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Why We Need Sleep: How Sleep Loss Affects Alertness and Performance

Christopher W. Jones, PhD, Marc Kaizi-Lutu, Mathias Basner (Department of Psychiatry, Perelman School of Medicine, University of Pennsylvania)

Recommended amount of sleep and prevalence of insufficient sleep

To maintain well-being and alertness throughout the day, it is important to get a good night of sleep. It is recommended that U.S. adults sleep between 7-9 hours each day (it is recommended that adolescents and children sleep longer).[1-3] However, ~30% of U.S. adults report sleeping less than the recommended amount.[4] A variety of factors can influence the timing and duration of sleep. Typically, people tend to trade sleep for the demands of work or a job, traveling, engaging in personal or family time, and social activities.[4-6]

One common pattern for working adults is to restrict sleep during the week (when work and family demands are high) and sleep more on the weekend to recover.[5,7,8] Although vulnerability to the adverse effects of sleep loss differs from person to person, this sleep-wake pattern may lead to an overall lack of sleep.[9,10] In this brief paper, we will use this common sleep-wake pattern to illustrate *how* sleep loss impairs behavioral alertness and performance. We will also discuss the science behind the restorative benefits of recovery sleep and how to manage fatigue.

Tired and slow to respond? How sleep loss affects behavioral alertness and performance

Before we discuss *how* sleep loss affects behavioral alertness and performance, we first need to provide some background on sleep regulation and define both behavioral alertness and performance.

Sleep is regulated by 2 processes: a homeostatic process and a circadian process (circadian rhythm). The sleep homeostatic process tracks your sleep-wake history and the intensity of wakefulness (essentially, how long you have been awake and how active you were). The circadian process is a network of biological clocks that control your daily biological rhythms.[11-13] These 2 processes interact to influence your behavioral alertness and performance. Behavioral alertness refers to vigilant attention: your ability to quickly respond to a stimulus (e.g., something you hear or see). Performance refers to how you do on a cognitive task: how quickly and accurately you respond to a stimulus. Vigilant attention is often measured by performance

on the Psychomotor Vigilance Test.[14-17] These 2 processes also impact your subjective levels of sleepiness and fatigue. Subjective sleepiness/fatigue can be measured using surveys and/or questionnaires.[18-20]

Sleep can be lost in different ways. Sleep can be lost *acutely*. Acute sleep loss occurs when sleep is deprived for a continuous period (e.g., overnight) that results in over 16 hours of wakefulness (total sleep deprivation). Sleep can also be lost *chronically*. Chronic sleep loss occurs when sleep periods are consistently shorter than the recommended amount (chronic sleep restriction). Chronic sleep loss over days or weeks is the most common type of sleep loss. However, acute sleep deprivation occurs in some professions with 24/7 operations that require workers to stay awake for extended periods (e.g., military personnel and healthcare professionals).[20]

Regardless of *how* sleep is lost, the more sleep that is lost, the greater the deficits in behavioral alertness and performance.[21,22] For example, consider a 5-day work week where you only sleep 6 hours each night. This would result in a steady build-up of decrements in vigilant attention and increasing ratings of sleepiness and fatigue. These consequences would worsen with each subsequent night of sleep loss.[21,22] If you only slept 4 hours each night, the build-up of behavioral alertness and performance deficits would be greater and quicker. If you continued this for 2 weeks, your behavioral alertness levels would be the same as if you stayed awake for 3 consecutive nights (64-88 hours of total sleep deprivation)![22,23] During the work week, you would experience difficulty staying awake as your physiological sleepiness increases.[24,25] Studies have shown that subjective measures of behavioral alertness are significantly lower than objective measures. In other words, people tend to think they aren't as impaired as they actually are. Underestimating your actual level of fatigue or vigilance could increase your risk of an accident.[22,26]

Sleep loss impairs many domains of behavioral and cognitive performance,[27-29] such as:

- The ability to learn new tasks and information, as well as the ability to store and manipulate information
- Long-term memory recollection and the ability to convert short-term memories to long-term memories
- Decision making and avoiding risk
- Emotion regulation and maintaining emotional composure under pressure

Can you recover from sleep loss and how long does it take?

Scientists still aren't sure how much sleep you need to recover from sleep loss. It is still being investigated! Studies suggest that multiple days of recovery sleep are needed to restore your behavioral alertness and performance to well-rested levels after a prolonged period of sleep loss. On the first night of recovery sleep, the amount your behavioral alertness and performance improves is directly related to the amount you sleep. However, it appears that the improvements stop increasing after 10 hours of recovery sleep.[24] Importantly, 1 night of recovery sleep is not enough to restore you to well-rested levels. This may take multiple days, during which you may be more susceptible to further sleep loss.[21,30-32] Also, if you consistently get good sleep prior to sleep loss, you may be less impacted by sleep loss. This concept is known as banking sleep.[30,33]

Once you are deprived of sleep, how can you improve your behavioral alertness?

The news is not all bad! If your behavioral alertness and performance are struggling due to insufficient sleep, there are things you can do to help. The most effective way to increase behavioral alertness and reduce fatigue is to take a nap.[20,34] A short nap (30-45 minutes) can mitigate the effects of sleep loss. Short is important! If you sleep too long, you may experience sleep inertia when you awake. Sleep inertia is excessive grogginess.[20] If you experience sleep inertia after a nap, caffeine can help. Caffeine can reduce sleep inertia and is also an effective tool to promote behavioral alertness and performance during sleep loss. Importantly, caffeine does not mitigate all negative effects of sleep loss.[34,35] Finally, appropriately timed bright light, enriched with spectral blue light, exposure can improve behavioral alertness, providing a short-term boost in performance.[36] While these countermeasures can improve behavioral alertness and performance, they are not a substitute for consistent healthy sleep over time.[20,36]

2510 North Frontage Road
Darien, IL 60561
Phone: 630.737.9702
coordinator@srsnet.org

Suggested/Additional Reading

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Lowe CJ, Safati A, Hall PA. The neurocognitive consequences of sleep restriction: A meta-analytic review. *Neuroscience & Biobehavioral Reviews*. 2017; 80:586-604.

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Phone: 630.737.9702
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