MERCOLA
Take Control of Your Health

How Sleep Influences Learning, Memory and General Health

Analysis by Dr. Joseph Mercola | October 21, 2023

STORY AT-A-GLANCE

- Sleep impacts your ability to learn and your creative capacity. Deep sleep is also crucial for brain detoxification, and can have a significant impact on your risk for Alzheimer's disease
- Around 12 months of age, when the infant is starting to learn to crawl, stand and walk, there's a tremendous increase in stage 2 sleep, during which the brain is actively editing and making decisions about what information to retain and which to discard
- Sleep allows your brain to consolidate abstract pieces of information, collating them into cohesive patterns that allow you to make sense of the world around you, and your experiences of it
- Sleep is important before learning, as it helps prepare your brain to soak up new information. It's also crucial after learning, at which point the data are saved and integrated with what you already know
- Sleep increases your ability to gain insights that would otherwise remain elusive by about 250%. Simply dreaming about performing an activity increases your actual physical performance 10fold

Editor's Note: This article is a reprint. It was originally published March 30, 2019.

In the video above, Rhonda Patrick, Ph.D., a biomedical scientist, interviews 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."

In this episode, Walker discusses how sleep impacts your ability to learn and your creative capacity, and the importance of deep sleep for brain detoxification, which can influence your risk for Alzheimer's disease. The interview starts out with a discussion about how sleep patterns change during infancy, and the implications thereof.

Right around 12 months of age, when the infant is starting to learn to crawl, stand and walk, there's a tremendous bump in stage 2 sleep, which is a light, non-REM type of sleep during which the brain is very active editing and making decisions about what information to retain and which to discard. In this case, the learning has to do with motor skills development.

Language development also occurs during this phase of life, and sleep plays an important role here too. In fact, sleep plays a crucial role any time you're learning something new, be it language or mathematics, for example, regardless of your age.

How Sleep Impacts Learning Processes

What's more, sleep allows your brain to consolidate many different abstract pieces of information, sort of collating them into cohesive patterns that allow you to make sense of the world around you, and your experiences of it. In other words, sleep is crucial for abstract learning — for connecting the proverbial dots — opposed to simply learning individual facts.

While this is particularly relevant during early development, this is something that you continue to do throughout life, and why sleep deprivation can have such a dramatic impact on your mental well-being, triggering confusion and negative emotional states.

According to Walker, 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.[1]

- First, 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.

  Walker theorizes that your hippocampus could potentially have a time-limited capacity to store new information.[2] 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, effectively clearing out your short-term hippocampal storage.

- Second, you 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 discusses fascinating research demonstrating 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.

What's more, while we make associative connections during waking consciousness, the connections we make during REM sleep are "the long shots," the more bizarre and sometimes illogical associations between seemingly disparate pieces of information. And this is precisely why our dreams oftentimes make no logical sense.

Quality Sleep Boosts Your Creativity

This is also why REM sleep allows us "to divine remarkably creative insight" into problems we could not solve during the day with logical, rational thinking. According to Walker, REM sleep is therefore crucial to acquiring wisdom (opposed to straight knowledge) — the ability to discern and extract meaning from your life experiences.

It's also crucial to creative problem-solving, and many scientific discoveries have occurred as a result of dreaming. One example is that of Otto Loewi, who was awarded the Nobel Prize in Medicine for his discovery that the primary language of nerve cell communication is chemical, not electrical, as previously thought. The elegantly simple scientific experiment that led to Loewi's award-winning discovery came to him in a dream.[3,4]

The chemical responsible for nerve cell communication is now known as acetylcholine, which is also the chemical responsible for the randomization of data connections during dreaming, as it disrupts the connection between the hippocampus, where memories of events and places are stored, and the neocortex, where facts, ideas and concepts are stored and the actual replay of memories take place.

Indeed, overwhelming evidence shows increasing sleep boosts both productivity and creativity.[5,6] Sleep increases your ability to gain insights that would otherwise remain elusive by about 250%. According to Walker, simply dreaming about performing an activity increases your actual physical performance 10fold.

As old and new memories are integrated to form a new whole, new possible futures are also imagined. (This is what you actually perceive as "the action" of your dream.) The sum total of these processes is what allows you to assign meaning to life events and new pieces of information alike.

Sleep Deprivation Fuels Feelings of Loneliness

Walker also discusses some of his more recent research,[7,8,9] which suggests loneliness may be closely tied to lack of sleep. For this experiment, 18 young adults were tested under two conditions: after a good night's sleep and after a night of interrupted sleep.

They were then asked to view video clips of people walking toward them, and were instructed to stop the tape once they felt the person's presence was infringing on their personal space. Interestingly, after sleep deprivation, the participants' need for personal space was much greater than after a good night's sleep.

When sleep deprived, they stopped the oncoming person at a distance that was 60% greater than when they'd had a good night's rest. Brain scans also revealed that when sleep-deprived, they had 60% greater activity in the amygdala, an area of the brain that perceives threats.

In other words, the oncoming person was perceived as more threatening when they were tired. This perceived threat amplification from sleep deprivation can also make you more anxious in general, so it may play an important role in anxiety as well.

In a nutshell, the experiment suggests that the more sleep-deprived you are, the less social you become. What's more, others pick up on this largely subconscious cue to be left alone, and further tests revealed people are more likely to rate you as being lonely when you're sleep-deprived — and they're far less likely to want to interact with you as well. As noted by Walker, "sleep deprivation can turn us into social lepers."[10]

Loneliness has reached crisis proportions in the U.S. and has severe health consequences. For example, loneliness increases your all-cause mortality risk by a whopping 45%, Walker says, and he believes sleep deprivation may actually be a significant underlying factor. The good news is this is something you have a lot of control over and can do something about.

Sleep Deprivation Triggers Fight-Flight-or-Freeze Response

It's also worth noting that, according to Walker, they've been unable to find a single psychiatric disorder in which sleep does not play a role, which really highlights the importance of addressing sleep whenever you struggle with any kind of mental health problem, be it mild or severe.

Walker also notes that research has confirmed high-anxiety individuals are more prone to be negatively impacted by lack of sleep. So, if you know you're prone to anxiety, depression or negative moods, you'll want to be extra careful about getting sufficient amounts of high quality sleep. Unfortunately, high-anxiety individuals are also more prone to insomnia, which feeds the vicious cycle.

"The biological red thread narrative of insomnia is an amplified fight or flight nervous system," Walker says. "You constantly see an overactive sympathetic nervous system in people with insomnia." Cortisol plays an important role here, and in people who have trouble falling asleep, you typically see a spike in the stress hormone cortisol right at bedtime, when it should normally start to fall.

In people struggling with the other type of insomnia, where they have trouble staying asleep for the duration of the night, you often find mysterious spikes in cortisol at those times, when cortisol levels should normally be really low.

Walker suggests mindfulness-based stress reduction techniques, including meditation, for insomnia, as it calms down your sympathetic nervous system (the fight or flight response) and facilitates the mental disengagement necessary to allow you to fall asleep and not get stuck in rumination and worry.

Other Important Health Benefits of Sleep

Sleep is also required for:

- **Maintaining metabolic homeostasis in your brain —** Wakefulness is associated with mitochondrial stress and without sufficient sleep, neuron degeneration sets in, which can lead to dementia.[11,12,13] Animal research reveals inconsistent, intermittent sleep results in considerable and irreversible brain damage.

  Mice lost 25% of the neurons[14,15] located in their locus coeruleus,[16] a nucleus in the brainstem associated with arousal, wakefulness and certain cognitive processes. In a similar vein, research published in the journal Neurobiology of Aging[17] suggests

people with chronic sleep problems develop Alzheimer's disease sooner than those who sleep well.

To learn more, see Walker's paper, "Sleep: A Novel Mechanistic Pathway, Biomarker, and Treatment Target in the Pathology of Alzheimer's Disease?"[18]

- **Maintaining biological homeostasis —** Your body contains an array of body clocks that regulate everything from metabolism to psychological functioning.

  When you upset your circadian rhythm by not getting enough sleep, the results cascade through your system, raising **blood pressure**, dysregulating hunger hormones and blood sugar, increasing the expression of genes associated with inflammation, immune excitability, diabetes, cancer risk and stress[19] and much more.

  While the master clock in your brain synchronizes your bodily functions to match the 24-hour light and dark cycle, each and every organ, indeed, each cell has its own biological clock. In 2017, the Nobel Prize for medicine was actually awarded for the discovery of these body clocks.

  Even half your genes have been shown to be under circadian control, turning on and off in cyclical waves. All of these clocks, while having slightly different rhythms, are synchronized to the master clock in your brain. Needless to say, when these clocks become desynchronized, a wide array of health problems can ensue.

- **Removal of toxic waste from your brain through the glymphatic system —** This system ramps up its activity during deep sleep, thereby allowing your brain to clear out toxins, including harmful proteins linked to brain disorders such as Alzheimer's.

  By pumping cerebral spinal fluid through your brain's tissues, the glymphatic system flushes the waste from your brain, back into your body's circulatory system. From there, the waste eventually reaches your liver, where it can be eliminated.[20,21]

This short list should clue you in to many of the possible health ramifications of insufficient sleep. Considering the fact that sleep plays a key role in everything from

gene expression and hormone regulation to brain detoxification and cognition, it becomes clear that there aren't many facets of your being that can skate by unscathed when you skimp on sleep.

How Sleep Loss Affects Your Heart and Cardiovascular Health

Importantly, research shows sleep is a significant factor in heart and cardiovascular health. For example, lack of sleep:

- **Prematurely ages your heart —** In a study[22] involving "a representative sample of U.S. adults," people who got seven hours of sleep each night had hearts showing signs of being 3.7 years older, based on biological age, than their chronological age. Here, "heart age" was defined as "the predicted age of a person's vascular system based on their cardiovascular risk profile."

  This concept was initially introduced by the Framingham Heart Study published in 2008. People who regularly slept either six or eight hours had hearts that were on average 4.5 years older than their chronological age, while those who got just five hours or less of sleep each night had the oldest biological heart age — 5.1 years older than their chronological age.

  As noted by lead author Quanhe Yang, senior scientist in the Division for Heart Disease and Stroke Prevention of the U.S. Centers for Disease Control and Prevention,[23] having a higher biological heart age raises your risk of developing heart disease.

  Of the 12,755 participants in this study, 13% slept just five hours or less per night; 24% got six hours; 31% got seven hours; 26% slept for eight; and about 5% got nine or more hours of sleep each night.

  Considering the ideal sleep time — based on hundreds of studies looking at sleep and health — is between seven and nine hours, these statistics reveal at least 37% of American adults aren't getting anywhere near healthy amounts of sleep.

- **Raises your blood pressure and promotes vascular inflammation —** While this link has been previously noted, a set of studies[24,25] published last year found that even if you sleep a healthy number of hours, the quality of that sleep can have a significant impact on your risk for high blood pressure and vascular inflammation associated with heart disease.

  Here, 323 healthy women between the ages of 20 and 79 wore sleep trackers that recorded onset, duration and quality of their sleep. Those who had mild sleep disturbance such as taking longer to fall asleep or waking up one or more times during the night were "significantly more likely to have high blood pressure than those who fell asleep quickly and slept soundly."

Are Nighttime EMFs Robbing You of Healthy Sleep?

A factor that can have a significant impact on your sleep quality (and overall health) is electromagnetic fields (EMFs) emitted from household wiring, electronic and wireless devices. EMF exposure has a detrimental effect on your health regardless of the time of your exposure, but it's particularly problematic at night, for a number of different reasons.

For starters, EMF exposure reduces your melatonin production,[26] which will make it more difficult to fall asleep since you may not feel sufficiently sleepy. What's more, melatonin is also a powerful antioxidant, and low levels have been repeatedly linked to an increased risk of cancer,[27] so the impact on your melatonin production can have both short- and long-term effects.

Deep sleep is also the most important time for your brain health, as this is when its detoxification processes ramp up and take place, as explained in the section on the glymphatic system above.

EMF exposure has also been linked to neuronal changes that affect memory and your ability to learn[28] — something to keep in mind if you're in school, or have school-aged children. Importantly, EMFs also harm your body's mitochondria by producing excessive

oxidative damage. This in turn can cause or contribute to virtually any chronic ailment, including premature aging. To minimize your EMF exposure at night:

1. Turn your cellphone off. At bare minimum, keep it in airplane mode and put it in a faraday bag.[29] That will zero out any radiation. Never sleep with your cellphone under your pillow when it's on, or for that matter put it on your body when it is not in airplane mode.
2. If you're currently using your phone as an alarm clock, consider getting a battery-driven alarm or better yet an audio only clock[30] that has no light to disrupt your sleep. At bare minimum, keep the cellphone several feet away from your bed.
3. Turn off your Wi-Fi at night. Ideally, hard wire your home so you have no Wi-Fi at all in your home.

For a more comprehensive information about the health problems linked to insufficient sleep, and dozens of ways to improve your sleep, see "**Sleep — Why You Need It and 50 Ways to Improve It**."

Sources and References

- [1] Harv Rev Psychiatry. 2008;16(5):287-98
- [2] Sleep Medicine September 2008; 9(supplement 1): S29-S34
- [3] Singapore Medical Journal 2014 Jan; 55(1): 3–4
- [4] The Atlantic May 15, 2018
- [5] Trends in Cognitive Sciences June 2018; 22(6): 491-503
- [6] Science Daily May 15, 2018
- [7] Nature Communications 2018; 9: 3146
- [8] Gizmodo August 14, 2018
- [9] ABC News August 14, 2018
- [10] The Guardian August 16, 2018
- [11] Journal of Neuroscience 19 March 2014, 34(12): 4418-4431
- [12] Penn Medicine Press Release March 18, 2014
- [13] Medical News Today March 20, 2014
- [14] Journal of Neuroscience 19 March 2014, 34 (12) 4418-4431
- [15] Science Daily March 18, 2014
- [16] Scholarpedia, Locus Coeruleus
- [17] Neurobiology of Aging August 2014; 35(8): 1813-1820

- [18] Trends Neurosci. 2016 Aug; 39(8): 552–566
- [19] BBC News October 9, 2013
- [20] Science News October 17, 2013
- [21] Medical News Today October 18, 2013
- [22] Sleep Health October 2018; 4(5): 448-455
- [23] Business Insider August 14, 2018
- [24] Journal of the American Heart Association 2018 Jun 9;7(12). pii: e008590
- [25] Forbes June 28, 2018
- [26] Bioelectromagnetics 1998;19(2):123-7
- [27] Biomed Research International 2014, article ID 169459
- [28] Scientific Reports 2017; 7: 41129
- [29] Mission Darkness Faraday Bag
- [30] Talking Clock