The Benefit of Sleep for the Brain\*

AMAZING BREAKTHROUGH!

Scientists have discovered a revolutionary new treatment that makes you live longer. It enhances your memory and makes you more creative. It makes you look more attractive. It keeps you slim and lowers food cravings. It protects you from cancer and dementia. It wards off colds and the flu. It lowers your risk of heart attacks and stroke, not to mention diabetes. You even feel happier, less depressed, and less anxious. Are you interested?

While it may sound exaggerated, nothing about this fictitious advertisement would be inaccurate. If it were for a new drug, many people would be disbelieving. Those who were convinced would pay large sums of money for even the smallest dose. Should clinical trials back up the claims, share prices of the pharmaceutical company that invented the drug would skyrocket.

Of course, the ad is not describing some miracle new medicine or a wonder drug, but rather the proven benefits of a full night of sleep. The evidence supporting these claims has been documented in more than 17,000 well-scrutinized scientific reports to date. As for the prescription cost, well, there is not one. It is free. Yet all too often, we shun the nightly invitation to receive our full dose of this all-natural remedy with terrible consequences. Sleep is the universal health care provider: whatever the physical or mental ailment, sleep has a prescription it can dispense.

SLEEP FOR THE BRAIN

Sleep is not the absence of wakefulness. It is far more than that. Our nighttime sleep is an exquisitely complex, metabolically active, and deliberately ordered series of unique stages.

Numerous functions of the brain are restored by, and depend upon, sleep. No one type of sleep accomplishes all. Each stage of sleep-light, REM sleep, deep NREM sleep, and REM sleep-offer different brain benefits at different times of night. Thus, no one type of sleep is more essential than another. Losing out on any one of these types of sleep will cause brain impairment.

Of the many advantages conferred by sleep on the brain, that of memory is especially impressive, and particularly well understood. Sleep has proven itself time and again as a memory aid: both before

learning, to prepare your brain for initially making new memories, and after learning, to cement those memories and prevent forgetting.

SLEEP THE NIGHT BEFORE LEARNING

Sleep before learning refreshes our ability to initially make new memories. It does so each and every night. While we are awake, the brain is constantly acquiring and absorbing novel information (intentionally or otherwise). Passing memory opportunities are captured by specific parts of the brain. For fact-based information, or what most of us think of as textbook-type learning, such as memorizing someone’s name, a new phone number, or where you parked your car, a region of the brain called the hippocampus helps apprehend these passing experiences and binds their details together. A long, finger-shaped structure tucked deep on either side of your brain, the hippocampus offers a short-term reservoir, or temporary information store, for accumulating new memories. Unfortunately, the hippocampus has a limited storage capacity, almost like a camera roll or, to use a more modern-day analogy, a USB memory stick. Exceed its capacity and you run the risk of not being able to add more information or, equally bad, overwriting one memory with another: a mishap called interference forgetting.

How, then, does the brain deal with this memory capacity challenge? Some years ago, my research team wondered if sleep helped solve this storage problem by way of a file-transfer mechanism. We examined whether sleep shifted recently acquired memories to a more permanent, long-term storage location in the brain, thereby freeing up our short-term memory stores so that we awake with a refreshed ability for new learning.

We began testing this theory using daytime naps. We recruited a group of healthy young adults and randomly divided them into a nap group and a no nap group. At noon, all the participants underwent a rigorous session of learning (one hundred face-name pairs) intended to tax the hippocampus, their short-term memory storage site. As expected, both groups performed at comparable levels. Soon after, the nap group took a ninety-minute siesta in the sleep laboratory with electrodes placed on their heads to measure sleep. The no-nap group stayed awake in the laboratory and performed menial activities, such as browsing the Internet or playing board games. Later that day, at six p.m., all participants performed another round of intensive learning where they tried to cram yet another set of new facts into their short-term storage reservoirs (another one hundred face-name pairs). Our question was simple: Does the learning capacity of the human brain decline with continued time awake across the day and. if so, can sleep reverse this saturation effect and thus restore learning ability?

Those who were awake throughout the day became progressively worse at learning, even though their ability to concentrate remained stable (determined by separate attention and response time tests). In contrast, those who napped did markedly better, and actually improved in their capacity to memorize facts. The difference between the two groups at six p.m. was not small: a 20 percent learning advantage for those who slept.

Having observed that sleep restores the brain’s capacity for learning, making room for new memories, we went in search of exactly what it was about sleep that transacted the restoration benefit. Analyzing the electrical brainwaves of those in the nap group brought our answer. The memory refreshment was related to lighter, stage 2 NREM sleep, and specifically the short, powerful bursts of electrical activity called sleep spindles. The more sleep spindles an individual obtained during the nap, the greater the restoration of their learning when they woke up.

Perhaps more remarkable, as we analyzed the sleep-spindle bursts of activity, we observed a strikingly reliable loop of electrical current pulsing throughout the brain that repeated every 100 to 200 milliseconds. The pulses kept weaving a path back and forth between the hippocampus, with its short-term, limited storage space and the far larger, long-term storage site of the cortex (analogous to a large- memory hard drive). In that moment, we had just become privy to an electrical transaction occurring in the quiet secrecy of sleep, one that was shifting fact-based memories from the temporary storage depot (the hippocampus) to a long-term secure vault (the cortex). In doing so, sleep had delightfully cleared out the hippocampus, replenishing this short-term information repository with plentiful free space. Participants awoke with a refreshed capacity to absorb new information within the hippocampus, having relocated yesterday’s imprinted experiences to a more permanent safe hold. The learning of new facts could begin again, anew, the following day.

We and other research groups have since repeated this study across a full night of sleep and replicated the same finding: the more sleep spindles an individual has at night, the greater the restoration of over- night learning ability come the next morning.

\* Adapted from: Walker, M. (2017). *Why we sleep: Unlocking the power of sleep and dreams*. (Chapter 6). New York, NY: Scribner.