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Why Our Brains Require Sleep

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Sleep. It's something we should spend about one third of our lives doing. We all know that when you sleep, it clears your mind, and when you don't sleep, it leaves your mind a little murky. **Within the brain,** sleep enriches a diversity of functions, including our ability to learn, memorize and make logical decisions and choices. **Within the body,** sleep stimulates our immune system, retards inflammation, reforms the body's metabolic state (by fine-tuning the balance of insulin and circulating blood glucose). Sleep regulates our appetite, helping control body weight, and maintains a healthy microbiome within the gut, which also directly effects inflammation. Sleep is the single most effective thing we can do to reset our brain and body health each and every day.

In spite of knowing a great deal about sleep, we still haven't understood why it is that sleep, of all of our activities, has such an incredible restorative function for the mind. Recent research has revealed that sleep may actually be an elegant design solution for one of the brain's most basic needs – house cleaning.

The first problem that every organ must solve is having a continuous supply of macro-nutrients, micro-nutrients and oxygen to fuel the estimated **37 trillion cells** throughout the body. In the brain this is especially critical as it uses about **25% of the body's entire energy supply**, even though it accounts for only about **2%** of the body's total mass. The supply route for all these nutrients and oxygen is the **60 thousand miles of arteries** running throughout your body.

Now, while every cell uses these nutrients and oxygen for its fuel, every cell also produces **waste products**. The clearance (or removal) of that waste is performed by the body's *lymphatic system*, which is a second parallel network of drainage vessels that also extends throughout the body. Think: Housekeeping. It collects waste products from the spaces between the cells and transports this waste material 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 incredibly active organ (using 25% of the body's daily energy supply) and it produces a correspondingly large amount of waste that must be cleared. And yet, it lacks any lymphatic vessels to perform this task. The brain and the spinal canal are surrounded by a large pool of clean, clear fluid called *cerebrospinal fluid* or "*CSF*", which acts as a protective cushion.

New evidence has shown how the brain has evolved by developing a unique waste clearance system, (unrelated to the lymph waste clearance system in the rest of the body). There is a specialized network of drainage channels that facilitates this process. The CSF is literally pumped throughout the brain substance traveling along the outsides of the blood vessels. This CSF flow bathes and flushes the waste from the spaces between the brain's cells, called neurons. However, what is amazing about this waste clearance process is that it primarily occurs ONLY while the body is asleep. Neuroscientists have discovered that during sleep the brain synapses – the connections between neurons - shrink by nearly 20% , opening up spaces in between the cells and allowing the CSF fluid to flow and thereby cleanse the entire brain.

There is a particular type of waste that the brain needs to clear during sleep in order to stay healthy. The waste product that recent studies have focused on is called **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 during sleep.

So, if sleep, is a significant 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. 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 cognitive diseases of the mind tomorrow.

A comment about the what is called the “body clock” or *circadian rhythm*, 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 that evolved near the equator 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 Arctic, 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.

Today we live in a culture of jet lag, global travel, 24-hour business, shift work, resulting in 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 irreversible result of which may not be revealed until later in our lives. We may not have any memory at all of what it once was to have a 'clear and clean mind'.

Sleep tight.

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