

Why Our Brains Require Sleep

Sleep. It's something we spend about a third of our lives doing. We all know based on our own experience that when you sleep, it clears your mind, and when you don't sleep, it leaves your mind murky. But while we know a great deal about sleep, we still haven't understood why it is that sleep, of all of our activities, has this incredible restorative function for the mind.

Recent research has revealed that sleep may actually be a kind of elegant design solution to some of the brain's most basic needs, a unique way that the brain meets the high demands and the narrow margins that set it apart from all the other organs of the body.

Almost all biological species continuously encounters a series of problems and their corresponding solutions. The first problem that every organ must solve is a continuous supply of nutrients to fuel all those cells of the body. In the brain, that is especially critical; its intense electrical activity uses 25% of the body's entire energy supply, even though the brain accounts for only about 2% of the body's total mass. The circulatory system solves the nutrient delivery problem by supplying nutrients and oxygen to every corner of our body. In the brain, the blood vessels form a complex network that supplies the entire brain volume, supplying nutrients and oxygen to each and every cell.

Now, while every cell requires nutrients and oxygen to fuel it, every cell also produces waste products. The clearance of that waste is the second basic problem that each organ has had to solve. The solution is the body's lymphatic system which is a second parallel network of vessels that extends throughout the body. It collects waste products from the spaces between the cells and transports these through the lymph channels, lymph nodes and finally into the blood stream so they can be disposed of.

The lymph system efficiently drains the waste of the entire body, except for the brain, where there are no lymph channels. The brain is an intensely active organ that produces a correspondingly large amount of waste that must be cleared. And yet, it lacks any lymphatic vessels.

The brain and the spinal canal solves its waste clearance problem by being surrounded by a large pool of clean, clear fluid called cerebrospinal fluid or CSF. The

CSF fills the space that surrounds the brain and the spinal cord. Waste products from the brain's cell metabolism make their way out to the CSF and into the blood stream. There is a specialized network of plumbing that organizes and facilitates this process. The CSF is pumped into and through the brain traveling along the outsides of the blood vessels. It bathes and flushes the waste from the spaces between the brain's cells. What's amazing is that no other organ takes this approach to clearing away the waste from between its cells. This waste clearance system is entirely unique to the brain.

What is amazing about this waste clearance process with the CSF washing through the brain, only occurs while the brain is asleep. Neuroscientists have discovered that at the same time when the brain goes to sleep, the brain cells themselves seem to shrink, opening up spaces in between them, allowing the CSF fluid to flow the entire and clear out the waste.

There is a particular type of waste that the brain needs to be clearing during sleep in order to stay healthy. The waste product that recent studies have focused on is amyloid-beta, which is a protein that's made in the brain all the time. This is important because in patients with Alzheimer's disease, amyloid-beta builds up and aggregates in the spaces between the brain's cells, instead of being cleared away. Research studies have measured how fast amyloid-beta is cleared from the brain when it's awake versus when it's asleep. Conclusion: the clearance of amyloid-beta is much more rapid from the sleeping brain.

So, if sleep, then, is part of the brain's solution to the problem of waste clearance, then this may dramatically change how we think about the relationship between sleep, amyloid-beta, and Alzheimer's disease. A series of recent clinical studies suggest that among patients who haven't yet developed Alzheimer's disease, worsening sleep quality and sleep duration are associated with a greater amount of amyloid-beta building up in the brain, and while it's important to point out that these studies don't prove that lack of sleep or poor sleep cause Alzheimer's disease, they do suggest that the failure of the brain to keep its house clean by clearing away waste like amyloid-beta may contribute to the development of conditions like Alzheimer's.

What this new research tells us about the importance of sleep is that it is a necessary state in order to refresh, clean and clear the mind. While we sleep every single night, our brains never rest. While our body is still and our mind is dreaming, the elegant machinery of the brain is quietly hard at work cleaning and maintaining this unimaginably complex machine. Like housework, if you stop cleaning your kitchen for a month, your home will become completely unlivable. When it comes to cleaning the brain, it is the very health and function of the mind and the body that's at stake, which is why understanding these very basic housekeeping functions of the brain today may be critical for preventing and treating diseases of the mind tomorrow.

A comment about the what is called the “body clock”, which runs the natural rhythm of our brain and body. It turns out that it's incredibly important in our lives. It's drives cultural sleeping behaviors. As a species, humans evolved near the equator and are well-equipped to deal with 12 hours of daylight and 12 hours of darkness. As humans migrated to every corner of the globe as in the Artic, they encountered perpetual daylight in summer and 24 hours of darkness in winter. So, the culture, the northern aboriginal culture, traditionally has been highly seasonal. In winter, there's a lot of sleeping going family life is shared indoors. And in summer, it's almost manic hunting and working activity very long hours, very active.

So, what happens to our natural rhythms? What would our sleeping patterns be in an ideal sense? It turns out that when people are living without any sort of artificial light at all, they sleep twice every night. They go to bed around 8:00 p.m. and sleep until midnight and then they sleep again from about 2:00 a.m. until sunrise. And in-between, they have a couple of hours of sort of meditative quiet in bed. And what is fascinating is that during this time, there's a surge of prolactin, the likes of which a modern day never sees. The people in these studies report feeling so awake during the daytime, that they realize they're experiencing true wakefulness for the first time in their lives. Today we live in a culture of jet lag, global travel, 24-hour business, shift work and chronic stress. While our modern ways of doing things may have their advantages, we should understand the accumulated cost to our health and our brains from lack of sleep and chronic stress; the result of which may not be revealed until later in our life. We may not have any memory at all of what it once was to have a ‘clear and clean mind’.

Sleep tight.

Gordon C. Gunn, M.D.

Ref. Ted Talks