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What Lack of Sleep Does to Your Brain

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Science may still be discovering the mechanisms behind why sleep is so important to your health, but you have probably experienced waking up after a poor night's sleep, feeling cranky, over-tired and mentally foggy.

This is only a small fraction of the mental and physical health issues you may suffer from sleep deprivation.

Sleep is one of the important pillars of good health; equally important as healthy foods, pure water and exercise. An increasing number of studies demonstrate how sleep relates to your sleep-wake cycles and plays a central role in multiple processes that are key to your health.

On the surface, you may have suffered through bad moods and poor energy levels from lack of sleep. Chronic sleep deprivation can also lead to depression, weight gain, increased risk of diabetes and cancer and increased risk of accidents. Sleep is necessary to feel alert, be productive and creative and for optimal body functioning.

Quality sleep doesn't often happen naturally. Bombarded with artificial light pollution, work stress and insufficient exposure to full-spectrum natural sunlight during daylight hours, you may need to make sleep a goal to enjoy the health benefits.

A recent study from the University Medical Center Freiburg in Germany set out to understand more about the function of sleep and the interrelationship with health disorders and treatments. Although it may appear as if sleep is an inactive state, your brain and body are actually quite busy while you're sleeping.

Synaptic Plasticity May Hold One Answer to the Importance of Sleep

Specifically, the researchers were interested in synaptic plasticity, or how the connectivity between neurons in your brain changes. Past research has demonstrated sleep has an influence on the strength of those neuronal connections.

This study looked at the overall strength of the connections between neurons and the

selective strengthening that occurs as your brain learns and encodes new information, called associate plasticity. The study engaged the participation of 20 individuals to evaluate synaptic plasticity with and without sleep deprivation.

The first stage of the research involved using transcranial magnetic stimulation (TMS) to the motor cortex of the brain in order to stimulate hand movement. After just one night of sleep deprivation the participants required less stimulation to elicit hand movement. This indicated a greater degree of neuron excitability in the brain.

This increased excitability also reduces the selective strengthening of the neurons important to learning. While the participants reacted more quickly to stimuli after deprivation, they learned more slowly. They tested the learned response by electrically stimulating a nerve in the arm immediately before administering TMS.

The expected response would have been for the relevant synapses for this movement to strengthen as the electrical stimulation mimicked the movement elicited by the TMS. It's an elementary mechanism of memory and learning that was inhibited with sleep deprivation.

From this information the researchers established that sleep essentially recalibrates homeostatic and associative plasticity in your brain. In other words, sleep is essential to learning adaptive behavior at the level of your brain's neurons.

Regions of Your Brain Act Differently After Sleep Deprivation

Interestingly, not all areas of the brain react in the same way to sleep deprivation. Some areas suffer from lack of sleep more than others.

Another study using brain scans studied participants after consecutive nights of no sleep and found areas of the brain involved with concentration and problem solving were especially sluggish.⁴

The researchers were focused on better understanding how sleep impacts the rhythmic nature of psychiatric and neurodegenerative disorders. Study co-author Derk-Jan Dijk, Ph.D., of the University of Surrey, England, was quoted in Science News saying:

"We've shown what shift workers already know. Being awake at 6 a.m. after a night of no sleep, it isn't easy. But what wasn't known was the remarkably different response of these brain areas."

The study enrolled 33 young adults who went without sleep for 42 hours. Over this period of time they participated in tasks measuring reaction time, memory and learning; had their melatonin levels measured to assess and track their sleep-wake cycles and

underwent 12 brain scans.

The researchers found specific areas of the brain's activity increased and decreased with the rise and fall of melatonin, such as in the hypothalamus.

However, there were other areas of the brain that continued a downward spiral of activity and ability to perform, not in harmony with the circadian rhythm but rather driven by growing sleep debt.⁶

As you might expect, the areas of the brain that experienced reduced function controlled learning, memory and the ability to perform simple tasks.

Light Pollution Affects Your Sleep Pattern

The challenge of getting quality sleep increases each year as new technological devices are produced that keep you entertained. When you are forced to go without electricity, such as camping or if the power goes out, you sleep deeper and arise more rested.

Light sources at night interrupt your circadian clock and melatonin levels, both responsible for how deeply you sleep and well-rested you feel the next day. An increase in sleep disruption happens more frequently with blue light emitted from digital devices and not just any source of artificial lighting.⁷

Many incandescent lights emit a red wavelength, which is not as detrimental as the blue lights from your eBook readers, computers, cell phones and energy efficient LED lights. This blue light is beneficial during the day as it boosts your attention, improves your mood and reduces your reaction times.⁸

At night these changes may have yet another effect on your body. According to a study published in Current Biology, increasing the number of hours you're exposed to artificial lighting may also have an effect on the strength of your muscles and density of your bones.

Researchers studied rats kept under 24-hour lighting conditions for six months and compared their strength and bone density to a control group exposed to 12 hours of light followed by 12 hours of dark.

The experimental group experienced weight gain, reduced strength and had higher blood glucose. The good news was the effects appeared to reverse after two weeks of normal lighting conditions.

The High Cost of Sleep Deprivation

After reviewing the study, Chris Colwell, Ph.D., neuroscientist, psychiatry professor and

sleep specialist at the University of California, Los Angeles was quoted in The New York Times, saying:

"The study is the first of its kind to show markers of negatively-affected muscle fibers, skeletal systems and motor performances due to the disruption of circadian clocks, remarkably in only a few months.

They found that not only did motor performance go down on tests, but the muscles themselves just atrophied and mice physically became weaker under just two months under these conditions."

Although stress, lifestyle choices and light pollution may affect the quality of your sleep, there is also an underdiagnosed sleep disorder that may affect the quality of sleep you experience.

Obstructive sleep apnea (OSA) is a sleep-related breathing disorder during which your air exchange may stop momentarily or decrease, despite your ongoing effort to breathe.

Unfortunately, you may not recognize the symptoms of OSA as they include changes to your breathing patterns while you're sleeping. While awake you may experience chronic drowsiness and fatigue, and your sleeping partner may complain of loud snoring at night.

The economic impact on employers may be as high as \$86.9 million in lost productivity each year, and just under \$150 billion is the economic burden of undiagnosed OSA, including lost productivity, motor vehicle accidents and workplace accidents.

The American Academy of Sleep Medicine (AASM) estimates 12 percent of the U.S. adult population suffers from OSA. In a companion report to their new analysis, researchers found that once treated, individuals experienced a positive impact on their health and quality of life, including better sleep quality, greater productivity and a 40 percent reduction in absence from work.

Sleep Deprivation Linked to Dementia

A lack of sleep may also increase your risk for dementia. Researchers from University of California Berkeley's Sleep and Neuroimaging Lab discovered that a lack of sleep leaves your brain more vulnerable to proteins believed to trigger dementia.

Alzheimer's disease has been diagnosed in almost 40 million U.S. adults and is considered one of the more debilitating forms of dementia. This study discovered beta-amyloid, a protein associated with those who suffer from Alzheimer's disease, aggregates in your brain when you are chronically sleep deprived. These deposits hinder your ability to sleep and thus set up a vicious cycle.

Lead author Bryce Mander, Ph.D., neuroscientist from the University of California

Berkeley was quoted in California Association UC Berkeley magazine, saying:

"What was unknown was whether or not that's just a side relationship that has nothing to do with the clinical symptoms of dementia, or if sleep disruption is part of why these toxic chemicals in the brain are causing memory loss. This is not to say that amyloid and other pathologies can't impact memory independent of sleep. But it does suggest that part of the way it impacts memory is through sleep-dependent memory."

Other research demonstrates that amyloid plaques, common in Alzheimer's disease, build up more quickly in sleep deprived lab animals. A second study then discovered how sleep clears toxins from your brain while sleeping, reducing your potential risk for dementia.

Risks Associated With Sleep Deprivation

Sleep deprivation, or a lack of quality sleep, has a significant impact on your brain health and your overall health and wellness. There are good reasons you may want to develop good sleep habits and strive to achieve quality sleep every night.

✓ Increased risk of car accidents	✓ Increased accidents at work	✓ Reduced ability to perform tasks
✓ Reduced ability to learn or remember	✓ Reduced productivity at work	✓ Reduced creativity at work or in other activities
✓ Reduced athletic performance	✓ Increased risk of type 2 diabetes, obesity, cancer, high blood pressure, osteoporosis and cardiovascular disease	✓ Increased risk of depression
✓ Increased risk of dementia and Alzheimer's disease	✓ Decreased immune function	✓ Slowed reaction time
✓ Reduced regulation of emotions and emotional perception	✓ Poor grades in school	✓ Increased susceptibility to stomach ulcers
✓ Exacerbates current chronic diseases such as Alzheimer's, Parkinson's, Multiple Sclerosis (MS) and cancer	✓ Cutting one hour of sleep a night increases the expression of genes associated with inflammation, immune excitability, diabetes, cancer risk and stress	✓ Contributes to premature aging by interfering with growth hormone production, normally released by your pituitary gland during deep sleep

How You May Improve Your Sleep Quality

Increasing the number of hours you sleep to eight each night and improving your quality

of sleep may help to significantly reduce your risks associated with sleep deprivation. Below are several suggestions that may help. For a more comprehensive list of strategies, see my previous article titled, "Want a Good Night's Sleep? Then Never Do These Things Before Bed."

✓ Turn your bedroom into an oasis for sleep

Your bed is a place to sleep and rest comfortably. Only two other activities will not significantly impede a restful sleep: reading and intimate relations with your significant other. Anything else, such as work, computers, cell phones or watching television will reduce the quality of your sleep. Reduce any noisy interruptions from pets or outdoor activities. You might consider removing your pet from the bedroom or using a white noise machine to reduce interruptions from outdoor noises.

✓ Establish a soothing pre-bedtime routine

Humans are creatures of habit. When you establish a soothing bedtime routine you go through each evening before bed, you're more likely to fall asleep easily. Activities such as a warm bath, reading a good book or relaxation exercises may help you fall asleep easier.

If you have trouble falling to sleep one night, it's better to leave the bedroom and read quietly than to try even harder to fall asleep. I would strongly recommend using blue-blocking glasses if you do this, to prevent your reading light from further depressing your melatonin production.

✓ Keep a consistent schedule

When you go to bed and wake up at the same times, your body becomes accustomed to the routine. This helps regulate your circadian clock so you fall asleep and stay asleep all night. Keep this routine even on the weekends.

✓ Get plenty of bright sunlight exposure in the morning and at noon

Exposure to bright light first thing in the morning stops production of the sleep-inducing hormone melatonin and signals to your body that it's time to wake up. Outdoor sunlight is best, so you might even want to take a quick walk outside.

Not only will this increase in physical activity help you sleep later, but taking your walk outdoors — either first thing in the morning or around noon when the sun high — gives you more exposure to bright sunlight. Light intensity is measured in lux units, and on any given day, the outdoor lux units will be around 100,000 at noon. Indoors, the typical average is somewhere between 100 to 2,000 lux units, about two orders of magnitude less.

I take a one-hour walk every day in the bright sunlight on the beach, so along with boosting my vitamin D, I also anchor my circadian rhythm at the same time and I rarely ever have trouble sleeping.

✓ At sundown, dim your lights (or use amber-colored glasses)

In the evening (around 8 p.m.) you'll want to dim your lights and turn off electronic devices. Normally, your brain starts secreting melatonin between 9 p.m. and 10 p.m., and these devices emit light that may stifle that process. After sundown, shift to a low-wattage bulb with yellow, orange or red light if you need illumination.

A salt lamp illuminated by a 5-watt bulb is an ideal solution that will not interfere with your melatonin production. If using a computer or smartphone, install blue light-blocking software like f.lux, which automatically alters the color temperature of your screen as the day goes on, pulling out the blue wavelengths as it gets late.

The easiest solution, however, is to use amber-colored glasses that block blue light. I found an Uvex model (S1933X) on Amazon that costs less than \$10 and works like a charm to eliminate virtually all blue light. This way you don't have to worry about installing programs on all your devices or buying special light bulbs for evening use. Once you have your glasses on, it doesn't matter what light sources you have on in your house.

✓ Check your bedroom for electromagnetic fields (EMFs)

These can disrupt your pineal gland and the production of melatonin and serotonin, and may have other negative effects as well. To do this, you need a gauss meter. You can find various models online, starting around \$50 to \$200. Some experts even recommend pulling your circuit breaker before bed to kill all power in your house.

✓ 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 may reduce your melatonin secretion. Exercise at least three hours before bed, and earlier if you can.

✓ Keep your room cool

The optimal temperature for sleeping is between 60 and 68 degrees Fahrenheit. If your room is cooler or warmer you may have a more restless night's sleep. During sleep your body's core temperature drops to the lowest level during a 24-hour period. The cooler your room is, the more conducive it may be to your body's natural drop in temperature.

✓ Evaluate your mattress and pillow

You'll experience more restful sleep when your mattress and pillows are comfortable and supportive. You'll want to consider replacing your mattress after nine or 10 years, the average life expectancy of a good quality mattress.

✓ Downshift your mental gymnastics before bed

Put all your work away at least one, and preferably two, hours before bed. You need a chance to unwind before falling asleep without being anxious about the next day's plans or deadlines.