty to decide a suitable course of action, as SD impairs the ability to integrate cognition and emotion to pass moral judgment.

However, the study used a debatable single assessment procedure of moral judgment, which can limit the generalizability of the results.

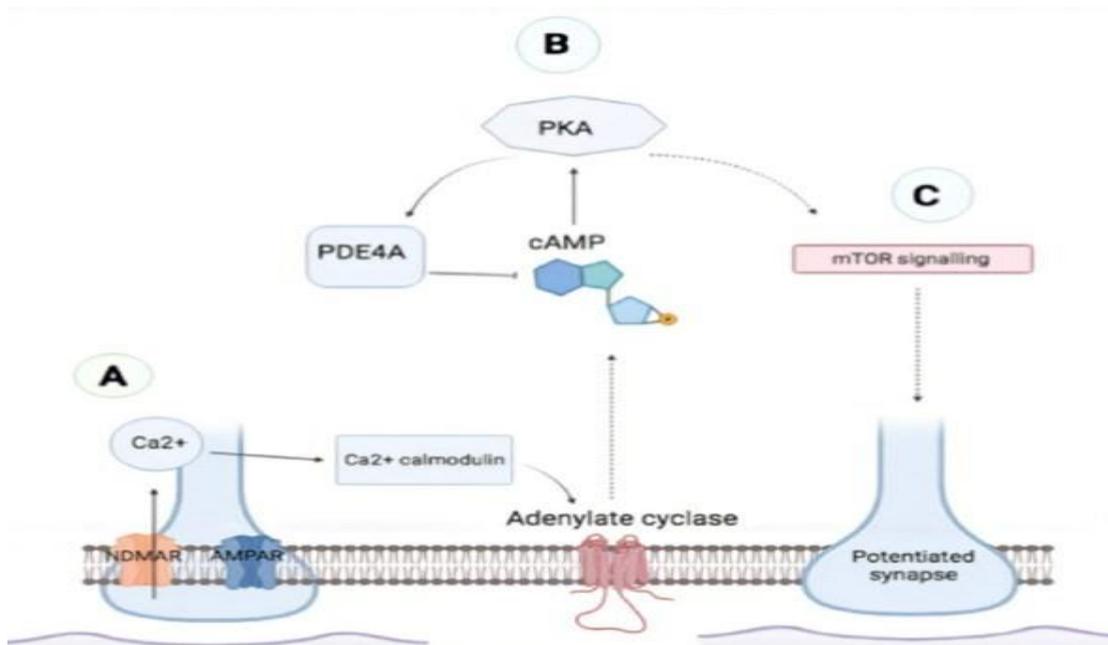
### The SD effects on memory

Sleep deprivation appears to disrupt memory consolidation in the hippocampus through long-term potentiation (LTP). The NMDA receptor is required for the consolidation phase of memory, as it allows memory to advance from an unstable to a more permanent form, which is disrupted in SD. Gais found that the NMDA receptors allow the expression of LTP through an increased  $Ca^{2+}$  influx. SD can impair the full activation of the glutamate receptor by altering the surface and receptor sub-unit composition expression, with a reduced  $Ca^{2+}$

influx. SD rats showed a reduction in the NMDA/AMPA ratio of the hippocampal cells, following hippocampal synapse stimulation. Although there were no alterations in the glutamate or channel sensitivity, it was observed that SD changes the NMDAR surface expression after a crosslinking assay indicated that the NR2A and NR1 components of the NMDA receptors remained in the cytoplasm after SD.

**Figure 2** indicates how sleep deprivation alters glutamatergic signaling through modifications in AMPA and NDMA receptor structure. This disturbance in the receptor function can reduce the molecular signaling cascades due to an attenuated calcium influx, resulting in fewer permanent memories being consolidated in the brain.

**Figure 2**



### The SD effects on attention and alertness

In the sleep state, there is an equal inhibitory action of the task-related default mode network (DMN) activity and the front parietal network (FPN) activity. This is supported by the increased arousal from the thalamus. This equal inhibition means there is consistent attentional performance in the brain. The DMN is the collection of brain areas that activate and deactivate depending on an individual’s external tasks, while the FPN are the networks and brain regions linked to attention. In a sleep-deprived state, there is an imbalanced inhibition between the task-related DMN and FPM activity, and inconsistent increasing arousal activity that influences the thalamic activity. This results in an irregular disturbance of the DMN activity and a reduced FPN activity during external tasks. Suppressing the DMN is vital to allow appropriate brain networks to achieve successful behavior towards tasks and goals, and without its suppression, an individual is unable to maintain attention to specific tasks. Once FPN activity and DMN action are altered, attention and concentration tasks will be unpredictable. After sleep is obtained, the arousal input from the thalamus will stabilize and allow the equal activity of the DMN and FPN to be re-established.

### Need and Significance of the Study

Sleep deprivation is a growing concern among university students, who often sacrifice rest for academic or social obligations. Despite widespread awareness about sleep’s role in mental health, the connection between sleep loss and cognitive functioning is often overlooked. Understanding how sleep deprivation impairs essential skills like memory and attention is critical, as these abilities are fundamental to academic achievement. This study can contribute to awareness campaigns and behavioral interventions promoting better sleep hygiene in academic environments

## Research Gaps

- Few studies have directly investigated the cognitive impairments in university students experiencing acute sleep deprivation.
- Most existing literature focuses on either clinical populations or broader age groups, not young adult learners specifically.
- There is a lack of within-subject experimental research designs comparing pre- and post-sleep deprivation performance under controlled conditions.
- Limited exploration of the neurobiological mechanisms responsible for cognitive deficits in student populations.
- Sparse data linking sleep deprivation specifically with academic performance indicators.

## Review of Literature

1. Walker (2017) outlined sleep's biological role in cognitive regulation.
2. Lim & Dinges (2010) demonstrated that even partial sleep loss severely impacts vigilant attention.
3. Hershner & Chervin (2014) reported how sleep deprivation reduces GPA among college students.
4. Durmer & Dinges (2005) reviewed the neurological impacts of sleep deprivation.
5. Killgore (2010) found impairments in reasoning and decision-making due to lack of sleep.
6. Goel et al. (2009) examined neurobehavioral consequences of total sleep deprivation.
7. Van Dongen et al. (2003) illustrated a dose-response link between sleep reduction and performance.
8. Curcio et al. (2006) emphasized the role of sleep in memory consolidation.
9. Lo et al. (2012) demonstrated cognitive impairments from partial deprivation.
10. Basner & Dinges (2011) focused on maintaining cognitive functioning via sleep strategies.
11. Mograss et al. (2009) found attention-related brainwave disturbances under sleep-deprived conditions.
12. Alhola & Polo-Kantola (2007) reviewed cognitive and behavioral consequences of sleep loss.
13. Gais et al. (2007) showed hippocampal memory disruptions in sleep-deprived individuals.
14. Ma et al. (2015) identified changes in prefrontal brain regions during attention tasks in sleep-deprived people.
15. Rasch & Born (2013) explored sleep's effect on memory formation and emotional regulation.

## Type of Research and Hypothesis

**Research Design:** Quantitative, within-subject experimental research.

### Hypothesis:

University students will perform significantly worse on tasks measuring attention and memory following 24 hours of sleep deprivation compared to their performance after 8 hours of normal sleep..

## Research Objectives:

1. To measure baseline cognitive performance of university students in attention and memory tasks.
2. To compare cognitive performance following a normal sleep cycle versus a sleep deprivation condition.
3. To assess the degree of cognitive impairment due to sleep deprivation in attention and memory.
4. To explore potential correlations between sleep deprivation and academic performance in students.

## METHODOLOGY

### Participants

A sample of 50 undergraduate students aged 18–25 will be recruited. Participants must be full-time students, physically and mentally healthy, and have a regular sleep pattern.

### Design and Procedure

The study uses a within-subjects design. Each participant will complete two sessions:

- **Condition 1:** Cognitive testing after 8 hours of sleep.
- **Condition 2:** Cognitive testing after 24 hours of sleep deprivation.

Tasks will include the **Stroop Test** (to measure attention and inhibition control) and the **Word Recall Test** (to measure short-term memory).

### Tools and Instruments

- Sleep Diary
- Stroop Color-Word Test
- Word List Memory Recall
- Response time & accuracy tracker software

### Data Analysis

Statistical analysis will be done using a **paired-samples t-test** to compare means across the two conditions.

### Ethical Considerations

- Informed consent will be obtained
- Confidentiality and anonymity assured
- Participants may withdraw at any time
- Debriefing after participation

## CONCLUSION

This research aims to highlight the negative effects of short-term sleep deprivation on cognitive functions among university students. It is expected to offer valuable insights into how inadequate sleep hampers memory and attention, directly affecting academic performance.

## Inclusion Criteria

- Age 18–25
- Enrolled full-time student
- Normal sleep patterns (6–8 hours/night)
- Consent to participate

## Exclusion Criteria

- Diagnosed sleep, psychiatric, or neurological disorders
- Use of sedatives or stimulants within 48 hours
- Irregular work shifts (e.g., night shift workers)

## Limitations

- Self-reported sleep data may be biased
- Study focuses only on acute sleep deprivation (not chronic)
- Results may not generalize to older adults or working professionals
- Real-world academic tasks may involve more complex processing than laboratory tests

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\*\*\*\*End of Research Paper\*\*\*\*