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# Power up your memory bank

Zapping people's brains with an electric current while they sleep might not sound such a good idea. But by boosting natural brain waves it can improve memory, as new work shows. This approach might one day help us learn better or provide new treatments for sleep disorders.

One of the functions of sleep is generally agreed to be the consolidation of memories: certain tasks learned before a snooze are remembered better than if no nap follows. Now Jan Born and his colleagues at the University of Lübeck in Germany think they know why.

One theory holds that levels of brain chemicals, or neuromodulators, are what affects memory during sleep. But Born wanted to test a competing idea — that waves, or oscillations, of electrical activity are responsible. To pinpoint which part of sleep contributes to strengthening memory, the team used a weak electrical current to boost brain activity during deep sleep.

Oscillations in electrical activity occur naturally, at different frequencies, during different sleep phases throughout the night. Oscillations are fastest during rapid eye movement (REM) sleep, and slowest in phases of deep sleep. Boosting the slow waves seems to be the key to boosting memory, says Born.

"By inducing such slow oscillations, we can say for the first time that slow oscillations are the cause" of memory enhancement during sleep, he says. The findings are published online in *Nature* this week (L. Marshall *et al. Nature* doi:10.1038/nature05278; 2006; News and Views doi:10.1038/nature05309; 2006).

Some previous studies have suggested a correlation between slow oscillations and memory enhancement. If people learn a task before sleeping, their brains show more slow-wave activity when they are asleep. But other researchers have failed to establish a link, leading some to believe that the waves are functionless by-products of the sleeping brain.

Born and his colleagues had 13 medical students memorize 46 pairs of words before going to sleep. Four electrodes were then strapped to each volunteer's scalp and, once the students were in a phase of slow-wave sleep, the researchers induced a weak electrical current for five periods of five minutes each. The students were allowed to sleep undisturbed until morning, when they were retested on the same word task.

A control group that did not receive brain stimulation remembered on average 37.4 words before they went to sleep and 39.5 when they woke up. The test group remembered an average of 36.5 words before sleeping, but recalled 41.2 after the treatment. Born says this improvement is remarkable, because medical students are presumably already skilled at remembering facts. What's more, there was no memory enhancement when the researchers tried to mimic the faster-oscillating brain waves in other phases of sleep, or when they applied the stimulation at the end of the night, rather than the beginning.

Sleep on it: taking a nap might help you remember what you've learnt.

"Memory gets better when artificial electrical stimulants help boost the natural brain waves."

The treatment didn't work for all tasks, however. Slowly oscillating waves seem to improve recall of words and facts, but the volunteers were no better at remembering a finger-tapping task. Born suspects that this type of memory is consolidated during REM sleep.

So how does it work? The team suggests that the slow oscillations help the brain replay newly formed memories during sleep, by triggering intracellular signals in nerve cells that strengthen the connections between them. That could explain, Born says, why memory gets better when artificial electrical stimulants help boost the natural brain waves.

But don't expect a do-it-yourself memory-enhancement kit to appear on the market overnight. It's easy to imagine, says Born, how overnight stimulation might come in handy for cramming for exams or memorizing that big presentation. But the team did not test the volunteers later, to see if the effect persists, and do not know if there are any long-term side effects to the treatment.

"I don't think one can do it at home," says Derk-Jan Dijk, a sleep expert at the University of Surrey's Sleep Research Centre in Guildford, UK. "We still need to find out what potential negative consequences could be if this stimulation is done for a longer period of time. Applying stimulation to the brain is something that for the time being we really would like to do in a controlled environment."

Similar electrically based approaches are sometimes used in psychiatry. Some patients with depression, for example, seem to benefit from a technique called transcranial magnetic stimulation, where an electromagnetic current is generated in the brain by an applied magnetic field.

Born thinks that his ideas too might be used in therapy some day. Perhaps, he suggests, doctors could boost the brain's natural waves to treat sleep disorders, depression or perhaps even the reduction in slow-wave sleep that comes with ageing. But he recognizes these applications are far in the future: "It's just a dream," he says. ■

**Kerri Smith**