

How Sleep Makes You Smart

by Jill Suttie

Many Americans are against sleep, equating it with laziness. But one of the world's leading experts on sleep says that's hurting our relationships and our ability to solve problems.

We spend almost a third of our lives asleep, giving more time to sleep than any other activity. Some of us are blessed with easy sleep; others of us suffer from insomnia or sleep disturbance. Yet, until recently, scientists have known very little about the purpose of sleep or how it affects our brains and day-to-day functioning.

Matt Walker is an associate professor of psychology at UC Berkeley and Principal Investigator at the Sleep and Neuroimaging Laboratory.

With the advent of functional MRI's, scientists can now peer inside our heads to see how a good night's sleep affects neural activity. One of the researchers leading this charge is Dr. Matthew Walker, neuroscientist and psychologist at the University of California, Berkeley. Walker runs a sleep research lab, where he has studied the relationship between sleep and memory, learning, and emotions.

I spoke with Walker recently about his research and what it means for those of us who don't get enough sleep.

Jill Suttie: What is the function of sleep?

Matt Walker: We don't sleep for one single reason. One of the failings in the field of sleep research over the past 40 or 50 years is that we went in search of the one single Holy Grail function of sleep. We now realize that sleep is necessary for a whole constellation of different functions for both the brain and the body.

JS: How do you study the relationship between sleep and, say, emotion?

MW: We try to do it in two ways: One is to look at the detriment that happens when you take sleep away through sleep deprivation; and the other is to look at the benefits of sleep and exactly what it is about that sleep when you do get it—the different stages or different types of sleep—that may be promoting emotional regulation. We can dial the system up and dial the system down in terms of sleep and look at what the consequences are to our emotional and mental health.

JS: So, what is the effect of sleep on emotional regulation?

MW: Let me take the deprivation circumstance first.

When you deprive people of sleep, certain deep emotional brain centers—areas such as the amygdala, which relates to aggression and fear, and the striatum, which relates to reward and positive emotion—become amplified in their reactivity to emotional events. The reason why these deep brain regions become so reactive is that they lose their connection with the prefrontal cortex. The prefrontal cortex helps control these deep emotional brain regions—it's very good at regulating them in a top-down way. You can think about a car analogy: The amygdala is your emotional gas pedal and the prefrontal cortex is your emotional brake.

In people who've had a good night of sleep, the connection between the deep brain and the prefrontal cortex has been refreshed or restored. As a consequence, the frontal lobe is able to regulate—in a socially appropriate, psychologically controlled way—the emotional amygdala. When you are sleep deprived, the frontal lobe and the amygdala become disconnected, and so you become all emotional gas pedal, without sufficient brake. You can see this loss of connectivity between these two structures [through MRI scans], and you can see that the effect is reversed when you've had a good night's sleep.

JS: Does losing sleep hurt your relationships, then?

MW: Socially appropriate responses and controlled emotional reactions are quintessential for cooperation and interactions with others, so sleep loss has the potential to impact such processes.

I should also say that a profile of frontal lobe disconnection with deep emotional brain centers is indicative of a number of psychiatric disorders, such as PTSD and depression.

What's striking is that those same psychiatric disorders also display co-occurring abnormalities in sleep. The assumption has been that the psychiatric conditions have been causing the sleep abnormalities. But we're now starting to realize that, instead, the sleep problems are making a significant contribution to the psychiatric condition as well.

JS: How do you know that sleep problems create psychopathology rather than the other way around?

MW: In biology, there's almost never a unidirectional direction of interaction. Much seems to be bi-directional, and I have no doubt that it's the case with sleep and psychiatric disorders. But the flow of traffic in that two-way street could be going more dominantly in one direction than the other.

Can you test that? Well, it's ethically debated, but some researchers have taken, for example, groups of patients with bipolar depression and experimentally sleep-deprived them in a laboratory. As a consequence, they causally triggered the onset of a manic phase. This establishes that sleep loss can act as a causal trigger that instigates certain psychiatric issues.

JS: Does that mean helping people sleep better—maybe by giving them a sleeping pill—could reduce psychiatric symptoms?

MW: Professor Allison Harvey, who's also in the psychology department here [at UC Berkeley], has been doing just what you're suggesting—not by way of drugs, but by behavioral interventions that help improve sleep. Her amazing research has clearly demonstrated that if you restore and normalize sleep in different severe mental health conditions, you can see very significant clinical improvements.

JS: You mentioned that lack of sleep increased reactivity in the brain's reward center as well as in the amygdala, which means we would experience more pleasure from positive emotional stimuli. That makes it sound like lack of sleep could be a positive.

MW: It does seem counterintuitive.

If you look at the anecdotal reports on sleep deprivation, there are times when people get quite giddy because of sleep deprivation. And at first it sounds like a good thing. But it's actually quite maladaptive. Firstly, for the brain to have extreme pendulum-like reactivity to either positive or negative emotional experiences means your reactions are not controlled and not likely socially appropriate. Second, going in the positive emotion direction more strongly is dangerous, because it pushes you more toward the domain of risk-taking and addiction.

JS: So, having a bad night's sleep affects our emotional reactivity. How does getting a good night's sleep help us emotionally?

MW: Many of the emotional benefits that sleep provides involve taking the painful sting out of difficult emotional experiences from the day before, or balancing our reactivity to next-day emotional challenges. Sleep even improves our capacity to recognize different and specific types of emotions in people's faces more accurately. We have been discovering that these benefits come from a very specific type of sleep, called Rapid Eye Movement, or REM, sleep.

What is striking about REM sleep is that it's the only time during a 24-hour period where your brain is devoid of any stress neuro-chemicals, especially one called norepinephrine. During REM sleep, we now believe the brain is reactivating emotional and problematic memories and bringing them back into your mind through reflective dreaming—but what is unique about REM sleep is that this occurs in a neuro-chemically safe environment, free of that stress chemistry.

You can therefore start to take away—like a soothing balm—the sharp edges off of those emotional memories. So you wake up the next day feeling better and not so emotional about those previous experiences. It's essentially overnight therapy.

JS: What is the relationship between sleep and learning?

MW: Sleep appears to be important for learning and memory in three ways.

We've found that sleep before learning is essential to prepare your brain so that it soaks up and learns new information the next day. There are unique short bursts of electrical activity called sleep spindles that occur during non-REM sleep, and we believe they help your brain move information from its short term storage site in the hippocampus to its long term storage site—upstairs in your cortex. As a result, you have a refreshed ability for new learning as you wake up each morning.

So, sleep before learning is critical; but you also need to sleep after learning, and to take that new information and essentially cement it into the neural architecture of the brain. Here, a different type of electrical activity comes into play: Slow wave sleep—a deeper state of non-REM sleep—which helps solidify recently learned memories, so that we don't forget them. It's like hitting the save button on a new word document that you've just typed up for the day.

More recently, we've realized there's an additional benefit for learning. Sleep is much more intelligent than we have previously considered. It not only takes individual pieces of information and saves them and protects them, but sleep can intelligently cross-link new pieces of information together. As a result, you can start to extract commonalities and develop novel insights into problems that you were having the day before.

JS: What is the evidence for that?

MW: We do lots of different tests to examine this. For example, there are tasks with hidden rules embedded within vast sets of information. You can also do some clever tests where subjects try to solve mathematical problems that are very laborious and very boring. Each math problem they do—and they do hundreds of them—is different; but there is a common hidden rule across all of them, which, if they figure it out, can help them shortcut all of the problems and pretty quickly come up with a novel answer. We've found that sleep will more than triple the probability that you'll figure out that hidden rule. Sleep seems to inspire a creative insight into previous problems and challenges we've faced.

JS: Sleep has these benefits. But I think most of us admire people who don't need a lot of sleep—someone like Bill Clinton, for example.

MW: Society has gotten to a stage where we equate sufficient sleep with laziness. That's a terrible thing. And it's strange because we don't always have that opinion. Consider a baby sleeping during the day. Nobody looks at the infant and says, "What a lazy baby." We don't do that because we realize that at that stage of life sleep is absolutely essential.

We, as a society, have abandoned the notion that sleep is essential and useful. If anything, we've become proud of what little sleep we're getting. In terms of a public health pandemic, we are with sleep where we were with smoking 50 years ago. We have all of the science to understand how bad it is when we're not getting enough sleep; but scientists have not yet managed to affect the mindset of the lay public enough to change public health policy. But I'm hopeful this will change, and change soon.

JS: Why do we have to sleep so much? It almost seems counter to evolution.

MW: When you think about sleep, it's the most ridiculous act to perform from an evolutionary perspective. You're vulnerable to predators, you're not finding a mate, you're not reproducing, you're not gathering nutritional resources, you're not socially interacting. It would seem like the most idiotic thing to do.

However, sleep seems to be present in every species that we have studied to date. And what that means is that sleep has fought its way heroically through every step along the evolutionary pathway. If that's true, then sleep must be serving some absolutely essential

function.

And that's what we're finding. We need that one-third of our life in sleep because sleep seems to support such a remarkable and broad constellation of different functions. Not just the brain; your body also benefits dramatically, your immune health, your metabolic system, your cardiovascular health. Indeed, there is not one major tissue or organ in the brain or body that is not benefitted by sleep.

JS: Can you make up for lost sleep?

MW: Sleep is not like the bank. You cannot accumulate a debt and then hope to pay it off at a later point in time. Sleep is an all-or-nothing phenomenon. Now that shouldn't be a surprise. Evolution has never been faced with the challenge of having to make up sleep, because human beings are one of the few species that will deliberately deprive themselves of sleep. So there is no mechanism to compensate it, no safety net developed by biology to deal with that. The idea that you can make it up is quite a misnomer.

JS: What in your research has really surprised you?

MW: I think what's surprised me has been the size of the benefit that you get from sleep when you obtain sufficient amounts, as well as the severity of the detriments that happen when you don't get sleep.

I would argue that, if you look at the other main biological drives—things like eating and drinking—it's fairly clear that the lack of one night of sleep causes detriments to your brain and body that far exceed anything you would see from a lack of food over the same duration of time. In fact, studies on animals in the 1980's demonstrated that rats will die as quickly of sleep deprivation as they will from food deprivation. Sleep is that essential.

JS: Do you make recommendations for people around sleep?

MW: Simply put, the single most important thing you can do each and every day to reset your brain and body health is to sleep. Once you start to get anything less than about 7 hours of sleep, we can start to measure biological and behavioral changes quite clearly.

People will say, "I can get by on 4 or 5 hours of sleep." But your subjective opinion of how you're doing with insufficient sleep is a miserable predictor of objectively how you're doing with insufficient sleep. Essentially it's like the drunk driver at the bar picking up his keys after a couple of drinks and saying, "No, no. I think I'm fine; I'm perfectly fine to drive."

JS: How does doing this research impact your own sleep?

MW: [Laughs] In two ways. Firstly, I do practice what I preach and I will routinely get between seven and a half to eight hours of sleep a night. If I don't, I can see and notice the imbalance.

Second, it does make you rather like the Woody Allen neurotic of the sleep world. If I travel to a different time zone, and I'm having a hard time getting to sleep at night, I'm lying there in bed thinking, This neuro-chemical is clearly not being released in my brain, this part of the body is not shutting down as it should be.

At that point, you're dead in the water. You can forget about getting any sleep for the

next few hours with all of that rumination.