

## **Scans of Monks' Brains Show Meditation Alters Structure, Functioning**

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ALL OF THE Dalai Lama's guests peered intently at the brain scan projected onto screens at either end of the room, but what different guests they were. On one side sat five neuroscientists, united in their belief that physical processes in the brain can explain all the wonders of the mind, without appeal to anything spiritual or nonphysical. Facing them sat dozens of Tibetan Buddhist monks in burgundy-and-saffron robes, convinced that one round-faced young man in their midst is the reincarnation of one of the Dalai Lama's late teachers, that another is the reincarnation of a 12th-century monk, and that the entity we call "mind" is not, as neuroscience says, just a manifestation of the brain.

It was not, in other words, your typical science meeting.

But although the Buddhists and scientists who met for five days last month in the Dalai Lama's home in Dharamsala, India, had different views on the little matters of reincarnation and the relationship of mind to brain, they set them aside in the interest of a shared goal. They had come together in the shadows of the Himalayas to discuss one of the hottest topics in brain science: neuroplasticity.

The term refers to the brain's recently discovered ability to change its structure and function, in particular by expanding or strengthening circuits that are used and by shrinking or weakening those that are rarely engaged. In its short history, the science of neuroplasticity has mostly documented brain changes that reflect physical experience and input from the outside world. In pianists who play many arpeggios, for instance, brain regions that control the index finger and middle finger become fused, apparently because when one finger hits a key in one of these fast-tempo movements, the other does so almost simultaneously, fooling the brain into thinking the two fingers are one. As a result of the fused brain regions, the pianist can no longer move those fingers independently of one another.

LATELY, HOWEVER, scientists have begun to wonder whether the brain can change in response to purely internal, mental signals. That's where the Buddhists come in. Their centuries-old tradition of meditation offers a real-life experiment in the power of those will-o'-the-wisps, thoughts, to alter the physical matter of the brain.

"Of all the concepts in modern neuroscience, it is neuroplasticity that has the greatest potential for meaningful interaction with Buddhism," says neuroscientist Richard Davidson of the University of Wisconsin, Madison.

The Dalai Lama agreed, and he encouraged monks to donate (temporarily) their brains to science. The result was the scans that Prof. Davidson projected in Dharamsala. They compared brain activity in volunteers who were novice meditators to that of Buddhist monks who had spent more than 10,000 hours in meditation. The task was to practice "compassion" meditation, generating a feeling of loving kindness toward all beings.

"We tried to generate a mental state in which compassion permeates the whole mind with no other thoughts," says Matthieu Ricard, a Buddhist monk at Shechen Monastery in Katmandu, Nepal, who holds a Ph.D. in genetics.

IN A STRIKING difference between novices and monks, the latter showed a dramatic increase in high-frequency brain activity called gamma waves during compassion meditation. Thought to be the signature of neuronal activity that knits together far-flung brain circuits, gamma waves underlie higher mental activity such as consciousness. The novice meditators "showed a slight increase in gamma activity, but most monks showed extremely large increases of a sort that has never been reported before in the neuroscience literature," says Prof. Davidson, suggesting that mental training can bring the brain to a greater level of consciousness.

Using the brain scan called functional magnetic resonance imaging, the scientists pinpointed regions that were active during compassion meditation. In almost every case, the enhanced activity was greater in the monks' brains than the novices'. Activity in the left prefrontal cortex (the seat of positive emotions such as happiness) swamped activity in the right prefrontal (site of negative emotions and anxiety), something never before seen from purely mental activity. A sprawling circuit that switches on at the sight of suffering also showed greater activity in the monks. So did regions responsible for planned movement, as if the monks' brains were itching to go to the aid of those in distress. "It feels like a total readiness to act, to help," recalled Mr. Ricard.

The study will be published next week in Proceedings of the National Academy of Sciences. "We can't rule out the possibility that there was a pre-existing difference in brain function between monks and novices," says Prof. Davidson, "but the fact that monks with the most hours of meditation showed the greatest brain changes gives us confidence that the changes are actually produced by mental training."

That opens up the tantalizing possibility that the brain, like the rest of the body, can be altered intentionally. Just as aerobics sculpt the muscles, so mental training sculpts the gray matter in ways scientists are only beginning to fathom.