

Sleep Promotes Brain Health

Analysis by [Dr. Joseph Mercola](#) March 30, 2024

For an activity that takes up about one-third of our lives,¹ surprisingly little is known about what happens during sleep. However, part of its purpose is to help cleanse your brain, an organ that consumes about 20% of your body's total energy expenditure.²

Your brain performs a number of complex energy-demanding processes, including neuron firing, synaptic transmission and maintenance of the ion gradients used for neural signaling. The primary source of energy for the brain is glucose, which it gets primarily from your diet. But as nutrients are consumed, metabolic waste is generated in the process.³

Your brain takes advantage of sleep – a time when your body is seemingly at rest – to flush waste and clear out debris that could otherwise lead to degenerative disease, according to scientists at Washington University School of Medicine in St. Louis.⁴

Your Brain Detoxes via the Glymphatic System

To understand why sleep is so crucial for your brain, it helps to understand how the body eliminates metabolic and cellular waste. Most of your body uses the lymphatic system for this purpose. As Forbes explains:⁵

"In short, a specialized "sewerage" infrastructure called the lymphatic system. This is made up of various vessels and channels that, like our circulatory system, spread across the entire body. These vessels are filled with a fluid called lymph, which flows through tissues and organs, washing up and collecting debris as it goes. Dirty lymph is eventually drained into the blood vessels, where it is carried to the kidneys and liver for final filtration and removal."

In the brain, however, it's the glymphatic system that removes waste products, acting as a "brain-wide metabolite clearance system."⁶ By pumping cerebrospinal fluid through your brain's tissues, your glymphatic system flushes waste from your brain back into your circulatory system and liver for elimination.

It operates similarly to the lymphatic system in the rest of your body but is specialized for the unique environment of your brain and central nervous system. The term "glymphatic" combines "glial cells," which are cells in your brain that bring nutrients to neurons, and "lymphatic," reflecting its similarity to the body's lymphatic system.

The glymphatic system facilitates the removal of metabolic waste products from the central nervous system (CNS). It does so through a network that involves the

perivascular space – the space surrounding blood vessels – cerebrospinal fluid and glial cells.

The glymphatic system is particularly active during sleep, which may actually serve to "kickstart" the system,⁷ highlighting the importance of a good night's sleep for brain health.

Brain Waves Help Flush Out Waste While You Sleep

"The accumulation of metabolic waste is a leading cause of numerous neurological disorders, yet we still have only limited knowledge of how the brain performs self-cleansing," researchers wrote in the journal *Nature*.⁸ While it's known that the brain flushes out waste during sleep, the method behind remained largely unknown. But by studying the brains of sleeping mice, the Washington University School of Medicine researchers revealed that neurons underlie the process. They generate electrical signals that jump-start rhythmic brain waves, propelling cerebrospinal fluid through the brain.

"Our study demonstrates that neurons serve as master organizers for brain clearance," researchers wrote in *Nature*, adding:⁹

"Here we demonstrate that neural networks synchronize individual action potentials to create large-amplitude, rhythmic and self-perpetuating ionic waves in the interstitial fluid of the brain. These waves are a plausible mechanism to explain the correlated potentiation of the glymphatic flow ..."

In other words, neurons in the brain coordinate signals to create large, rhythmic waves of electrical energy that move through the brain's interstitial fluid, which fills the spaces around brain cells. The waves are similar to rhythmic pulses that travel through the brain's fluid, helping to mix and move it around.

These electrical waves are thought to boost the function of the glymphatic system, helping cerebrospinal fluid penetrate deeper into the brain and pick up waste, enhancing the cleaning process.

When the researchers altered the waves to reduce their intensity, it significantly reduced the infiltration of cerebrospinal fluid into certain brain regions, further demonstrating the importance of these waves in the brain's self-cleaning process.

Further, when the researchers artificially generated these waves using transcranial optogenetic stimulation, a method where light is used to control cells in the brain that have been genetically modified to respond to light, it increased the movement of cerebrospinal fluid into the brain tissue, improving the clearance of waste.

Interestingly, brain wave patterns change during sleep cycles, with taller brain waves moving fluid more forcefully. The researchers may conduct further research to

determine why brain waves have varying rhythmicity during sleep. Study author Li-Feng Jiang-Xie explained in a news release:¹⁰

"We think the brain-cleaning process is similar to washing dishes. You start, for example, with a large, slow, rhythmic wiping motion to clean soluble wastes splattered across the plate. Then you decrease the range of the motion and increase the speed of these movements to remove particularly sticky food waste on the plate.

Despite the varying amplitude and rhythm of your hand movements, the overarching objective remains consistent: to remove different types of waste from dishes. Maybe the brain adjusts its cleaning method depending on the type and amount of waste."

Sleep Is Crucial for Abstract Learning

Sleep also has a significant **impact on your learning processes**, enabling your brain to merge various abstract pieces of information and organize them into comprehensive patterns. This process helps in understanding the world and your experiences within it. Essentially, sleep is vital for abstract learning, which involves connecting the dots, rather than merely acquiring isolated facts.

This mechanism is especially important during early development but remains a lifelong necessity. Consequently, lack of sleep can significantly affect your mental health, leading to confusion and negative emotional responses.

According to Professor Matthew Walker, Ph.D., founder and director of the University of California Berkeley's Center for Human Sleep Science and author of "Why We Sleep: The New Science of Sleep and Dreams," sleep affects your learning and memory processes both before and after learning, and cheating yourself of sleep on either end will impact your ability to learn.^{11,12}

For instance, sleep is important before learning, as it helps prepare your brain to soak up new information. Walker's research shows that sleep-deprived students have a 40% reduction in their ability to retain new information compared to those who got a full eight hours of sleep. He theorizes that your hippocampus could potentially have a time-limited capacity to store new information.¹³

When you remain awake for more than 16 hours, your hippocampus effectively runs out of storage space and cannot receive further input. To continue learning, you need to sleep, during which the information stored in your hippocampus is transferred into long-term storage in other parts of your brain, essentially clearing out your short-term hippocampal storage. You also need sleep after learning, to properly save and hold on to those new individual facts — and integrate the new information with what you already know.

Walker states that, during sleep, your brain quite literally replays what it has learned, but at 10 to 20 times the speed of normal waking consciousness, and this is thought to be part of memory consolidation, as it increases synaptic strength.

This gathering and storing of new information occurs primarily during non-REM sleep. Then, during REM sleep (dream sleep), your brain fuses all of this new information with the entirety of everything you've already stored in your memory banks, creating a continuously evolving and growing "mind-wide web of associations," Walker explains.¹⁴

Poor Sleep May Make You Anxious

Sleep also influences your mental health, including increasing anxiety. In research conducted by Walker and colleagues, brain scans were conducted on 18 young adults as they watched emotional videos, both after a good night's rest and a sleepless night. Questionnaires were used to gauge anxiety levels in the study participants, while the brain scans revealed that lack of sleep dampened activity in the medial prefrontal cortex (mPFC), a brain area known to help quell anxiety, and amped up emotional centers.¹⁵

Meanwhile, those who slept well demonstrated notable declines in anxiety, with slow wave non-rapid eye movement (NREM) sleep appearing particularly beneficial. It's during slow-wave NREM deep sleep that neural oscillations become synchronized and heart rate and blood pressure drop.

"Deep sleep had restored the brain's prefrontal mechanism that regulates our emotions, lowering emotional and physiological reactivity and preventing the escalation of anxiety," Eti Ben Simon, the study's lead author, said in a news release.¹⁶

Walker further explained:¹⁷

"We have identified a new function of deep sleep, one that decreases anxiety overnight by reorganizing connections in the brain ... Deep sleep seems to be a natural anxiolytic (anxiety inhibitor), so long as we get it each and every night."

Lack of sleep could increase anxiety levels by up to 30%, the study found, with Walker noting, "Without sleep, it's almost as if the brain is too heavy on the emotional accelerator pedal, without enough brake."¹⁸ If you regularly feel emotionally off-kilter, too little sleep could be to blame. In a separate study, Walker and colleagues revealed that sleep deprivation also fuels feelings of loneliness, for instance.¹⁹

Sources and References

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