Your Brain on Meditation

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The current scientific findings are exciting enough to encourage even the most resistant to sit down on the cushion: They suggest that meditation—even in small doses—can profoundly influence your experience of the world by remodeling the physical structure of your brain.

How Meditation Trains Your Brain

Using a magnetic resonance imaging (MRI) machine, Eileen Luders, a re-searcher in the Department of Neurology at the University of California Los Angeles School of Medicine, looks for evidence that meditation changes the physical structure of the brain. Until recently, this idea would have seemed absurd. "Scientists used to believe that the brain reaches its peak in adulthood and doesn't change—until it starts to decrease in late adulthood," Luders says. "Today we know that everything we do, and every experience we have, actually changes the brain."

Indeed, Luders finds several differences between the brains of meditators and nonmeditators. In a study published in the journal NeuroImage in 2009, Luders and her colleagues compared the brains of 22 meditators and 22 age-matched nonmeditators and found that the meditators (who practiced a wide range of traditions and had between 5 and 46 years of meditation experience) had more gray matter in regions of the brain that are important for attention, emotion regulation, and mental flexibility. Increased gray matter typically makes an area of the brain more efficient or powerful at processing information. Luders believes that the increased gray matter in the meditators' brains should make them better at controlling their attention, managing their emotions, and making mindful choices.

Why are there differences between the brains of meditators and nonmeditators? It's a simple matter of training. Neuroscientists now know that the brain you have today is, in part, a reflection of the demands you have placed on it. People learning to juggle, for example, develop more connections in areas of the brain that anticipate moving objects. Medical students undergoing periods of intense learning show similar changes in the hippocampus, an area of the brain important for memory. And mathematicians have more gray matter in regions important for arithmetic and spatial reasoning.

More and more neuroscientists, like Luders, have started to think that learning to meditate is no different from learning mental skills such as music or math. Like anything else that requires practice, meditation is a training program for the brain. "Regular use may strengthen the connections between neurons and can also make new connections," Luders explains. "These tiny changes, in thousands of connections, can lead to visible changes in the structure of the brain."

Those structural changes, in turn, create a brain that is better at doing whatever you've asked it to do. Musicians' brains could get better at analyzing and creating music. Mathematicians' brains may get better at solving problems. What do meditators' brains

get better at doing? This is where it gets interesting: It depends on what kind of meditation they do.

Over the past decade, researchers have found that if you practice focusing attention on your breath or a mantra, the brain will restructure itself to make concentration easier. If you practice calm acceptance during meditation, you will develop a brain that is more resilient to stress. And if you meditate while cultivating feelings of love and compassion, your brain will develop in such a way that you spontaneously feel more connected to others.

Improve Your Attention

New research shows that meditation can help you improve your ability to concentrate in two ways. First, it can make you better at focusing on something specific while ignoring distractions. Second, it can make you more capable of noticing what is happening around you, giving you a fuller perspective on the present moment.

Some of the most fascinating research on how meditation affects attention is being conducted by Antoine Lutz, PhD, an associate scientist at the Waisman Laboratory for Brain Imaging and Behavior at the University of Wisconsin at Madison, in collaboration with Richard Davidson and the Laboratory for Affective Neuroscience at the University of Wisconsin. Their work has shown that concentration meditation, in which the meditator focuses complete attention on one thing, such as counting the breath or gazing at an object, activates regions of the brain that are critical for controlling attention. This is true even among novice meditators who receive only brief training. Experienced meditators show even stronger activation in these regions. This you would expect, if meditation trains the brain to pay attention. But extremely experienced meditators (who have more than 44,000 hours of meditation practice) show less activation in these regions, even though their performance on attention tasks is better. The explanation for this, in Lutz's view, is that the meditation training can eventually help reduce the effort it takes to focus your attention. "This would be consistent with traditional accounts of progress in meditation practice. Sustaining focus becomes effortless," Lutz says. This suggests that people can immediately enhance concentration by learning a simple meditation technique, and that practice creates even more progress.

The researchers also looked at whether vipassana meditation training can improve overall attention. (Vipassana means "to see things as they really are," and the meditation techniques are designed to increase focus, awareness, and insight.) Researchers label our inability to notice things in our environment as "attentional blink." Most of us experience this throughout the day, when we become so caught up in our own thoughts that we miss what a friend says to us and have to ask her to repeat it. A more dramatic example would be a car accident caused by your thinking about a conversation you just had and not noticing that the car in front of you has stopped. If you were able to reduce your attentional blink, it would mean a more accurate and complete perception of reality—you would notice more and miss less.

To test whether meditation reduces attentional blink, participants had to notice two things occurring in rapid succession, less than a second apart. The findings, published in PLoS

Biology, reveal that the meditation training improved the participants' ability to notice both changes, with no loss in accuracy.
What explained this improvement? EEG recordings—which track patterns of electrical activity in the brain, showing precise moment-by-moment fluctuations in brain activation—showed that the participants allocated fewer brain resources to the task of noticing each target. In fact, the meditators spent less mental energy noticing the first target, which freed up mental bandwidth for noticing what came next. Paying attention literally became easier for the brain.
As a result, Lutz and his colleagues believe that meditation may increase our control over our limited brain resources. To anyone who knows what it's like to feel scattered or overwhelmed, this is an appealing benefit indeed. Even though your attention is a limited resource, you can learn to do more with the mental energy you already have.

Reduce Your Stress

Research also shows that meditation can help people with anxiety disorders. Philippe Goldin, director of the Clinically Applied Affective Neuroscience project in the Department of Psychology at Stanford University, uses mindfulness meditation in his studies. The general practice is to become aware of the present moment—by paying attention to sounds, your breath, sensations in your body, or thoughts or feelings—and to observe without judgment and without trying to change what you notice.
Like most of us, the participants in Goldin's studies suffer from all sorts of disturbances of the mind—worries, self-doubt, stress, and even panic. But people with anxiety disorders feel unable to escape from such thoughts and emotions, and find their lives overtaken by them. Goldin's research shows that mindfulness meditation offers freedom for people with anxiety, in part by changing the way the brain responds to negative thoughts.

In his studies, participants take an eight-week mindfulness-based course in stress reduction. They meet once weekly for a class and practice on their own for up to an hour a day. The training includes mindfulness meditation, walking meditation, gentle yoga, and relaxation with body awareness as well as discussions about mindfulness in everyday life.
Before and after the intervention, participants have their brains scanned inside an fMRI (or functional MRI) machine, which looks at brain activity rather than the structure of the brain, while completing what Goldin calls "self-referential processing"—that is, thinking about themselves. An fMRI scanner tracks which brain areas consume more energy during meditation and, therefore, which regions are more active.
Ironically, the brain-scanning sessions could provoke anxiety even in the calmest of people. Participants must lie immobilized on their back with their head held in the brain scanner. They rest their teeth on dental wax to prevent any head movement or talking. They are then asked to reflect on different statements about themselves that appear on a screen in front of their face. Some of the statements are positive, but many of them are not, such as "I'm not OK the way I am," or "Something's wrong with me." These are exactly the kinds of thoughts that plague people with anxiety.

The brain scans in Goldin's studies show a surprising pattern. After the mindfulness intervention, participants have greater activity in a brain network associated with processing information when they reflect on negative self-statements. In other words, they pay more attention to the negative statements than they did before the intervention. And yet, they also show decreased activation in the amygdala—a region associated with stress and anxiety. Most important, the participants suffered less. "They reported less anxiety and worrying," Goldin says. "They put themselves down less, and their self-esteem improved."
Goldin's interpretation of the findings is that mindfulness meditation teaches people with anxiety how to handle distressing thoughts and emotions without being overpowered by them. Most people either push away unpleasant thoughts or obsess over them—both of which give anxiety more power. "The goal of meditation is not to get rid of thoughts or emotions. The goal is to become more aware of your thoughts and emotions and learn how to move through them without getting stuck." The brain scans suggest that the anxiety sufferers were learning to witness negative thoughts without going into a full-blown anxiety response.

Research from other laboratories is confirming that mindfulness meditation can lead to lasting positive changes in the brain. For example, a recent study by Massachusetts General Hospital and Harvard University put 26 highly stressed adults through an eight-week mindfulness-based course in stress reduction that followed the same basic format as Goldin's study. Brain scans were taken before and after the intervention, along with participants' own reports of stress. The participants who reported decreased stress also showed decreases in gray -matter density in the amygdala. Previous research had revealed that trauma and chronic stress can enlarge the amygdala and make it more reactive and more connected to other areas of the brain, leading to greater stress and anxiety. This study is one of the first documented cases showing change occurring in the opposite direction—with the brain instead becoming less reactive and more resilient. Together, these studies provide exciting evidence that small doses of mental training, such as an eight-week mindfulness course, can create important changes in one's mental well-being.

Feel More Compassionate
The cultivation of friendliness creates inner strength.

We typically think of our emotional range as something that is fixed and unchanging—a reflection of the personality we're born with. But research is revealing the possibility that we may be able to cultivate and increase our ability to feel the emotional state of compassion. Researchers have found that feeling connected to others is as learnable as any other skill. "We are trying to provide evidence that meditation can cultivate compassion, and that you can see the change in both the person's behavior and the function of the brain," Lutz says.

So what does compassion look like in the brain? To find out, Lutz and his colleagues compared two groups of meditators—one group whose members were experienced in compassion meditation, and the other a group whose members were not—and gave them

the same instructions: to generate a state of love and compassion by thinking about someone they care about, extend those feelings to others, and finally, to feel love and compassion without any specific object. As each of the participants meditated inside the fMRI brain scanners, they were occasionally interrupted by spontaneous and unexpected human sounds—such as a baby cooing or a woman screaming—that might elicit feelings of care or concern.

All of the meditators showed emotional responses to the sounds. But the more experienced compassion meditators showed a larger brain response in areas important for processing physical sensations and for emotional responding, particularly to sounds of distress. The researchers also observed an increase in heart rate that corresponded to the brain changes. These findings suggest that the meditators were having a genuine empathic response and that the experienced meditators felt greater compassion. In other words, compassion meditation appears to make the brain more naturally open to a connection with others.

These meditation techniques may have benefits beyond the experience of spontaneous compassion. A study by psychology professor Barbara Fredrickson and her colleagues at the University of North Carolina, Chapel Hill, and the University of Michigan, found that a seven-week lovingkindness meditation course also increased the participants' daily experience of joy, gratitude, and hope. The more participants meditated, the better they felt. Participants also reported a greater sense of self-acceptance, social support, purpose in life, and life satisfaction, while experiencing fewer symptoms of illness and depression. This study provides strong evidence that chipping away at the illusion of separation can open us up to a far more meaningful connection to life.

Commit to Change

As the evidence for the benefits of meditation grows, one of the most important outstanding questions is, How much is enough? Or, from the perspective of most beginning meditators, How little is enough to see positive change?

Researchers agree that many of the benefits happen early on. "Changes in the brain take place at the very beginning of learning," Luders says. And many studies show change in a matter of weeks, or even minutes, among inexperienced meditators. But other studies suggest that experience matters. More practice leads to greater changes, both in the brain and in a meditator's mental states. So while a minimal investment in meditation can pay off for your well-being and mental clarity, committing to the practice is the best way to experience the full benefits.

Luders, who was a lapsed meditator when she started her research, had such a positive experience being around seasoned meditators that she was motivated to come back to the practice. "It's never too late," Luders says. She suggests starting small and making meditation a regular habit. "The norm in our study was daily sessions, 10 to 90 minutes. Start with 10."

If you do, you may discover that meditation has benefits beyond what science has revealed. Indeed, it will take time for science to catch up to the wisdom of the great meditation teachers. And even with the advances in brain technology, there are changes both subtle and profound transmitted only through direct experience. Fortunately, all you need to get started is the willingness to sit and be with your own body, breath, and mind.