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Sound waves boost older adult' memory, deep sleep

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Gentle sound stimulation—such as the rush of a waterfall—synchronized to the rhythm of brain waves significantly enhanced deep sleep in older adults and improved their ability to recall words, reports a new Northwestern Medicine study.

Deep sleep is critical for memory consolidation. But beginning in middle age, deep sleep decreases substantially, which scientists believe contributes to memory loss in aging.

The sound stimulation significantly enhanced deep sleep in participants and their scores on a memory test.

"This is an innovative, simple and safe non-medication approach that may help improve brain health," said senior author Dr. Phyllis Zee, professor of neurology at Northwestern University Feinberg School of Medicine and a Northwestern Medicine sleep specialist. "This is a potential tool for enhancing memory in older populations and attenuating normal age-related memory decline."

The study will be published March 8 in *Frontiers in Human Neuroscience*.

In the study, 13 participants 60 and older received one night of acoustic stimulation and one night of sham stimulation. The sham stimulation procedure was identical to the acoustic one, but participants did not hear any noise during sleep. For both the sham and acoustic stimulation

sessions, the individuals took a memory test at night and again the next morning. Recall ability after the sham stimulation generally improved on the morning test by a few percent. However, the average improvement was three times larger after pink-noise stimulation.

The older adults were recruited from the Cognitive Neurology and Alzheimer's Disease Center at Northwestern.

The degree of slow wave sleep enhancement was related to the degree of memory improvement, suggesting slow wave sleep remains important for memory, even in old age.

Although the Northwestern scientists have not yet studied the effect of repeated nights of stimulation, this method could be a viable intervention for longer-term use in the home, Zee said.

Previous research showed acoustic simulation played during deep sleep could improve memory consolidation in young people. But it has not been tested in older adults.

The new study targeted older individuals—who have much more to gain memory-wise from enhanced deep sleep—and used a novel sound system that increased the effectiveness of the sound stimulation in older populations.

The study used a new approach, which reads an individual's brain waves in real time and locks in the gentle sound stimulation during a precise moment of neuron communication during deep sleep, which varies for each person.

During deep sleep, each brain wave or oscillation slows to about one per second compared to 10 oscillations per second during wakefulness.

Giovanni Santostasi, a study coauthor, developed an algorithm that delivers the sound during the rising portion of slow wave oscillations. This stimulation enhances synchronization of the neurons' activity.

After the sound stimulation, the older participants' slow waves increased during sleep.

Larger studies are needed to confirm the efficacy of this method and then "the idea is to be able to offer this for people to use at home," said first author Nelly Papalambros, a Ph.D. student in neuroscience working in Zee's lab. "We want to move this to long-term, at-home studies."

Northwestern scientists, under the direction of Dr. Roneil Malkani, assistant professor of neurology at Feinberg and a Northwestern Medicine sleep specialist, are currently testing the acoustic stimulation in overnight sleep studies in patients with memory complaints. The goal is to determine whether acoustic stimulation can enhance memory in adults with mild cognitive impairment.

Previous studies conducted in individuals with mild cognitive impairment in collaboration with Ken Paller, professor of psychology at the Weinberg College of Arts and Sciences at Northwestern, have demonstrated a possible link between their sleep and their memory impairments.

Provided by Northwestern University

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