Q&A: Researchers explore the use of ultrasound to achieve mindfulness

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Mindfulness is the ability to be fully aware in the moment—conscious of one's thoughts and actions. While mindfulness can be trained through activities like meditating, slow breathing and strolling, researchers in the

Center of Consciousness Studies at the University of Arizona is working on developing a new approach to achieving mindfulness.

A team led by research assistant professor Jay Sanguinetti is experimenting with ultrasound technology to modulate brain activity and enhance mindfulness. Sanguinetti's team at the Science Enhanced Mindfulness Lab, or SEMA Lab, is specifically focused on accelerating mindfulness during meditation.

Sanguinetti's team uses low-intensity ultrasound, an emerging tool to target specific parts of the brain responsible for enhancing meditation skills. The researchers apply ultrasound to study participants engaged in meditation.

Research at the SEMA Lab is still in its early stages. The lab is part of the Center for Consciousness Studies in the College of Social and Behavioral Sciences, which recently launched a new minor in consciousness studies that integrates principles of basic science with humanistic and social scientific disciplines.

Sanguinetti and Brian Lord, a graduate student in the SEMA Lab, spoke with University of Arizona News about the motivation behind the launch of the SEMA Lab, the lab's vision, and their current and upcoming projects.

Q: What motivated you to start the SEMA Lab?

Sanguinetti: I co-founded the lab with Shinzen Young after completing my post-doc in Albuquerque back in 2017. The basic idea that both Shinzen and I were thinking about independently is: Can you use neurotechnology to help people get the benefits from meditation? Shinzen was actually asking, "Could you use brain stimulation?"

I was working on a project with the Department of Defense where I was trying to combine brain stimulation with meditation training for support personnel, like doctors and nurses. The idea was, if they learn how to meditate, they would be better able to support the needs of the soldiers who have all kinds of emotional and psychological needs that arise from being on the battlefield.

Shinzen was not opposed to that project with the Department of Defense, and we just started doing the project. Basically, we were trying to combine what's called focused ultrasound with meditation. In the beginning, we tried it on me and Shinzen and one of the other lab members, which is usually how you start. We all sort of felt like it boosted our meditation practice. We expanded the project every year, and in 2019 we decided to move to Tucson together and started the SEMA Lab.

Q: Brian, what interested you in the lab?

Lord: I joined the SEMA Lab in 2020. I came to the University of Arizona because I was interested in consciousness science. And this is one of the best places in the world for that, because it hosts the Science of Consciousness Conference. I didn't know about focused ultrasound until I met Jay, and I was immediately impressed by the technology. It is a uniquely powerful form of brain stimulation; it can do things that nothing else can, like target sub-cortical regions of the brain with more precision and accuracy than other noninvasive neuromodulation devices.

Q: Why did you want to focus this research on people who meditate?

Sanguinetti: I've been meditating for a long time, personally, and experience a lot of the benefits myself. But I never thought I would study

it academically or scientifically. I started following climate science and what is happening to the planet and the ecosystem. I started thinking, "How can I make an impact on these big problems that I think are coming for humanity?" At that time, I was studying visual science and working on problems that would ultimately help machines see better, so machine vision. That became misaligned with my worry about what's going to happen with climate change and how people adapt to it. So, I pivoted my whole career in 2017 to mindfulness science, or what's called contemplative science.

Q: What happens when you apply ultrasound to meditating people's brains?

Sanguinetti: It really depends on where you target in the brain. If we do a modulation of a part of the right prefrontal cortex, people feel happier. But if you move it to a different brain region, you'll get a different effect. In meditation studies, we're actually targeting a part of the brain called the default mode network. When you target that area, people don't really report being happier; their mood and emotions don't change too much. It's more of a meditation-like effect where they feel like they can get deeper into the meditation state.

It's like a beam of acoustic energy. It's almost like a bullet shape or a pencil shape, so you can target anywhere in the brain, and you've got this cone of energy that goes into that spot.

Q: Not all of your study participants have prior experience with meditation. What do you observe in those participants?

Lord: Experienced meditators, almost universally, will feel the ultrasound. They'll feel the effects of it, they'll enjoy it, and it'll enhance

their meditation consistently. But for people that are novices at meditation, they're not as introspective. They're not as familiar with that kind of stuff. A substantial portion of them don't report anything. But others would start to say things like, "I felt less attached to my thoughts." In the meditation world, this kind of thing is called equanimity. You are giving the brain kind of a gentle nudge; it's not overly forcing the brain to do anything. With experienced meditators, they are able to use that nudge and go right into a deep meditation. But if you do it to someone who doesn't have much experience with meditative states, it can be a bit harder for them to drop into it, because their brain doesn't know how to do that yet.

Because this focused ultrasound tool is so new, I've been focusing on a lot of the basic psychophysiology of it—looking at the EEG effects, looking at the MRI effects, trying to characterize exactly how this tool works. I have the benefit of getting to do some of that foundational work. It's a really exciting place to be as a researcher.

Q: What are your goals for the future?

Sanguinetti: If you say that the outcome is understanding whether you can facilitate meditation training with ultrasound, we're still in the early stages of testing that. We've just finished a study that we started in 2020, that Brian's about to publish, where we targeted the default mode network in the brain. But this was on people not meditating. We did the first step, which is, "Can we modulate the meditation network?" The next step is seeing if we can combine that protocol with meditation training.

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