

BRAINSCAN

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INSIDE

McGovern scientists are developing and testing tools to help young people with the practice of mindfulness.

MINDFULNESS

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An equitable approach to mental health

Mental health is the defining public health crisis of our time, according to U.S. Surgeon General Vivek Murthy, and the nation's youth is at the center of this crisis. From 2010-2018, adolescent depression increased by 50%, suicides increased by 30%, and emergency room visits by parents of children who attempted suicide or had suicidal ideation increased an astounding 100 percent. The pandemic only intensified this crisis.

Mindfulness is now well-documented to effectively treat anxiety and depression in adults, and there is exciting new evidence that mindfulness training has mental well-being benefits for youth. The emotional benefits of mindfulness training also correspond to measurable changes in the brain. Scalable, equitable interventions like mindfulness hold great promise in reducing suffering and improving functional outcomes for our vulnerable youth.

SUSAN WHITFIELD-GABRIELI

*Professor of Psychology,
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ON THE COVER

Pranamasana, or prayer pose, is a yoga position that McGovern PhD student Sugandha Sharma uses to calm her body and mind.



Quieting the Mind

As researchers find mounting evidence that mindfulness benefits mental health, McGovern scientists develop and test tools to help young people with the practice.

Isaac Treves (center), a PhD student in the lab of John Gabrieli, is the lead author of two studies which found that mindfulness training may improve children's mental health. Treves and his co-authors Kimberly Wang (left) and Cindy Li (right) also practice mindfulness in their daily lives.



Psychiatrists and pediatricians have sounded an alarm. The mental health of youth in the United States is worsening. Youth visits to emergency departments related to depression, anxiety, and behavioral challenges have been on the rise for years. Suicide rates among young people have escalated, too. Researchers have tracked these trends for more than a decade, and the Covid-19 pandemic only exacerbated the situation.

“It’s all over the news, how shockingly common mental health difficulties are,” says [John Gabrieli](#), the Grover Hermann Professor of Health Sciences and Technology at MIT and an investigator at the McGovern Institute. “It’s worsening by every measure.”

Experts worry that our mental health systems are inadequate to meet the growing need. “This has gone from bad to catastrophic, from my perspective,” says [Susan Whitfeld-Gabrieli](#), a professor of psychology at Northeastern University and a research affiliate at the McGovern Institute. “We really need to come up with novel interventions that target the neural mechanisms that we believe potentiate depression and anxiety.”

TRAINING THE BRAIN

One approach may be to help young people learn to modulate some of the relevant brain circuitry themselves. Evidence is accumulating that practicing mindfulness—focusing awareness on the present, typically through meditation—can change patterns of brain activity associated with emotions and mental health. “There’s been a steady flow of moderate-size studies showing that when you help people gain mindfulness through training programs, you get all kinds of benefits in terms of people feeling less stress, less anxiety, fewer negative emotions, and sometimes more positive ones as well,” says Gabrieli, who is also a professor of brain and cognitive sciences at MIT. “Those are the things you wish for people.”

Researchers have even begun testing mindfulness-based interventions

head-to-head against standard treatments for psychiatric disorders. The results of recent studies involving hundreds of adults with anxiety disorders or depression are encouraging. “It’s just as good as the best medicines and the best behavioral treatments that we know a ton about,” Gabrieli says.

Much mindfulness research has focused on adults, but promising data about the benefits of mindfulness training for children and adolescents is emerging as well. In studies supported by the McGovern Institute’s [Poitras Center for Psychiatric Disorders Research](#) in 2019 and 2020, Gabrieli and Whitfeld-Gabrieli found that sixth-graders in a Boston middle school who participated in eight weeks of mindfulness training experienced reductions in feelings of stress and increases in sustained attention. More recently, Gabrieli and Whitfeld-Gabrieli’s teams have shown how new tools can support mindfulness training and make it accessible to more children and their families—from a smartphone app that can be used anywhere to real-time neurofeedback inside an MRI scanner.

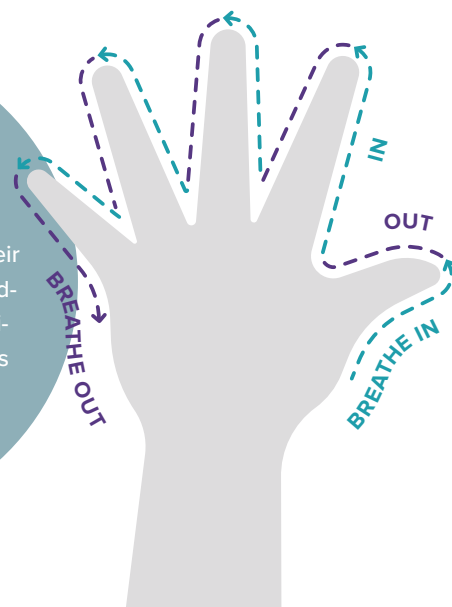
MINDFULNESS AND MENTAL HEALTH

Mindfulness is not just a practice, it is a trait—an open, non-judgmental way of attending to experiences that

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Breathe In, Breathe Out

Children enrolled in John Gabrieli’s mindfulness study learned to trace the outline of their fingers in rhythm with their in-and-out breathing pattern. This multi-sensory breathing technique has been shown to relieve anxiety and relax the body.





“If there were a medicine with as much evidence of its effectiveness as mindfulness, it would be flying off the shelves of every pharmacy.”

JOHN GABRIELI

Grover Hermann Professor of Health Sciences and Technology at MIT and McGovern Institute Investigator

some people exhibit more than others. By assessing individuals' mindfulness with questionnaires that ask about attention and awareness, researchers have found the trait associates with many measures of mental health. Gabrieli and his team measured mindfulness in children between the ages of eight and ten and found it was highest in those who were most emotionally resilient to the stress they experienced during the Covid-19 pandemic. As the team reported this year in the journal [PLOS One](#), children who were more mindful rated the impact of the pandemic on their own lives lower than other participants in the study. They also reported lower levels of stress, anxiety, and depression.

Mindfulness doesn't come naturally to everyone, but brains are malleable, and both children and adults can cultivate mindfulness with training and practice. In their [studies of middle schoolers](#), Gabrieli and Whitfeld-Gabrieli showed that the emotional effects of mindfulness training corresponded to measurable changes in the brain: Functional MRI scans revealed changes in regions involved in stress, negative feelings, and focused attention.

Whitfeld-Gabrieli says if mindfulness training makes kids more resilient, it could be a valuable tool for managing symptoms of anxiety and depression before they become severe. “I think it should be part of the standard school day,” she says. “I think we would have

a much happier, healthier society if we could be doing this from the ground up.”

Data from Gabrieli's lab suggests broadly implementing mindfulness training might even pay off in terms of academic achievement. His team found in a [2019 study](#) that middle school students who reported greater levels of mindfulness had, on average, better grades, better scores on standardized tests, fewer absences, and fewer school suspensions than their peers.

Some schools have begun making mindfulness programs available to their students. But those programs don't reach everyone, and their type and quality vary tremendously. Indeed, not every study of mindfulness training in schools has found the program to significantly benefit participants, which may be because not every approach to mindfulness training is equally effective.

“This is where I think the science matters,” Gabrieli says. “You have to find out what kinds of supports really work and you have to execute them reasonably.

A recent report from Gabrieli's lab offers encouraging news: mindfulness training doesn't have to be in-person. Gabrieli and his team found that children can benefit from practicing mindfulness at home with the help of an app.

When the pandemic closed schools in 2020, school-based mindfulness programs came to an abrupt halt. Soon thereafter, a group called Inner Explorer had developed a smartphone app that could teach children mindfulness at home. Gabrieli and his team were eager to find out if this easy-access tool could effectively support children's emotional well-being.

In October of this year, they reported in the journal [Mindfulness](#) that after 40 days of app use, children between the ages of eight and ten reported less stress than they had before beginning mindfulness training. Parents reported that their children were also experiencing fewer negative emotions, such as loneliness and fear.

The outcomes suggest a path toward making evidence-based mindfulness training for children broadly accessible. “Tons of people could do this,” says Gabrieli. “It's super scalable. It doesn't cost money; you don't have to go somewhere. We're very excited about that.”

VISUALIZING HEALTHY MINDS

Mindfulness training may be even more effective when practitioners can visualize what's happening in their brains. In Whitfeld-Gabrieli's lab, teenagers have had a chance to slide inside an MRI scanner and watch their brain activity shift in real time as they practiced mindfulness meditation. The visualization they see focuses on the brain's default mode network (DMN), which is most active when attention

is not focused on a particular task. Certain patterns of activity in the DMN have been linked to depression, anxiety, and other psychiatric conditions, and mindfulness training may help break these patterns.

Whitfeld-Gabrieli explains that when the mind is [free to wander](#), two hubs of the DMN become active. “Typically, that means we’re engaged in some kind of mental time travel,” she says. That might mean reminiscing about the past or planning for the future, but can be more distressing when it turns into obsessive rumination or worry. In people with anxiety, depression, and psychosis, these network hubs are often hyperconnected.

“It’s almost as if they’re hijacked,” Whitfeld-Gabrieli says. “The more they’re correlated, the more psychopathology one might be experiencing. We wanted to unlock that hyperconnectivity for kids who are suffering from depression and anxiety.” She hoped that by replacing thoughts of the past and the future with focus on the present, mindfulness meditation would rein in overactive DMNs, and she wanted a way to encourage kids to do exactly that.

The neurofeedback tool that she and her colleagues created focuses on the DMN as well as separate brain region that is called on during attention-demanding tasks. Activity in those regions is monitored with functional MRI and displayed to users in a game-like visualization. Inside the scanner, participants see how that activity changes as they focus on a meditation or when their mind wanders. As their mind becomes more focused on the present moment, changes in brain activity move a ball toward a target.

Whitfeld-Gabrieli says the real-time feedback was motivating for adolescents who participated in a

recent study, who all had histories of anxiety or depression. “They’re training their brain to tune their mind, and they love it,” she says.

In March, she and her team reported in [Molecular Psychiatry](#) that the neurofeedback tool helped those study participants reduce connectivity in the DMN and engage a more desirable brain state. It’s not the first success the team has had with the approach. Previously, they found that the decreases in DMN connectivity brought about by mindfulness meditation with neurofeedback were associated with reduced hallucinations for patients with schizophrenia. Testing the clinical benefits of the approach in teens is on the horizon; Whitfeld-Gabrieli and her collaborators plan to investigate how mindfulness meditation with real-time neurofeedback affects depression symptoms in an upcoming clinical trial.

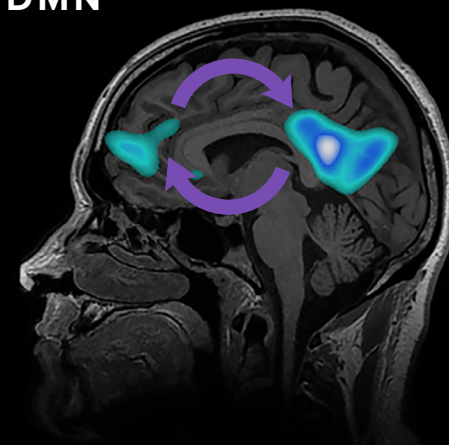
Whitfeld-Gabrieli emphasizes that the neurofeedback is a training tool, helping users improve mindfulness techniques they can later call on anytime, anywhere. While that training currently requires time inside an MRI scanner, she says it may be possible create an EEG-based version of the approach, which could be deployed in doctors’ offices and other more accessible settings.

Both Gabrieli and Whitfeld-Gabrieli continue to explore how mindfulness training impacts different aspects of mental health, in both children and adults and with a range of psychiatric conditions. Whitfeld-Gabrieli expects it will be one powerful tool for combating a youth mental health crisis for which there will be no single solution. “I think it’s going to take a village,” she says. “We are all going to have to work together, and we’ll have to come up with some really innovative ways to help.” ●

TUNING THE MIND

The default mode network (DMN) is a large-scale brain network that is active when a person is not focused on the outside world and the brain is at wakeful rest.

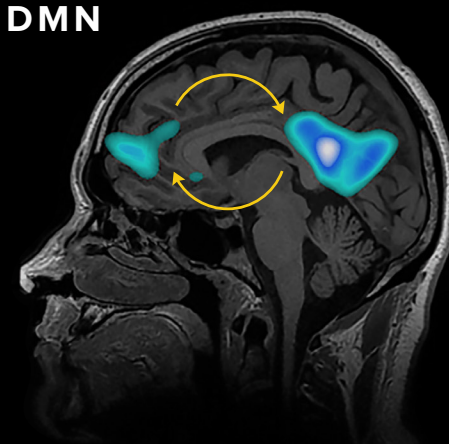
OVERACTIVE DMN



- WORRYING
 - DELUSIONAL
 - RUMINATING
- about the future
thinking
about the past

The DMN is often over-engaged in adolescents with depression and anxiety, as well as teens at risk for these affective disorders.

HEALTHY DMN



- PLANNING
 - CREATIVE
 - REMINISCING
- for the future
thinking
about the past

DMN activation and connectivity can be “tuned” to a healthier state through the practice of mindfulness.



Joseph Itiat (left) and Sam Merrow (right) are the newest members of the K. Lisa Yang Postbaccalaureate Scholar Program.

K. Lisa Yang Postbaccalaureate Program Names New Scholars

Two young researchers in McGovern Institute labs, Joseph Itiat and Sam Merrow, are the newest members of the K. Lisa Yang Postbaccalaureate Scholar Program. Funded by philanthropist [Lisa Yang](#), the Yang Postbac Scholar Program provides two years of paid laboratory experience, mentorship, and education to recent college graduates from backgrounds underrepresented in neuroscience.

Itiat moved to the United States from Nigeria in 2019 to pursue a degree in psychology and cognitive neuroscience at Temple University. Today, he is a Yang postbac in [John Gabrieli](#)'s lab studying the relationship between learning and value processes and their influence on future-oriented

decision-making. Ultimately, Itiat hopes to develop models that map the underlying mechanisms driving these processes. "Being African, with limited research experience and little representation in the domain of neuroscience research," Itiat says, "I chose to pursue a postbaccalaureate research program to prepare me for a top graduate school and a career in cognitive neuroscience."

Merrow first fell in love with science while working at the Barrow Neurological Institute in Arizona during high school. After graduating from Simmons University in Boston, Massachusetts, Merrow joined [Guoping Feng](#)'s lab as a Yang postbac to pursue research on glial cells and brain disorders. "As a queer, nonbinary, LatinX person, I have not met anyone like me in my field, nor have I had role models that hold

a similar identity to myself," says Merrow. "My dream is to one day become a professor, where I will be able to show others that science is for anyone."

Previous Yang postbacs include Alex Negron, Zoe Pearce, Ajani Stewart, and Maya Taliaferro. ●

Awards

[GUOPING FENG](#) | Member, National Academy of Medicine

[GUOPING FENG, ILA FIETE, SATRA GHOSH, IAN WICKERSHAM](#) | BRAIN Initiative (BRAIN CONNECTS) Grants, NIH

[FAN WANG](#) | Pioneer Award, NIH



NEUROTECHNOLOGY

Flexible Fibers

Engineers in **Polina Anikeeva's** lab have designed a soft hydrogel optical fiber that stimulates peripheral nerves, stretches with the body, and could one day help researchers in identifying the origins and treatments for nerve-related pain. The new fibers are meant as an experimental tool that can be used by scientists to explore the causes and potential treatments for peripheral nerve disorders in animal models. (*Nature Methods*)

In a separate study, the **Anikeeva** lab collaborated with researchers at the Picower Institute to advance the clinical potential of a thin, flexible fiber designed to simultaneously monitor and manipulate neural activity at targeted sites in the brain. (*Science Advances*)



GENOME ENGINEERING

Nature's Scissors

A diverse set of species, from snails to algae to amoebas, make programmable DNA-cutting enzymes called Fanzors—and a new study from **Jonathan Gootenberg** and **Omar Abudayyeh** has identified thousands of them. The discovery of Fanzors, whose ability to cut DNA in an RNA-guided manner was reported by **Feng Zhang's** group earlier this year, opens a new frontier of RNA-guided biology. (*Science Advances*) ●



CELLULAR & MOLECULAR NEUROSCIENCE

Brain Atlas

A new atlas developed by **Guoping Feng** and colleagues catalogs a diverse array of more than two million brain cells throughout the marmoset brain. The atlas helps establish marmosets—small monkeys whose brains share many functional and structural features with the human brain—as a valuable model for neuroscience research. (*Science Advances*)



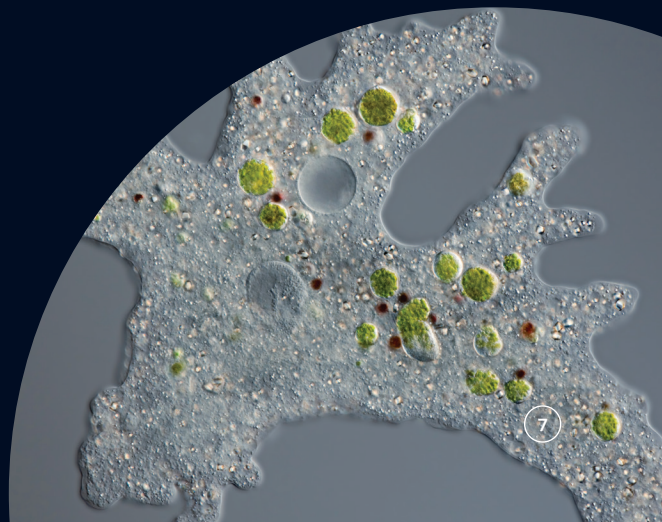
COMPUTATIONAL NEUROSCIENCE

Smarter AI

Ila Fiete, Mehrdad Jazayeri, and **Robert Yang** have found that “self-supervised” models, which learn about their environment from unlabeled data, can show activity patterns similar to those of the mammalian brain. The studies, supported by the K. Lisa Yang ICoN Center, suggest that researchers may be getting closer to building artificial systems that emulate natural intelligence. (*NeurIPS 2023*)

Idiosyncratic AI

Josh McDermott and colleagues have found that computational models of hearing and vision can build up their own idiosyncratic “invariances”—meaning that they respond the same way to stimuli with very different features. The findings offer a new way for researchers to evaluate how well these models mimic the organization of human sensory perception. (*Nature Neuroscience*)





SURVEY SAYS

57%

of the McGovern Institute community practices some form of mindfulness.

In a survey distributed to the McGovern Institute community, more than half of the 74 researchers, faculty, and staff who responded said that they practice mindfulness as a way to reduce anxiety and stress.



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