Eight weeks to a better brain: Meditation study shows changes associated with awareness, stress

January 21, 2011

Sue McGreevey, MGH Communications
(From *Harvard Gazette*)

Participating in an eight-week mindfulness meditation program appears to make measurable changes in brain regions associated with memory, sense of self, empathy, and stress. In a study that will appear in the Jan. 30 issue of Psychiatry Research: Neuroimaging, a team led by Harvard-affiliated researchers at Massachusetts General Hospital (MGH) reported the results of their study, the first to document meditation-produced changes over time in the brain's gray matter.

"Although the practice of meditation is associated with a sense of peacefulness and physical relaxation, practitioners have long claimed that meditation also provides cognitive and psychological benefits that persist throughout the day," says study senior author Sara Lazar of the MGH Psychiatric Neuroimaging Research Program and a Harvard Medical School instructor in psychology. "This study demonstrates that changes in brain structure may underlie some of these reported improvements and that people are not just feeling better because they are spending time relaxing."

Previous studies from Lazar's group and others found structural differences between the brains of experienced meditation practitioners and individuals with no history of meditation, observing thickening of the cerebral cortex in areas associated with attention and emotional integration. But those investigations could not document that those differences were actually produced by meditation.

For the current study, magnetic resonance (MR) images were taken of the brain structure of 16 study participants two weeks before and after they took part in the eight-week Mindfulness-Based Stress Reduction (MBSR) Program at the University of Massachusetts Center for Mindfulness. In addition to weekly meetings that included practice of mindfulness meditation

— which focuses on nonjudgmental awareness of sensations, feelings, and state of mind — participants received audio recordings for guided meditation practice and were asked to keep track of how much time they practiced each day. A set of MR brain images was also taken of a control group of nonmeditators over a similar time interval.

Meditation group participants reported spending an average of 27 minutes each day practicing mindfulness exercises, and their responses to a mindfulness questionnaire indicated significant improvements compared with pre-participation responses. The analysis of MR images, which focused on areas where meditation-associated differences were seen in earlier studies, found increased gray-matter density in the hippocampus, known to be important for learning and memory, and in structures associated with self-awareness, compassion, and introspection.

Participant-reported reductions in stress also were correlated with decreased gray-matter density in the amygdala, which is known to play an important role in anxiety and stress. Although no change was seen in a self-awareness-associated structure called the insula, which had been identified in earlier studies, the authors suggest that longer-term meditation practice might be needed to produce changes in that area. None of these changes were seen in the control group, indicating that they had not resulted merely from the passage of time.

“It is fascinating to see the brain’s plasticity and that, by practicing meditation, we can play an active role in changing the brain and can increase our well-being and quality of life,” says Britta Hölzel, first author of the paper and a research fellow at MGH and Giessen University in Germany. “Other studies in different patient populations have shown that meditation can make significant improvements in a variety of symptoms, and we are now investigating the underlying mechanisms in the brain that facilitate this change.”

Amishi Jha, a University of Miami neuroscientist who investigates mindfulness-training’s effects on individuals in high-stress situations, says, “These results shed light on the mechanisms of action of mindfulness-based training. They demonstrate that the first-person experience of stress can not only be reduced with an eight-week mindfulness training program but that this experiential change corresponds with structural changes in the amygdala, a finding that opens doors to many possibilities for further research on

MBSR's potential to protect against stress-related disorders, such as post-traumatic stress disorder." Jha was not one of the study investigators. James Carmody of the Center for Mindfulness at University of Massachusetts Medical School is one of the co-authors of the study, which was supported by the National Institutes of Health, the British Broadcasting Company, and the Mind and Life Institute.

Reprinted from…
http://news.harvard.edu/gazette/story/2011/01/eight-weeks-to-a-better-brain/

Mindfulness Meditation: A mental workout to benefit the brain

By Elizabeth Brown, graduate student at Harvard University
(From Science in the News)

Meditation has ancient, religious roots, but it has also become a secular practice, implemented to promote wellbeing and to treat depression and anxiety. Skeptics might be wary of this jump from spiritual origins to medical treatment, but mounting evidence suggests that meditation can have tangible effects on the brain. In a practice called mindfulness meditation, people concentrate on the present moment: on breathing, physical sensations, sounds, thoughts, and emotions. To brains accustomed to planning, predicting, story-telling, wondering, remembering, regretting, and worrying, fixating on the present is unusual and challenging. However, spending time thinking in this new way produces measurable changes in both the white and gray matter that make up the brain.

Gray matter is the portion of the brain that is made up of nerve cell bodies, while white matter is made up of long and slender extensions of the cell bodies called "axons." The cell bodies of the gray matter release chemical or electrical signals in response to the electrical impulses of the nervous system, while white matter forms connections between the cells, allowing communication between different brain regions. This communication between the gray and white matter in the brain is what constitutes thinking. Changes in both gray and white matter can be measured with different types of magnetic resonance imaging (MRI) **(Figure 1)**, which detects differences in blood flow to brain regions by stimulating changes in the magnetic fields of iron atoms in the blood. Many studies have now been conducted using MRI to examine the effects of meditation on the brain. This research is starting to reveal how changes in the brains of meditators may translate into mental benefits.

Changes that matter

For example, after eight weeks of a mindfulness-based stress reduction class, participants exhibited increased gray matter in four regions of the brain: the left-hippocampus, the posterior cingulate cortex, the left temporoparietal junction, and the cerebellum **(Figure 1)**. These areas of the brain are involved

in the regulation of emotion, compassion, coordination, learning, and memory. Tellingly, defects and decreased gray matter in the hippocampus and cerebellum (the opposite of what is seen in meditators) have been associated with post-traumatic stress disorder, anxiety, depression, and sleep disorders. In addition, participants exhibited decreased gray matter in the amygdala—the region of the brain that controls the release of stress hormones **(Figure 1)**. So, in the hippocampus and cerebellum, more gray matter contributes to coordination, memory, and emotional regulation, while in the amygdala more gray matter contributes to stress. Meditators then, might be expected to have better emotional regulation and less stress compared to non-meditators. Indeed, these changes in gray matter over the eight-week period were not observed among control subjects who had no meditation experience before or during the study. The changes in gray matter observed in mindful meditators correspond to emotional and behavioral improvements, including decreased anxiety, decreased risk of depression relapse, decreased insomnia, and increased compassion. Importantly, improvements in anxiety and depression among mindful meditators have been observed in many studies, indicating that at least some mental health benefits from meditation have strong scientific support.

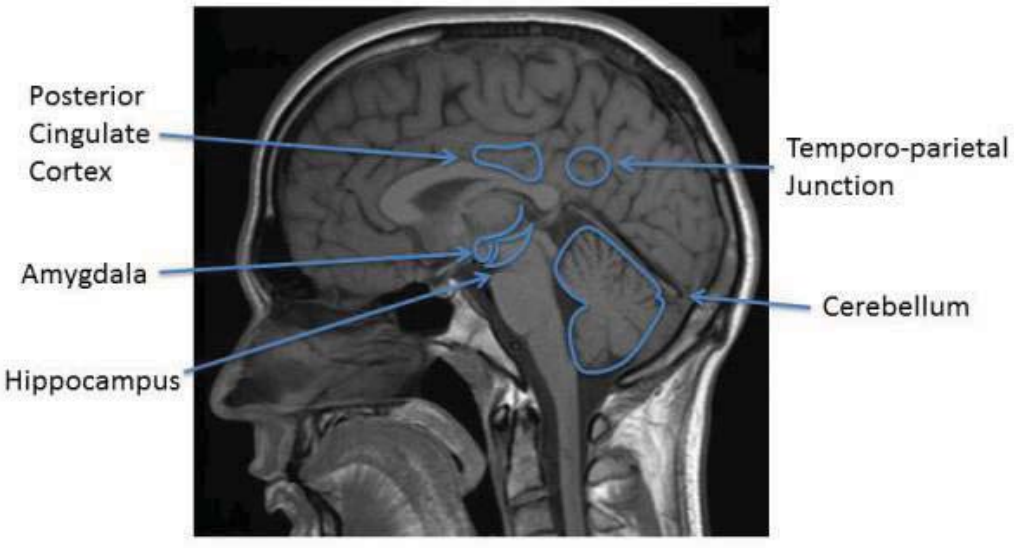

Figure 1*. Profile of a human brain using an MRI. Regions outlined that change after eight weeks of mindfulness meditation training. Original image by Helmut Januschka, modified.*

Functional connectivity MRIs (fcMRIs) detect correlations in the changes of blood flow across the brain, and reflect white matter connectivity between different regions. They have also been used to examine the impact of mindfulness meditation. Using fcMRIs, experienced meditators in one study exhibited increased connectivity compared to non-meditators. Furthermore, another study using a type of MRI known as diffusion tensor imaging, which detects white matter fibers directly**(Figure 2)**, revealed that meditators have an increased density of axons, increased integrity of the protein sheaths surrounding the axons, and increased efficiency of signal transmission through the axons [4]. Researchers are still trying to figure out why increased connectivity results in some of the benefits of meditation.

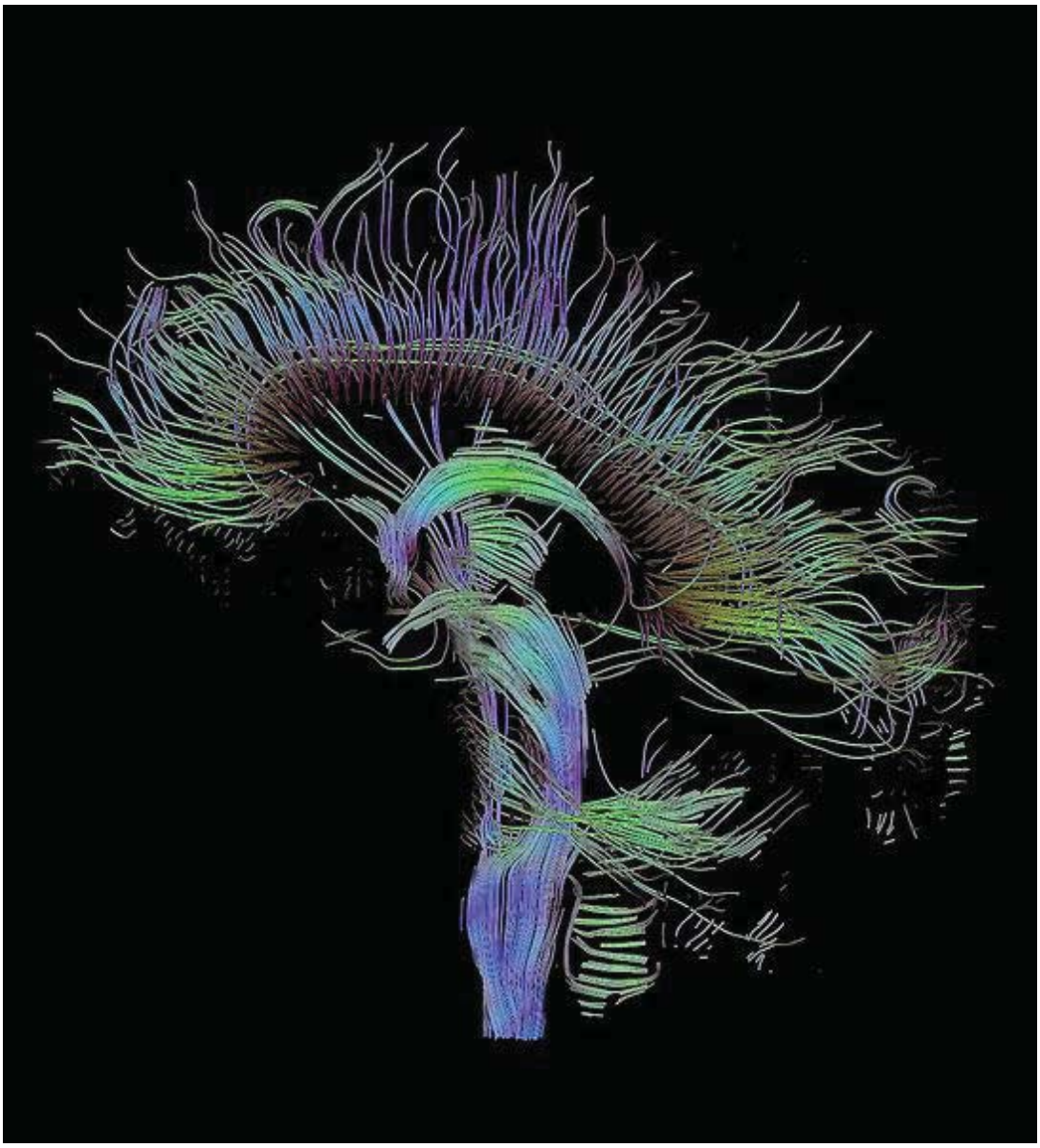

***Figure 2**. Profile of a human brain using diffusion tensor imaging, showing the white matter connections of the brain. Image by Thomas Schultz, http://www.sci.utah.edu/~gk/DTI-data/.*

Better Brainwaves

Researchers conducting these studies wondered whether this increased connectivity in meditators actually translates into better communication between different regions of the brain and enhanced efficiency in switching attention from one sensation or thought to the next. They investigated this by measuring alpha rhythms, the electrical signals or "brainwaves" that transmit sensory and motor information. They found that when asked to switch their focus of attention meditators exhibited alpha rhythms with greater amplitude

than non-meditators, as measured by another MRI technique called magnetoencephalography. This increased amplitude is thought to indicate improved transmission of signals throughout the brain. Researchers hypothesize that this improved transmission may be responsible for the reductions in pain and negative thoughts reported by mindful meditators, as they may be better at changing focus from negative sensations or thoughts to positive or neutral stimuli. If so, this would explain why directing the focus of attention in meditation and improved connectivity leads to some of the observed mental benefits.

The potential for mindfulness meditation and related practices to change people's brains is a promising area of ongoing research. Replication of these brain-imaging studies in larger groups of people will be an important confirmation of results. Furthermore, basic research into the function of different brain regions and the significance of changes to brain matter density and connectivity will clarify how these changes to the brain impact people's moods, behaviors, and bodies. For instance, the effects of meditation may go beyond the brain. Earlier research, described in "Calming Your Nerves and Your Heart Through Meditation" supports a reduction in heart disease among people practicing transcendental meditation—another form of meditation that involves the use of mantras. Other current research is investigating whether mindfulness meditation can improve learning and boost the immune system. Such benefits may seem far-reaching for a simple thought exercise. However, these studies indicate that meditation may be like actual brain exercise, stimulating physical changes to neural fibers and having widespread ramifications for the body.

Reprinted from…
http://sitn.hms.harvard.edu/flash/2013/mindfulness-meditation-a-mental-workout-to-benefit-the-brain/