

# How Sleep Deprivation Impairs Cognitive Performance and Learning

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## STORY AT-A-GLANCE

- › Sleep deprivation significantly impacts learning by affecting the hippocampus, which plays a role in long-term memory formation
- › Both REM (rapid eye movement) and NREM (non-REM) sleep stages are necessary for effective learning and memory consolidation
- › Even minor sleep restrictions negatively impacts memory, producing effects on memory formation and retention comparable to those caused by complete sleep deprivation
- › Creatine supplementation helps partially offset cognitive decline caused by lack of sleep by replenishing the brain's energy stores, reducing fatigue and improving memory and processing capacity
- › Strategies to improve sleep quality are included below, such as maintaining a consistent sleep schedule, creating a restful environment and reducing exposure to light in the evening

Could missing out on sleep be undermining your academic or work achievements? Recent studies suggest it's true. Only 26% of Americans meet the recommended eight hours of sleep each night,<sup>1</sup> and this widespread sleep deficit has profound implications for cognitive and physical performance.

When you skip a night's rest, you're not only battling exhaustion. Research shows that sleep deprivation significantly impairs your reaction time, elevates your blood pressure,

compromises memory formation, reduces attention span and hinders executive functions, all of which are vital for successful learning and everyday decision-making.<sup>2,3,4</sup>

If you're facing this challenge, you're not alone. Understanding the specific ways sleep deprivation affects your brain and adopting practical strategies to regain your cognitive function helps address the root causes of sleep loss, enhancing both performance and overall well-being.

## **Diagnosing and Addressing Sleep Deprivation**

Diagnosing sleep deprivation often begins with self-reported sleep patterns. Individuals are typically asked to track their sleep duration and quality over a period of time. This data provides a baseline understanding of their sleep habits and helps identify any discrepancies from the recommended sleep duration. However, self-reports are sometimes unreliable due to subjective bias or inaccurate recall.

To gain a more objective measure, various tests are employed to assess the impact of sleep deprivation on cognitive and physical performance. Reaction time tests, for instance, are commonly used to evaluate how quickly an individual responds to stimuli. These tests are important because sleep deprivation is known to slow reaction times, which is particularly dangerous in situations requiring quick decision-making, such as driving or operating machinery.

Memory tests are another tool used to gauge the effects of sleep deprivation. These tests often involve recalling information or recognizing patterns, which are significantly impaired when an individual is sleep-deprived. The results from these tests provide insight into how well the brain is functioning in terms of memory consolidation and retrieval, both of which are essential for learning and academic success.

Conventional methods for addressing sleep deprivation typically focus on improving sleep quality and duration. This involves lifestyle changes such as establishing a regular sleep schedule, creating a restful sleep environment and reducing screen time before

bed. Supplements like melatonin are also sometimes recommended to help regulate sleep cycles. Later in this article, I'll cover more tips for improving sleep.

## **The Impact of Sleep Deprivation on Brain Function and Learning Abilities**

Researchers from the Department of Psychology of the University of Jyväskylä<sup>5</sup> found that sleep deprivation significantly impairs learning by affecting your hippocampus, the part of your brain that plays an essential role in long-term memory formation. When you're sleep-deprived, the hippocampus' ability to consolidate information diminishes, leading to poorer retention of learned material.

Moreover, the researchers highlighted the importance of both REM (rapid eye movement) and NREM (non-REM) sleep stages in memory consolidation. Disruptions in either stage negatively impact how well memories are formed and stored. These disturbances in sleep patterns lead to noticeable declines in memory performance.

However, they also noted<sup>6</sup> that short-term sleep loss does not cause permanent damage to learning abilities, indicating that recovery is possible with proper rest. A well-rested brain is better equipped to tackle daily challenges and process new information effectively, underscoring the necessity of maintaining consistent sleep routines for optimal cognitive functioning.<sup>7,8,9</sup>

## **Even Minor Sleep Loss Weakens Memory Retention**

Another study published in the journal *Neuroscience & Biobehavioral Reviews*<sup>10</sup> confirmed that restricting sleep — even just a few hours fewer than usual — negatively affects how well you form and retain memories.

When you don't get enough sleep, your brain's ability to process and store new information takes a hit. This happens because sleep plays an important role in strengthening the synaptic connections between your brain cells, which is essential for

memory formation. Without adequate sleep, these connections don't strengthen as effectively, making it harder to remember what you've learned.

The research also revealed that both REM and NREM stages are vital for different types of memory. REM sleep is particularly important for emotional and procedural memories, like learning a new skill, while NREM sleep helps consolidate factual information, such as studying for a test. When sleep is restricted, both of these sleep stages are disrupted, leading to impaired memory consolidation.

Interestingly, the study<sup>11</sup> showed that the effects of sleep restriction on memory are similar to those caused by complete sleep deprivation. This means that even partial sleep loss will lead to noticeable declines in memory performance. The underlying mechanism involves the brain's circadian rhythm and the balance between different sleep stages, which are essential for optimizing cognitive functions.

## **Brain Connectivity Changes After Sleep Deprivation**

The cumulative effects of sleep loss also impact the brain's structural connectivity, as revealed in another study published in the *International Journal of Psychophysiology*.<sup>12</sup> The researchers found that staying awake for 36 hours changes how different parts of the brain communicate with each other.

This research focused on the anterior cingulate cortex (ACC), a region important for controlling impulses and managing attention. After being sleep-deprived, the ACC showed increased connections with the left angular gyrus and the right hippocampus. These changes suggest that certain brain areas are working harder to compensate for the lack of sleep.

However, the authors<sup>13</sup> also observed that the ACC had reduced connections with other parts of the brain, such as the right insular cortex, right paracingulate gyrus and both sides of the putamen. This decrease in connectivity makes it harder to control impulses and regulate behavior.

These alterations in brain connectivity were linked to poorer performance on tasks that require inhibitory control, like stopping yourself from making a mistake. This means that when you're sleep-deprived, your brain's ability to regulate itself is impaired, making it more difficult to concentrate and make good decisions.<sup>14</sup>

## **Creatine Helps Counteract the Effects of Sleep Deprivation**

Creatine is well-known for enhancing physical performance, but it also plays a key role in brain energy metabolism. When sleep is limited, your brain's adenosine triphosphate (ATP) stores, which fuel cognitive function, become depleted more quickly.<sup>15</sup>

By increasing the availability of energy in your brain, creatine helps maintain cognitive functions like memory and quick decision-making even when you're sleep-deprived. This extra energy helps your brain stay sharp, reducing the negative impact of missing sleep.<sup>16</sup>

A February 2024 paper published in *Scientific Reports*<sup>17</sup> found that creatine supplementation boosts your brain's performance even when you're not getting enough sleep. Fifteen healthy participants were instructed to stay awake the entire night, for two days. During the first night, they received a dose of creatine, while on the second night, they were given a placebo.

The researchers assessed the participants' brain function by conducting memory and reaction time tests. The results showed that creatine supplementation partially offset the energy depletion typically caused by sleep deprivation. This led to reduced fatigue and better cognitive performance, with notable improvements in processing capacity and short-term memory. The authors concluded:<sup>18</sup>

*"[C]reatine has the potential to be used in prolonged cognitive activity during sleep deprivation. Our study showed the effect of a high dose of creatine against sleep deprivation-induced deterioration in cognitive performance, lasting up to nine [hours] and showing its maximum cognitive effect at four [hours] after oral administration."*

# These Strategies Will Help You Sleep Better

While creatine offers valuable support for cognitive function when you lack sleep, addressing sleep deprivation itself is still essential for maintaining overall cognitive and physical health. Here are some strategies I recommend taking to improve your sleep quality and overall well-being:

- 1. Establish a consistent sleep schedule** — Going to bed and waking up at the same time every day helps regulate your body's internal clock. Aim for seven to eight hours of sleep each night and try to stick to your schedule even on weekends. Consistency reinforces your circadian rhythm, making it easier to fall asleep and wake up naturally.
- 2. Create a restful sleep environment** — Your bedroom should be a sanctuary for sleeping. Ensure your sleeping area is quiet, dark and cool to promote uninterrupted rest. The optimal temperature for sleeping is between 60 and 68 degrees Fahrenheit.

Remove any distractions such as TV and electronic devices. Reducing noise and light helps your body enter deeper sleep stages, which are essential for memory consolidation and stress reduction.

Invest in comfortable and supportive mattress and pillows also helps you get a good night's sleep. You'll want to consider replacing your mattress after nine or 10 years, the average life expectancy of a good-quality mattress.

- 3. Limit exposure to light before bedtime** — The blue light emitted by phones, tablets and computers interferes with your ability to fall asleep. Avoid using these devices at least an hour before bedtime. Instead, engage in relaxing activities like reading a book or practicing mindfulness. Dimming the lights in the evening will also signal to your body that it's time to wind down, enhancing your sleep quality.
- 4. Manage stress through relaxation techniques** — High stress levels make it difficult to relax and fall asleep. Incorporate stress-reducing practices into your daily routine,

such as deep breathing exercises, meditation or gentle yoga. By calming your mind before bed, you'll lower your stress hormones, improve your ability to concentrate and enhance your overall cognitive function.

- 5. Eliminate electromagnetic fields (EMFs) in your bedroom** – EMFs disrupt your pineal gland and the production of melatonin and serotonin, and have other negative effects. To reduce your EMF exposure, consider unplugging electronic devices as well as your Wi-Fi before bedtime. Some experts even recommend pulling your circuit breaker before going to bed to kill all the power in your house.
- 6. Exercise daily** – Your body thrives on exercise and movement. It reduces your risk of cardiovascular disease and metabolic disorders. Exercise will help you get to sleep more easily and sleep more soundly. However, your body also releases cortisol during exercise, which reduces your melatonin secretion. Exercise at least three hours before bed, and earlier if you can.
- 7. Try Emotional Freedom Techniques (EFT)** – This technique is a form of psychological acupressure, based on the same energy meridians used in traditional acupuncture for more than 5,000 years to treat physical and emotional ailments, but without the invasiveness of needles. It's highly effective in reducing stress and promoting relaxation. Check out the video below for basic steps on how to do EFT for relaxation and destressing.

## Sources and References

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