Ultrasound technology can be used to boost mindfulness, study finds

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Acoustic intensity measurements. (A) Skull attenuation and geometric deformation of acoustic temporal peak pressure recorded in water and through a sample of cadaver parietal bone (“skull”). Center of the beam and FWHM are displayed. Lateral shift displayed in (A) and axial shift in (C). The periodic variation in peak intensity in the axial plane in panel C is thought to be due to standing waves created by the annular geometry of the transducer. (B) Skull-attenuated ultrasound intensity map is overlaid on a single subject’s MRI. Estimation of peak focus was determined using recorded neuronavigation coordinates from that subject’s TFUS session. (D) Spatial distribution of
One of the intriguing abilities of the human mind is daydreaming, where the mind wanders off into spontaneous thoughts, fantasies and scenarios, often without conscious effort, allowing creativity and reflection to flow freely.

In a new study published in *Frontiers in Human Neuroscience*, University of Arizona researchers used low-intensity ultrasound technology to noninvasively alter a brain region associated with activities such as daydreaming, recalling memories and envisioning the future. They found that the technique can ultimately enhance mindfulness, marking a major advancement in the field of neuroscience.

The researchers used low-intensity ultrasound technology called transcranial-focused ultrasound (TFUS) to alter the default mode network of the brain, a system of connected brain areas that are especially active during activities like daydreaming.

"We are the first to show that the default mode network can be directly targeted and noninvasively modulated," said lead study author Brian Lord, a postdoctoral researcher in the U of A Department of Psychology.

One area of the default mode network, the posterior cingulate cortex, has been implicated as a major player in how the mind grasps onto experiences, said Lord, who is part of the Science Enhanced
Mindfulness (SEMA) Lab, at the university's Center for Consciousness Studies. The default mode network is active when people engage in introspection or let their minds wander, perhaps embedding themselves in a story, recalling past memories or planning future scenarios.

"This is how we form narratives about ourselves," Lord said.

While this narrative-making is natural and important to get a coherent sense of oneself, it can also impede people from being present in the moment, Lord said. For instance, when someone is trying to meditate, it could lead to rumination and negative thinking.

To enhance mindfulness and help people engage more with the current moment, Lord's team used TFUS, a tool that can stimulate specific areas of the brain noninvasively with millimeter precision.

Unlike other noninvasive brain stimulation methods, such as transcranial electrical stimulation and transcranial magnetic stimulation, TFUS can penetrate below the cortex, the outermost layer of the brain. Just five minutes of stimulation can induce meaningful effects.

The experiment involved 30 participants who received TFUS to the posterior cingulate cortex of the default mode network of the brain. Researchers used functional magnetic resonance imaging, or fMRI, to observe changes in brain activity. Participants were asked to report their feelings and experiences before and after the TFUS treatment.

The study found that TFUS reduced the brain's connectivity within the default mode network and affected participants' mindfulness and subjective experiences, such as their sense of self and perception of time.

"The best part is you are using a minimal amount of energy to alter brain
activity. You are just giving a gentle push to the brain with low-intensity ultrasound," Lord said.

The ability to target and alter brain networks opens the possibility of using TFUS for precision therapeutics, which are medical treatments tailored specifically to an individual's unique characteristics, such as their genetic makeup, lifestyle and environment. TFUS could also potentially be used to treat mood disorders like depression and anxiety, a possibility other research groups are now exploring, Lord said.

"Unlike neuroimaging techniques where you can only make correlations with brain activity, noninvasive stimulation tools like TFUS allow you to probe the brain and develop causal models," Lord said. "That's a really powerful thing for the whole field of neuroscience."


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Provided by University of Arizona