

Mindfulness and meditation: Inward attention as a tool for mental health

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From a young age, people learn the importance of paying attention to the environment around them. Less emphasized is the value of paying attention to their inner environment. Neuroscientists are increasingly

studying how looking inward via mindfulness training can affect everything from depression and memory to stress levels and aging.

As researchers work to uncover the [neural mechanisms](#) underlying these [brain changes](#), they hope to elucidate [best practices](#) for people who want to incorporate mindfulness in their lives.

"Attentional training is a mechanism by which you can train your brain," says Erika Nyhus of Bowdoin College, who is chairing a session with new research on mindfulness at the annual meeting of the Cognitive Neuroscience Society (CNS) in Toronto. "Work to understand the neural mechanisms at play in this [mindfulness training](#) show potential pathways toward enhanced cognition but there are no short-cuts. It takes practice."

The cognitive neuroscientists presenting their latest findings at [CNS 2024](#) are excited about the potential benefits of mindfulness training not only to individuals but also to researchers exploring the roots of cognition in the brain. Together, their research suggests that [individual differences](#) in sensory and cognitive processing in our brains can both predict mental health and be amenable to training through new technological applications.

Tapping into inward senses

Tuning into interoception, how someone senses their body's internal state, is an important component of mindfulness training that could aid in managing mood disorders such as depression.

"Interoception matters in depression because our emotions are made up of both visceral body sensations and our cognitive appraisals of these sensations that help us make sense of those feelings and put them into context," says Norman Farb of the University of Toronto Mississauga. "For example, a fluttering in our belly could be judged as excitement or

anxiety depending on our context and appraisal habits."

Farb and his colleagues are working to disentangle how the brain processes these interoceptive signals. They are finding that training that focuses on internally paying [attention](#) is sufficient to pull resources away from "deeply entrenched appraisal habits, empowering the integration of novel sensation and feelings, which can help a person become 'unstuck' in how they relate to themselves and the world around them," he says.

In a large neuroimaging [study](#) of vulnerability to depression relapse, published in *NeuroImage Clinical*, Farb and colleagues found that one of the biggest indicators of past, present, and future depression was how much individuals inhibited sensory and motor processing.

Those who maintained rather than inhibited this processing relapsed into depression at much lower rates, despite having a history of depression that indicated a high relapse risk. "This result contrasts other neural indicators of depression as being driven by too much activity in regions supporting judgment and appraisal," Farb says, "And it points to the importance of maintaining sensation in times of stress as a sign of mental resilience."

In another set of studies [published in ENeuro](#), Farb and colleagues looked specifically at attention to the breath, a central practice in mindfulness training. They found that while attention to external senses such as vision activates the corresponding visual cortex, attention to the breath tends to deactivate the cerebral cortex, including regions where appraisal and cognitive control occurs.

"This suggests that mindfulness exercises may first help people to use their attention to stop doing so much with their brains, providing relief from rumination and judgment," Farb says.

"It also has a fascinating implication for how interoception differs from the external senses: interoceptive processing may be continuously represented in the brain to regulate biological processes such as the breath or heartbeat. To detect it, we just need to quiet down."

As Farb's team's research continues to understand how paying attention to the breath changes brain processes, they are also excited to begin applying what they have learned in technology-driven applications. They hope to create "microinterventions," such as daily self reflections that will enable individuals to tune into interoception to help manage emotions.

"There's a lot more work to be done to make mindfulness communicable, relevant, and useful to the current generation of humans on the planet," he says.

Harnessing the power of technology

For the past decade, David Ziegler has been working on a digital meditation-inspired game rooted in the fundamental concept of internal attention. His team at Neuroscape at the University of California, San Francisco, has completed [clinical trials](#) and testing of the game with several groups in an effort to bring the practice of meditation to anyone, anywhere.

"Even though not everyone will resonate with the practice, they should at least have the opportunity to engage with it in an effective way and judge for themselves if they think they would benefit from it," he says.

Their mediation app, MediTrain, is rooted in basic research in neuroplasticity and specifically how the brain can compensate for deficits in attentional control.

At CNS 2024, Ziegler is presenting data from recently published papers that used the app in [young adults](#), aging adults, and adolescents with childhood neglect, as well as a new study in healthy older adults. In all the work, the researchers found attention benefits from the digital training, and in the newest study they found that the training also led to a decrease in stress reactivity and a lengthening of telomeres (a blood biomarker of cellular aging).

The app uses an adaptive algorithm that makes the sessions more difficult if an individual is doing well or easier if they are struggling. "It's a personalized experience for every individual at every point in their training," Ziegler explains.

In one of the [studies](#) published in *Nature Human Behaviour*, the researchers recruited healthy young adults to participate in six weeks of meditation training via the app.

They found gains in both sustained attention and working memory in this group, which has proven difficult for researchers in the past. These improvements were associated with positive changes in key neural signatures of attentional control. Thus by focusing their attention inward, young adults were able to improve their outward attention.

The biggest challenges in this work, Ziegler says, is determining who responds to meditation and how much of a "dose" someone needs to reap the benefit. "I truly believe that technology is key to answering those questions," he says.

"One of our biggest upcoming studies is a nationwide dose-response study of MediTrain in thousands of older adults across the country that can really only be done with a fully mobile, digital form of meditation."

The researchers participating in the CNS 2024 symposium on

mindfulness and meditation are eager to see the potential benefits of these practices extend to broad populations. Nyhus, Farb, and Ziegler not only all study mindfulness and meditation but they are also practitioners, though they may have started with some hesitance or skepticism.

"As a scientist, I am always skeptical, wondering is it really worth all this hype?" says Nyhus, whose work in this space was inspired by an 8-week course she took in Mindfulness Based Stress Reduction. She will be [presenting results from a study](#) that used principles from that course to study changes in episodic memory.

"You see mindfulness training everywhere and don't know if there is anything to it, but I was shocked to see the results we got in the lab." Nyhus hopes that by discovering the underlying mechanisms behind these results, she and others can leverage mindfulness training as a tool for cognitive enhancement.

More information: The symposium "[Neurocognitive Mechanisms of Mindfulness: Insights from Basic Research and Translational Science](#)" took place at 10amET on Monday, April 15, as part of the CNS 2024 annual meeting from April 13–16, 2024 in Toronto, Canada.

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