

SIMPLY SCIENCE



The Science of Sleep

Why Getting Enough ZZZZs Will Improve Your Life

BY AMY KLEIN

“You look tired.”

A well-meaning friend or two might tell you this from time to time. You put your hand to your eyes, hoping it doesn't show that much, but secretly you agree. You are tired. Very tired. But it's more than just tired; you feel that without a good night's sleep — a good week's sleep, actually — you have a hard time functioning. You find it more difficult to work, to think, and even to smile. It's harder to look good (those dark circles and puffy eyes!) and to feel good (even walking feels like trying to swim in quicksand). You know it's “just” sleep, but these days it feels genuinely essential.

It's true. Sleep is essential. It is a cornerstone of physical, mental, and emotional health. We know this because we make sure our babies and young children get twelve hours of sleep, gradually decreasing the number to eight hours as they grow. (Although when they're teenagers, they seem to be able to sleep forever.) We know our children need sleep in order to grow and function well in school, yet somehow we forget that as adults we need sleep too — quality sleep, every night. Scientists are just now figuring out why.

What Is Sleep?

The naturally recurring state of sleep, according to scientists, is characterized by reduced or no consciousness, suspended sensory activity, and inactivity of nearly all voluntary muscles. During sleep we have a decreased ability to react to stimuli. Sleep promotes the growth and rejuvenation of the immune, nervous, skeletal, and muscular systems. It is observed in all mammals, all birds, many reptiles, amphibians, and fish. Sleep is more easily reversible than being in hibernation or in a coma (although, if you have ever tried to wake a deep sleeper, there doesn't seem to be much difference).

There are two alternating states of sleep:

- **Non-rapid eye movement (NREM)** or “quiet” sleep. During the deep states of NREM sleep, blood supply to the muscles is increased, energy is restored, tissue growth and repair occur, and important hormones are released for growth and development. The American Academy of Sleep Medicine divides NREM further into three stages: N1, N2, and N3 (which is also called delta sleep or slow-wave sleep).
- **Rapid eye movement (REM)** or “active” sleep. During REM sleep, our brains are active and dreaming occurs. Our bodies become immobile, and breathing and heart rates are irregular.

Sleep proceeds in cycles of REM and NREM, usually four or five of them each night. Altogether an adult will spend approximately ninety minutes in REM sleep. The function of REM sleep is uncertain, but lack of it impairs a person's ability to learn complex tasks. There is a greater amount of deep sleep (stage N3) earlier in the night, while the proportion of REM sleep increases in the two cycles just before natural awakening.

Good for Your Brain

A good night's sleep is important for healthy brain function. “The negative effects of sleep deprivation on alertness and cognitive performance suggest decreases in brain activity and function, primarily in the [part of the brain]

involved in alertness and attention, and in ... the region subserving alertness, attention, and higher-order cognitive processes,” states a 2009 article in *The Journal of Sleep Research* on the effects of sleep deprivation on waking human regional brain activity.

“Our results of brain activity, alertness, and cognitive performance impairments following one night of sleep deprivation suggests that the neurobehavioral function of sleep in humans is to restore and sustain normal waking brain activity and behavior,” the researchers conclude. “These findings substantiate the biological necessity of sleep to normal brain functioning and are particularly powerful in underscoring the importance of adequate sleep for workplace productivity, public safety, and personal well-being.”

According to Professor Mark Gluck of Rutgers University, an expert in cognitive and computational neuroscience, sleep affects our daily lives by influencing two central processes — memory consolidation and emotional regulation.

Avi Karni and Dov Sagi, Israeli researchers at the Weizmann Institute, found that interrupting REM sleep sixty times a night completely blocked learning; interrupting non-REM sleep just as often did not.

Sleep is also essential for memory function, which is an important part of learning. “The consolidation of memories, or LTP, takes place during sleep or during deeply relaxed states,” reports a recent *Psychology Today* article called “It's Magical. It's Malleable. It's ... Memory.” Brain waves slow to theta rhythms, and the brain releases chemicals that enhance storage. The REM sleep associated with dreaming improves memory. In a Canadian study, students who slept after cramming for an exam retained more information than those who pulled an all-nighter.

Good for Health

A recent study conducted at Warwick University reported that people who sleep fewer than six hours a night are more likely to die before the age of sixty-five



than those who sleep longer. How well you sleep might be correlated to how long you live.

“Epidemiologic studies have shown that sleep duration is associated with overall mortality,” write Lisa Gallichio and Bindu Kalesan in “Sleep Duration and Mortality: A Systematic Review and Meta-analysis.” While they estimate that short sleepers showed only a relatively small increase in lifespan, the prevalence of sleep duration disorders is increasing, so the mortality rate associated with it will also increase.



Another study of more than thirty thousand adults in the scientific journal *Sleep* found that fewer than five hours' slumber a night can double a person's chance of heart attack, stroke, and angina. The researchers warned that sleep deprivation raises blood pressure, which increases the risk of artery damage.

Positive Mental Health

You already know that you feel happier when you are well rested, but did you know that poor sleep can cause depressive episodes? "Current evidence clearly shows

Snoring From A to ZZZ

What is something that everyone thinks only *other* people do? That's right, snoring. Most people, because they are sleeping, deny they have a snoring problem (unless the snoring is so bad that they wake *themselves* up). Snoring is the sound of obstructed air movement in breathing channels. Snoring is your body's way of crying out for the air it needs to perform basic functions. The snoring sound is your body trying to force air through the obstructions.

The Journal of Sleep Research tells us, "Snoring positional dependence [i.e., whether snoring depends on the position in which you sleep] is determined by body mass index, tonsil size, and age." Following are some common causes of snoring:

- Sleeping on your back, resulting in the tongue dropping to the back of the mouth
- Fat gathering in and around the throat
- Obstruction in the nasal passageways
- Relaxants such as alcohol or drugs, which relax throat muscles
- Throat weakness, which causes the throat to close during sleep
- A badly positioned jaw, often caused by muscle tension
- Obstructive sleep apnea, characterized by repetitive pauses in breathing during sleep. An apnea (meaning "without breath") usually lasts twenty to forty seconds and is associated with a reduction in blood oxygen saturation.

Roughly one in every fifteen Americans is affected by at least a moderate degree of sleep apnea.

One problem resulting from snoring is obvious — loss of sleep for the snorer and/or the snorer's spouse ("spousal arousal syndrome"). In addition to sleep deprivation and all the health problems that come with it, snoring has also been shown to increase the risk of heart attack by 34 percent and stroke by 67 percent. Blood pressure usually falls during the sleep cycle, but

interrupted sleep can adversely affect this normal decline, leading to hypertension and cardiovascular problems. Snoring can also cause sore throats, headaches, and a dry mouth in the morning.

How to Stop Snoring

• Maintain a healthful lifestyle.

Since there is a high correlation between obesity and snoring — the incidences triples in obese children — weight loss, even if you're not clinically obese, can stop or decrease snoring.

• **Change your sleep position.** If snoring is caused by sleeping on your back, you might be able to stop the problem by sleeping on your side or stomach, or adding pillows to aid airflow.

• **Reduce alcohol consumption.** Alcohol is a major contributor to snoring.

• **Try a snoring device.** There are more than three hundred devices registered at the U.S. Patent and Trademark office as cures for snoring, according to the scientific journal *The Laryngoscope*. In a study of eighty-three adults, only 5 percent were helped by a snoring device. Some 72 percent were aided by surgery.

• **Surgery.** There are two types of surgical procedures to cure snoring — uvulopalatoplasty and septoplasty. Uvulopalatoplasty is a surgical procedure whose purpose is to reduce or eliminate snoring. It is an outpatient procedure performed under local anesthesia in which a laser is used to remove parts or all of the uvula at the rear of the mouth. Septoplasty, or septal reconstruction, is surgery to repair a deviated septum, the partition between the two nasal cavities. It is done under general or local anesthesia, working through the nostrils.

Although snoring may seem like a minor problem, because it affects your sleep and the sleep of those around you, it pays to try to alleviate it.

that sleep and depression are strongly interrelated,” states a recent article in the journal *Nature and Science of Sleep*. Lack of sleep leads not only to increased risk of depressive episodes but to decreased responsiveness to intervention.

Also, there’s a reason you seem to have a shorter fuse when you lack sleep. Sleep deprivation amplifies reactivity, according to *The Journal of Neuroscience*. “Sleep deprivation is associated with enhanced reactivity toward negative stimuli,” it reports, as well as inability to process pleasure-evoking stimuli. That means that things that usually make you happy are less likely to do so if you’re tired.

Sleep problems are almost always associated with mental disorders, including depression, schizophrenia, Alzheimer’s disease, stroke, and head injury. And symptoms are strongly influenced by the amount of sleep a person gets. (Difficulties may arise from the medications used to control symptoms of a disorder, or from changes in the brain regions and neurotransmitters that control sleep.)

Good for Your Diet

Did you know that you can make only a certain number of decisions a day before you get “decision fatigue”? Researchers have discovered that, like your body, your brain gets fatigued the more you work it out. That’s why, when you haven’t slept enough, you have a harder time practicing self-control. Although you were able to avoid that chocolate cake in the fridge yesterday, today — after sleeping fitfully — you couldn’t help but eat a slice. It is almost not your fault.

“Self-control relies on some sort of

Sleep Learning

There’s an old joke in which a student falls asleep in class. The teacher tells the rest of the class, “I’m glad he fell asleep. That means he will remember everything I’ve taught.”

Sleep is essential for consolidating learning and strengthening memory. But scientists have long wondered if people can acquire new information while sleeping.

A new Weizmann Institute study that appeared in the August issue of *Nature Neuroscience* found that sleep learning is indeed possible. When subjects were sleeping, researchers rang a tone and then presented them with different odors. When the subjects awoke and the tone was played, they would start sniffing, even when no odor was present. This means people can learn new information while they sleep and can modify waking behavior.

Science has a long history of trying to find evidence for sleep learning. (Remember those weight-loss tapes people used to listen to in the 1980s?) It is difficult to prove that subjects are actually *sleeping* during the experiments. Some critics claim that subjects briefly wake up and then fall back asleep. But unlike most sleep learning experiments, the tones and odors in the Israeli experiment didn’t wake the subjects or disturb their sleep.

Moreover, sniffing, unlike other senses, is associated with the hippocampus, an area of the brain involved in memory formation. Sleepers had a better chance of recalling smells presented in non-REM sleep.

“Now that we know that some kind of sleep learning is possible, we want to find where the limits lie — what information can be learned during sleep and what information cannot,” said Anat Arzi, the research student assisting Professor Noam Sobel and the Weizmann Institute’s Department of Neurobiology, which pioneered the experiment along with researchers from Loewenstein Hospital and the Academic College of Tel Aviv-Jaffa. Arzi intends to continue investigating brain processing in altered states of consciousness.

limited energy source,” states the writer of “The Physiology of Willpower: Linking Blood Glucose to Self-Control” in *Personality and Social Psychology Review*. “Self-control failures are more likely when glucose is low or cannot be mobilized effectively to the brain,” including failure to control attention, regulate emotions, quit smoking, cope with stress, resist impulsivity, and refrain from criminal and

aggressive behavior.

Fatigue reduces fat cells’ ability to respond to insulin by about 30 percent, according to a study in the *Annals of Internal Medicine*. (In the long term, this decreased response could set the stage for type 2 diabetes, fatty liver disease, and weight gain.) So if you don’t get enough sleep, your body may decide to store as fat more of the food you eat.

Sleep Disorders

Although technically insomnia, or disturbed sleep, is a disorder, most people refer to insomnia as the consistent inability to fall and *stay* asleep.

According to the Centers for Disease Control and Prevention (CDC), more than a quarter of people in the United States report not getting enough sleep, and about 10 percent have chronic insomnia. According to the CDC, sleep disorders include the following:

- **Insomnia**, which can also take the form of early-morning awakening
- **Sleep apnea**, where sleep is interrupted by breathing problems (see sidebar on snoring)
- **Restless-leg syndrome**, which is characterized by an unpleasant “creeping” sensation that often seems to originate in the lower legs but is often associated with aches and pains throughout the legs
- **Narcolepsy**, an extreme condition in which a person suffers daytime sleep attacks coupled with sudden muscle weakness

“Sufficient sleep is not a luxury — it is a necessity and should be thought of as a ‘vital sign’ of good health,” the CDC says.

Stress is a known factor in causing sleep disturbance. In *The Journal of Clinical Endocrinology and Metabolism*, researchers compared patients with insomnia to those without a sleep disturbance. They found that “insomniacs with the highest degree of sleep disturbance secreted the highest amount of cortisol, particularly in the evening and nighttime hours,” suggesting that chronic insomnia is a disorder of sustained hyperarousal of the body’s stress response system.

Getting a Good Night’s Sleep

The million-dollar question that has plagued doctors, neuroscientists, sleep specialists, and insomniacs for decades is *how* to get a good night’s sleep. Of course, there is no one answer, but here are some tips:

- **Prepare for bedtime.** Kids can’t go from 100 mph to 0 in a few minutes. They need time to wind down and get

ready for bed. They wash up, put on pajamas, read a story or two, have a glass of milk, sit in low lighting, and *then* go to sleep. Adults, too, should create a routine to wind down. Stop all work, including errands and housework, at least an hour before bedtime. Ban all electronics from the bedroom, including cellphones. Do something to relax and move yourself into a calmer space, whether it’s reading, deep breathing, or taking a bath.

- **Make sure your sleep area is comfortable.** You should never have your computer or work area in your bedroom. A bedroom should be devoid of stressful reminders like bulletin boards full of to-do lists. Likewise, make sure you have the right lumbar support, pillows, mattress, and bedding for a comfortable night. The answer to your restlessness may lie in a new mattress pad or pillow.

- **Rethink your diet.** Many sleep experts advise eating your heaviest meal in the middle of the day and having a lighter meal at night. Your body works hard to digest the food you eat, so you may want to keep it simple in the three to four hours before bedtime. Alcohol, though it makes you sleepy, can often cause you to awaken during the night. Of course, for people with sleep problems, eliminating caffeine, especially in the afternoon, may just do the trick.

- **Exercise.** Physical fitness not only reduces stress but induces a fatigue that will help your otherwise overactive mind and underactive body want to snooze. Studies have shown that people who are physically active sleep better than those who are sedentary. The more energy you expend during the day (preferably earlier in the day), the sleepier you will feel at bedtime.

- **Forget your to-do lists.** There will always be more to do — more laundry, more housework, more memos to write, more errands. If you realize that sleeping tonight will help you accomplish everything you need to do tomorrow, you will make it your number-one priority to put it all aside to get a good night’s sleep.

Don’t Stress

If you ask most insomniacs what keeps them up worrying in the middle of the night, they will say, “I worry about not sleeping.” Worrying about not sleeping while you’re not sleeping is like worrying about your fear of dogs when facing a Rottweiler — it doesn’t help. If you are one of the millions of unfortunate people who have trouble falling asleep or staying asleep, experts recommend getting out of bed and forgetting about it.

In fact, new research shows that we may be too obsessed with getting seven or eight hours of consecutive sleep. Not everyone *needs* seven to eight hours of sleep a night. Some people do fine with less, others need more. Still, some

people might be “night owls” who need to go to sleep later, and staring at the ceiling from eleven p.m. on might not be so healthful.

In earlier times, people had a “split-sleep” schedule, sleeping for a few hours until past midnight and staying awake for a few hours before they went back to sleep again. In between they would do chores, read, or write. Workers in some countries have siestas in the late afternoon or a space for naps even at work.

The trick to getting your zzz’s, it seems, is not worrying about getting your zzz’s.

So relax! Go to sleep, wake up, relax, go back to sleep. And if you’re lucky, maybe you can catch a little afternoon nap to get you through your day. ■

