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As we sleep, speedy brain waves boost our ability to learn

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(PhysOrg.com)—Scientists have long puzzled over the many hours we spend in light, dreamless slumber. But a new study from the University of California, Berkeley, suggests we're busy recharging our brain's learning capacity during this traditionally undervalued phase of sleep, which can take up half the night.

UC Berkeley researchers have found compelling evidence that bursts of brain waves known as "sleep spindles" may be networking between key regions of the brain to clear a path to learning. These electrical impulses help to shift fact-based memories from the brain's hippocampus—which has limited storage space—to the prefrontal cortex's "hard drive," thus freeing up the hippocampus to take in fresh data. Spindles are fast pulses

of electricity generated during non-REM sleep, and they can occur up to 1,000 times a night.

"All these pieces of the puzzle tell a consistent and compelling story—that sleep spindles predict learning refreshment," said Matthew Walker, associate professor of psychology and neuroscience at UC Berkeley and senior author of the study to be published March 8 in the journal *Current Biology*.

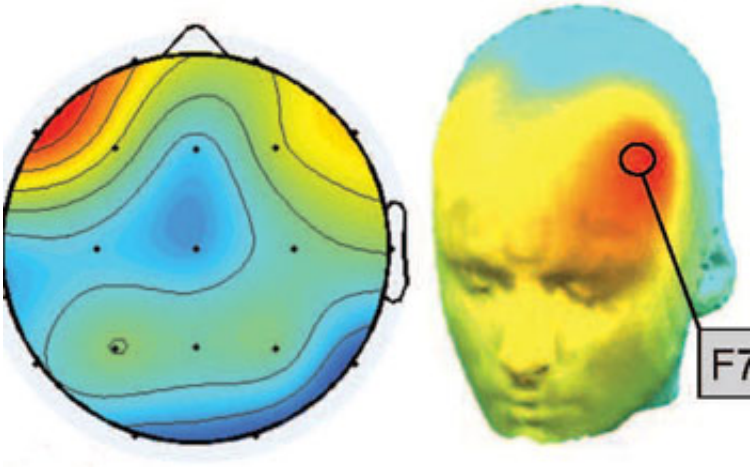
The study found that this spindle-driven networking was most likely to happen during Stage 2 of non-Rapid Eye Movement (NREM) sleep, which occurs before we reach the deepest NREM sleep and the dream state known as Rapid Eye Movement (REM) sleep. This shallow stage of dreamless slumber can account for half our sleeping hours, and happens most frequently during the second half of the night, or in the latter part of a period in which we sleep.

"A lot of that spindle-rich sleep is occurring the second half of the night, so if you sleep six hours or less, you are shortchanging yourself. You will have fewer spindles, and you might not be able to learn as much," said Bryce Mander, a post-doctoral fellow in psychology at UC Berkeley and lead author of the study.

As for broader societal ramifications, researchers said evidence that brain waves during the latter part of the sleep period promote our capacity to store fact-based memories raises the question of whether the early school day is optimal for learning.

"These findings further highlight the importance of sleep in our educational populations, where the need for learning is great, yet late bedtimes and early school start times prevent adequate sleep amounts," Mander said.

On average, adults spend one-third of their lives sleeping. Yet, no scientific consensus has been reached on why humans need sleep, Walker said. Previous research led by Walker has shown that a good night's rest helps us regulate our moods and cope with emotional challenges, while sleep deprivation can make otherwise reasonable people emotionally shaky, indicating a strong correlation between sleep loss and psychiatric disorders.



Sleep spindles over left frontal lobe indicate refreshed learning capacity

For this latest study, Walker and his team took 44 healthy young adults and subjected them to a rigorous memorizing task intended to tax the hippocampus. All participants performed at similar levels. The group was then divided, with one half taking a 90-minute nap while the other half stayed awake.

That evening, the entire group was subjected to another round of learning. The ability to memorize new information deteriorated for those who had remained awake throughout the day. In contrast, those who had napped not only performed better than the waking group, but actually improved their capability for learning, as if sleep had refreshed their

memory capacity, the study found.

Electroencephalogram tests, which measured electrical activity in the brains of the nappers, showed that the more sleep spindles the nappers produced, the more refreshed they were for learning. Furthermore, researchers were able to link sleep spindles to brain activity looping between the lobes of the brain that house the hippocampus and prefrontal cortex—two critical areas for memory.

"Our findings demonstrate that sleep may selectively seek out and operate on our memory systems to restore their critical functions," Walker said.

"This discovery indicates that we not only need sleep after learning to consolidate what we've memorized, but that we also need it before learning, so that we can recharge and soak up new information the next day."

Provided by University of California - Berkeley

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