

After reading “The Sleep Revolution,” which is all about the importance of a good night’s sleep... I found it really hard to... fall asleep. Before that I didn’t have much difficulty with it, but after being bombarded with endless statistics and research results illustrating the detriments of inadequate sleep, I became very anxious about how long I was lying awake in my bed.

★When we’re trying to get more out of life, sleep is usually the first thing that gets cut to make room in our schedules. Ironically, it can be hard to realize that by cutting back on sleep, we are decreasing productivity, creativity, concentration, patience, communication skills and a lot of what makes a good... human. That’s because less sleep results in a less effective brain and less healthy body. Pretty much whatever you’re doing, you end up doing it worse.

Of course there are some cases where you have no choice but to stay up late or wake up early. But I’d like to spend this video looking over why sleep is so important. By getting a new perspective on sleep, hopefully you’ll *enjoy* getting more of it rather than just feeling like you’re wasting 8 hours of your life. First, let’s take a look at what happens to your mind when you’re not completing the process of sleep properly.

★. In 1999, two professors at Loughborough University wanted to test how sleep affects the brain’s ability to react to changing conditions. They developed a computer game set in the business world, and MBA students had to promote sales of a virtual product. Then, halfway through the game, the dynamics of the virtual marketplace suddenly changed. Now strategies that used to work resulted in terrible sales. Only students who could quickly change and adapt could survive.

Students were split into two groups, one with restricted sleep and another where they could sleep as much as they liked. Most of the students who slept well quickly adapted to the changes and maintained their sales. On the other hand, the sleep-deprived students were unable to modify their strategy appropriately and very quickly became bankrupt.

The conclusion was that without sleep, their brains lost the ability to consider alternative solutions to problems. Brain scans have shown that when you’re lacking sleep, the neurons firing in the prefrontal cortex begin to slow down. The prefrontal cortex is particularly important for the behaviors that make us... human. This region is associated with planning, personality expression, decision making, attention control, reasoning, and problem solving. When you lack sleep, it’s harder for us to complete a thought or see a problem in a new way.

In a talk on the role of sleep in learning and creativity, Robert Stickgold discusses [an experiment](#) where subjects were supposed to come up with a string of numbers based on a different set of numbers they were provided with. The instructions were complicated, but after several trials everyone got the hang of it and could slowly but consistently solve the number puzzle. However, there was a trick to make the process much faster. The last three numbers in the sequence always ended up being a mirror image of the 3 numbers before it. They wanted to see how long it would take people to pick up on the trick. So, after everyone got a hang of the instructions, they had them wait 12 hours and then try it again. But, they were split into three groups: those who learned how to do the puzzle in the morning and got tested at night, those who learned how to do it at night and then stayed awake all night before trying in the morning, and those who tried in the morning but had gotten a good night's rest.

The first two groups showed about the same chance of discovering the trick in the puzzle. But with the 3rd group, again the only difference is that they got to sleep, they were 2.5 times more likely to gain the insight into the puzzle and catch the trick.

[Robert Stickgold] *“So you can gain these insights when you didn't even know there was an insight to find, just by sleeping on it. It's an amazing phenomenon, it really is. It's like... how does it do it?”*

Two big things on the sleep to-do list that allow for such insights are memory consolidation and information processing. While asleep, your brain looks at the information you picked up throughout the day, prunes out the useless junk and keeps the things worth remembering. Of the four stages of sleep, slow wave sleep and rapid eye movement have been shown to move electrical impulses between the brain stem, hippocampus, thalamus and cortex. These four areas serve as relay stations for memory formation. During this process, your brain takes the information in the short term memory and moves the important bits to long term memory.

In this World Science Festival program, Neurobiology professor Matthew Wilson describes an experiment designed to gain insight into this information processing step. They analyzed the brain activity of rats while they were making their way through a maze, and then compared that to their brain activity while sleeping. What they saw was that as the rat went into non-REM deep sleep, its brain was lighting up as if it was actually back in the maze... except it was replaying the information about 10 times faster than normal, and it was playing the events backwards and forwards and skipping around. The idea is that during this non-REM deep sleep phase, your brain is quickly reviewing the information you've gained throughout the day and taking notes. It's kind of

like flipping around in your textbook before your test the next day.

REM sleep however is played out at normal speed. This is why your dreams, however ridiculous, will follow some sequence of events. While you dream, your brain is seeing how unrelated pieces of information fit together and simulating scenarios you might need to be prepared for. What if my boss turns into the monster from Pan's Labyrinth, what would I do! Because your brain is playing around with information like this, some of our most creative insights can come to us in the form of dreams. August Kekulé in 1865 came up with the structure of the Benzene molecule in a dream. Elias Howe owes the invention of the sewing machine to a dream. Paul McCartney came up with the melody for *Yesterday* in a dream, and there's all kinds of examples like this.

Because of the timing at which these processes happen, it's suggested that you should go to sleep 3 hours after acquiring declarative knowledge like after studying from a book, and you should go to sleep 1 hour after working on procedural knowledge like playing an instrument. Also if you're trying to learn or remember something, you should definitely avoid alcohol. It's thought that the reason we don't remember much after drinking alcohol is that alcohol interferes with memory consolidation.

So insufficient sleep interferes with creativity and memory, but it can also interfere with your personality and competence in general. As mentioned earlier, the more "human" part of your brain, the prefrontal cortex shows less activity when you're sleep deprived. The Amygdala on the other hand, shows **more** activity. The amygdala is associated with processing emotional information and, as [this study](#) has found, "*a lack of sleep inappropriately modulates the human emotional brain response to negative aversive stimuli.*" Essentially, the less sleep you get, the more likely you are to interpret situations negatively, overreact to things and be more moody in general. This can manifest itself as more fights with your spouse as illustrated by **this article**, or as much more *drastic* behavior.

In 2009, a band of American soldiers from the 172nd infantry found themselves in court martial for murdering two men in Baghdad against a superior's orders. Their lawyers' defense was that the soldiers were too sleep deprived to make rational decisions.

David Randall's book *Dreamland* discusses several how in the early 80's military studies found that sleep deprived air force pilots "*changed their vocal patterns, no longer enunciating or speaking loudly enough [to be understood]*" by their co pilots. Maybe that didn't bother the military that much because in 1996 "...*crew fatigue was blamed for thirty-two accidents that destroyed American military aircraft, including three*

F-14 jetfighters that cost \$38 million each.” The military has spent millions of dollars testing all kinds of methods to keep soldiers awake longer, but in 2007 they concluded that the only way to recover from lost sleep was to ...sleep.

Now some of you may say “*I’m operating just fine on my 6 hours of sleep a night.*” And you could be one of the 5% of the population with the genetic mutation that lets you get by on only 6 hours of sleep. But as we discussed earlier, activity in the prefrontal cortex lessens when you lack sleep. And The prefrontal cortex is the only part of the brain that has the power of self-assessment, ...to think about how it is thinking. So if you’re not getting enough sleep, would your prefrontal cortex properly recognize that it’s working at sub-optimal capacity? Let’s put it this way: If your brain was operating at say only 85% of its performance capacity, could it make the mistake of thinking it was performing at 100% capacity?

It’s not only your brain that needs sleep, also on the sleep to do list is tissue repair, maintenance of metabolic pathways and the balancing of hormones. Sleep is very important for your body too.

A study at the University of Chicago put participants on a calorie restricted diet and then randomly assigned them to sleep 5.5 hours or 8.5 hours each night. Those who slept only 5.5 hours lost 55% less body fat. Again, they were on the same diets. The sleep deprived group did lose weight, but they were losing more **muscle**. They lost 60% more fat-free mass compared to those who slept well. They also reported feeling hungrier. An important factor in this was that the sleep deprived group were shown to have much higher ghrelin levels. Ghrelin is a hormone that causes you to retain fat and feel more hungry. It has been shown that just one night of poor sleep leads to a 15% increase in this “hunger hormone.”

Our bodies are very complex dynamic systems so usually it’s not only one hormone that gets disrupted. Lack of sleep also means lowered levels of the satiety hormone leptin, and less melatonin. Melatonin has some very powerful anti-aging and anti-cancer properties, and as the Journal of pineal research found, melatonin increases weight loss by increasing brown adipose tissue. Brown adipose tissue or BAT Fat actually acts a lot like muscle in that it increases your metabolic rate and burns white adipose tissue- white adipose tissue is the fat you don’t want.

Inadequate sleep also increases Cortisol, which has been shown to increase the worst type of fat -visceral fat, the stuff that surrounds your organs. Cortisol also encourages your body to break down muscle for fuel through a process called gluconeogenesis.

Whether you are trying to make some “gains” or just want to lose a bit of fat, your time in the gym needs to be complemented with proper sleep.

One more key hormone secreted during sleep is Human Growth Factor (HGH), otherwise known as “the youth hormone”. As the name suggests, it stimulates growth, cell reproduction and cell regeneration, which means increased muscle, more fat loss, and other things like improved skin elasticity. Human growth hormone even plays a role in [improving cognitive function](#) and a *deficiency* in it has been [linked with depression](#). At the [University of Berkeley](#), lack of sleep was the top predictor of depression symptoms among graduate students.

It’s important to get enough sleep, but also to get it at the right time. While it depends on each individual’s circadian rhythm, in general 10PM to 2AM is when your body secretes the most growth hormone (that is- IF you’re asleep at that time).

Thomas Edison, a famous opponent of sleep, said that “*Sleep is a criminal waste of time, inherited from our cave days.*” Did him dying of type 2 diabetes in an era when the disease was exceptionally rare have anything to do with that? Maybe.

The other thing on the sleep to do list is waste cleanup. The brain takes up 2% of the body’s mass yet burns up one quarter of the body’s energy supply. Throughout the course of the day, the brain produces a decent amount of waste.

The brain handles this waste cleanup task during sleep via something called the glymphatic system in which brain cells shrink to allow for cerebrospinal fluid to flood into the brain and flush out the waste. Kind of like a dishwasher. One thing that needs to be flushed out is the compound adenosine. Adenosine is a byproduct of your neurons and other cells when they burn up adenosine triphosphate, the main molecule that our bodies use to store energy. As adenosine builds up, you start to slow down and accumulate a “sleep pressure”. When your adenosine levels reach a certain point, your body sends you signals to go to sleep.

Caffeine works by bonding to the same receptors as adenosine, *tricking* the body into thinking it’s not tired. While caffeine will wake you up, it will interfere with your sleep cycle if taken too late in the day. Cristopher Drake, associate professor of behavioral neurosciences at Wayne State University School of Medicine led a study that found that taking caffeine even *6 hours before* bed can lead to a measureable objective loss of 1 hour of sleep. What this means is that it may seem like you got say 7 hours of sleep

after having a coffee mid day, but a sleep monitor would show that you're not properly dipping into the normal ranges of REM and deep sleep, leading to an actual sleep total of 6 hours. For this reason it's recommended to finish your caffeine at least 8 or more hours before you go to sleep.

Like adenosine, Amyloid beta is another waste product that is created in the brain as a consequence of being alive. Unfortunately, excess amyloid beta is [toxic to the brain](#) and Amyloid plaques have been thoroughly linked to Alzheimer's disease. It's understood that Alzheimer's patients don't *create* significantly more amyloid beta than other people, but they simply were not *clearing it out* enough. Of course other lifestyle factors like diet play a role here, but sleep could be particularly critical for avoiding neurodegenerative disease.

Artificial intelligence, robots, and all kinds of automation are already replacing jobs nowadays and the technology is only expected to get better and better. Machine intelligence may be the last invention humanity will ever need to make, but at least until that point we need to set ourselves up access our creative insights and take advantage of the more human faculties of our brains. As Daniel Pink says in *A Whole New Mind*, it's the "*creative and emphatic 'right-brain' oriented thinkers whose abilities mark the fault line between who gets ahead and who doesn't.*" Without enough sleep, our bodies as well as these creative, insightful and emotionally adept human faculties of our brains suffer.