New technique uses sound to influence brain waves and sleep in dementia

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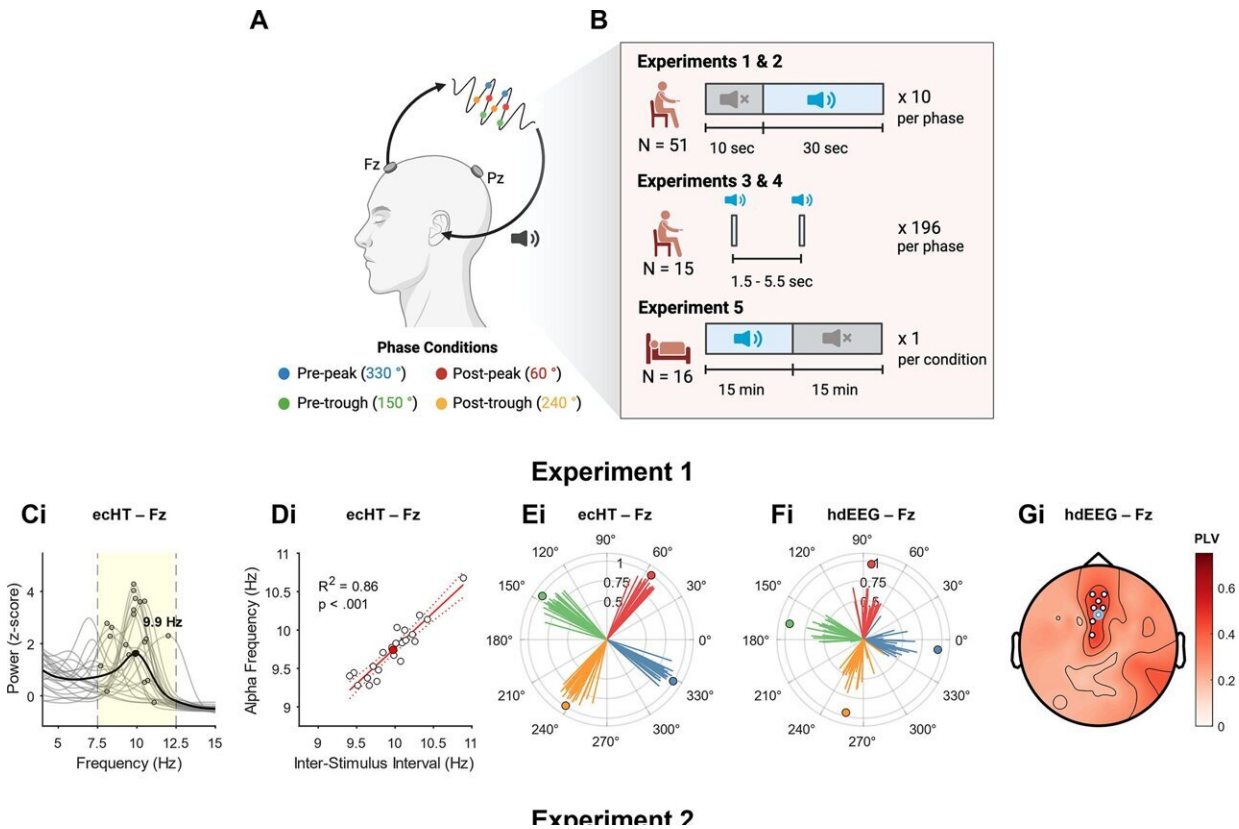

Experimental design and phase-locking validation. Credit: *PLOS Biology* (2024). DOI: 10.1371/journal.pbio.3002651

Using sound to stimulate certain brain waves has the potential to help those with dementia or cognitive decline sleep better, reveals a new

study. Sleep disturbances are a common feature in dementia and may affect up to half of people living with the condition.

During the study, the research team from the University of Surrey and the UK Dementia Research Institute Centre for Care Research & Technology at Imperial College London, used sound stimulation to target alpha rhythms, a type of brainwave, at precise timings of the wave to investigate how the brain responds.

This study is published in the journal *PLOS Biology*.

Alpha rhythms have been associated with memory and perception, and changes to the rhythms have been observed in those experiencing cognitive decline and dementia.

Senior author Dr. Ines Violante, Senior Lecturer in Psychological Neuroscience at the University of Surrey, explained, "Alpha oscillations are a defining characteristic of our brain's electrical activity, but we still do not fully understand their role in shaping fundamental brain functions.

"Using sound is a powerful, non-invasive approach to stimulate certain oscillations within the brain. It is important that we find ways of manipulating these oscillations to create tools for treatment applications, as we know that brain oscillations are slower in diseases, such as Alzheimer's disease."

In a series of experiments, researchers used an innovative brain modulation technique known as Alpha Closed-Loop Auditory Stimulation (aCLAS), in which sounds are timed to the precise phase of alpha rhythms. To monitor the effect of stimulation, measurements of electrical activity from the brain were continuously read in real-time, and when a brain wave reached a particular phase, a sound (a burst of

pink noise) was played on the participant.

Researchers observed that depending on the phase at which the sound was played, the alpha rhythm became faster or slower. The effect was also dependent on where the alpha oscillations were coming from in the brain.

Dr. Henry Hebron, a former doctoral student at the University of Surrey and first author of the publication, noted, "What we have found is that alpha oscillations can be manipulated via sound when we address this rhythm on its own terms, using a closed-loop approach. Surprisingly, when we performed our aCLAS experiment as participants were falling asleep, we observed that sounds at a particular phase prevented them from reaching deeper stages of sleep (without waking them), while the same sounds at a different phase were not disruptive.

"There is a lot more to be explored regarding neural oscillations-dependent behaviors, and we believe closed-loop approaches, such as the one we implemented here, could be key."

According to researchers, now they have shown they are able to influence alpha waves with sound, the next steps will be to explore whether they can modify the waves in such a way that enhances cognition and sleep, which could ultimately benefit dementia patients.

Professor Derk-Jan Dijk, Director of the Surrey Sleep Research Centre and Group Leader at the UK Dementia Research Institute Centre for Care Research & Technology Centre, said, "There is much to be uncovered about the role of the alpha rhythm in sleep and cognition. This technique could be influential in pushing our understanding and improving sleep functions in those with dementia. We are now investigating the effects of this closed-loop auditory stimulation approach in REM sleep, where alpha rhythms are present but their role

still unknown."

More information: A closed-loop auditory stimulation approach selectively modulates alpha oscillations and sleep onset dynamics in humans, *PLoS Biology* (2024). DOI: 10.1371/journal.pbio.3002651

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