

# Meditation Gives Brain a Charge, Study Finds

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Brain research is beginning to produce concrete evidence for something that Buddhist practitioners of meditation have maintained for centuries: Mental discipline and meditative practice can change the workings of the brain and allow people to achieve different levels of awareness. Those transformed states have traditionally been understood in transcendent terms, as something outside the world of physical measurement and objective evaluation. But over the past few years, researchers at the University of Wisconsin working with Tibetan monks have been able to translate those mental experiences into the scientific language of high-frequency gamma waves and brain synchrony, or coordination. And they have pinpointed the left prefrontal cortex, an area just behind the left forehead, as the place where brain activity associated with meditation is especially intense.

"What we found is that the longtime practitioners showed brain activation on a scale we have never seen before," said Richard Davidson, a neuroscientist at the university's new \$10 million W.M. Keck Laboratory for Functional Brain Imaging and Behavior. "Their mental practice is having an effect on the brain in the same way golf or tennis practice will enhance performance." It demonstrates, he said, that the brain is capable of being trained and physically modified in ways few people can imagine.

Scientists used to believe the opposite -- that connections among brain nerve cells were fixed early in life and did not change in adulthood. But that assumption was disproved over the past decade with the help of advances in brain imaging and other techniques, and in its place, scientists have embraced the concept of ongoing brain development and "neuroplasticity."

Davidson says his newest results from the meditation study, published in the Proceedings of the National Academy of Sciences in November, take the concept of neuroplasticity a step further by showing that mental training through meditation (and presumably other disciplines) can itself change the inner workings and circuitry of the brain.

The new findings are the result of a long, if unlikely, collaboration between Davidson and Tibet's Dalai Lama, the world's best-known practitioner of Buddhism. The Dalai Lama first invited Davidson to his home in Dharamsala, India, in 1992 after learning about Davidson's innovative research into the neuroscience of emotions. The Tibetans have a centuries-old tradition of intensive meditation and, from the start, the Dalai Lama was interested in having Davidson scientifically explore the workings of his monks' meditating minds. Three years ago, the Dalai Lama spent two days visiting Davidson's lab.

The Dalai Lama ultimately dispatched eight of his most accomplished practitioners to Davidson's lab to have them hooked up for electroencephalograph (EEG) testing and brain scanning. The Buddhist practitioners in the experiment had undergone training in the Tibetan Nyingmapa and Kagyupa traditions of meditation for an estimated 10,000 to 50,000 hours, over time periods of 15 to 40 years. As a control, 10 student volunteers with no previous meditation experience were also tested after one week of training.

The monks and volunteers were fitted with a net of 256 electrical sensors and asked to meditate for short periods. Thinking and other mental activity are known to produce slight, but detectable, bursts of electrical activity as large groupings of neurons send messages to each other, and that's what the sensors picked up. Davidson was especially interested in measuring gamma waves, some of the highest-frequency and most important electrical brain impulses.

Both groups were asked to meditate, specifically on unconditional compassion. Buddhist teaching describes that state, which is at the heart of the Dalai Lama's teaching, as the "unrestricted readiness and availability to help living beings." The researchers chose that focus because it does not require concentrating on particular objects, memories or images, and cultivates instead a transformed state of being.

Davidson said that the results unambiguously showed that meditation activated the trained minds of the monks in significantly different ways from those of the volunteers. Most important, the electrodes picked up much greater activation of fast-moving and unusually powerful gamma waves in the monks, and found that the movement of the waves through the brain was far better organized and coordinated than in the students. The meditation novices showed only a slight increase in gamma wave activity while meditating, but some of the monks produced gamma wave activity more powerful than any previously reported in a healthy person, Davidson said.

The monks who had spent the most years meditating had the highest levels of gamma waves, he added. This "dose response" -- where higher levels of a drug or activity have greater effect than lower levels -- is what researchers look for to assess cause and effect.

In previous studies, mental activities such as focus, memory, learning and consciousness were associated with the kind of enhanced neural coordination found in the monks. The intense gamma waves found in the monks have also been associated with knitting together disparate brain circuits, and so are connected to higher mental activity and heightened awareness, as well.

Davidson's research is consistent with his earlier work that pinpointed the left prefrontal cortex as a brain region associated with happiness and positive thoughts and emotions. Using functional magnetic resonance imaging (fMRI) on the meditating monks, Davidson found that their brain activity -- as measured by the EEG -- was especially high in this area.

Davidson concludes from the research that meditation not only changes the workings of the brain in the short term, but also quite possibly produces permanent changes. That finding, he said, is based on the fact that the monks had considerably more gamma wave activity than the control group even before they started meditating. A researcher at the University of Massachusetts, Jon Kabat-Zinn, came to a similar conclusion several years ago.

Researchers at Harvard and Princeton universities are now testing some of the same monks on different aspects of their meditation practice: their ability to visualize images and control their thinking. Davidson is also planning further research.

"What we found is that the trained mind, or brain, is physically different from the untrained one," he said. In time, "we'll be able to better understand the potential importance of this kind of mental training and increase the likelihood that it will be taken seriously."