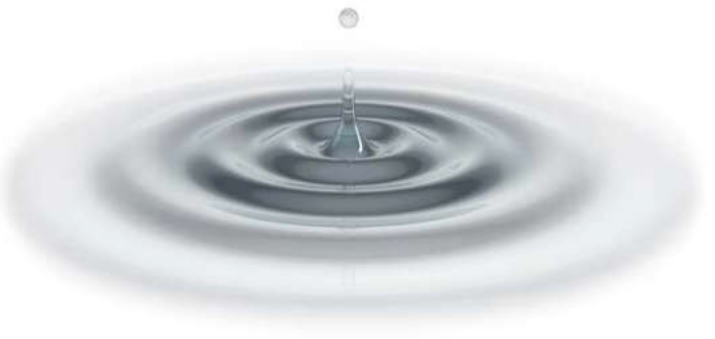
Now and Zen:
How mindfulness can change your brain and improve your health



Tuesday, March 8, 2016
6:00 – 7:30 p.m.

The Joseph B. Martin Conference Center
The New Research Building
Harvard Medical School
77 Avenue Louis Pasteur
Boston, MA 02115

THE Longwood SEMINARS AT HARVARD MEDICAL SCHOOL

HARVARD MEDICAL SCHOOL

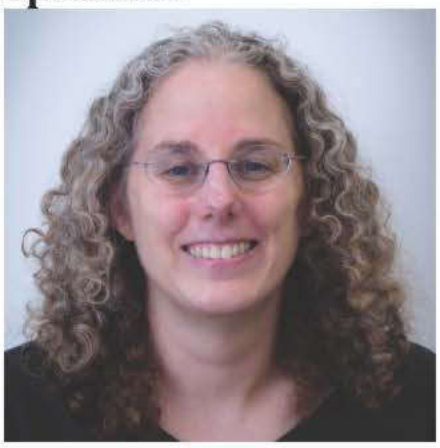
Now and Zen:
How mindfulness can change your brain and improve your health

Moderator

John Denninger, MD, PhD

- Instructor in Psychiatry, Harvard Medical School
- Director of Research, Benson-Henry Institute for Mind Body Medicine at Massachusetts General Hospital
- Associate Director, Mass General-McLean Adult Psychiatry Residency Program

Speakers



Sara Lazar, PhD

- Assistant Professor of Psychology, Harvard Medical School
- Associate Researcher, Department of Psychiatry at Massachusetts General Hospital

David Vago, PhD

- Instructor in Psychiatry, Harvard Medical School
- Associate Psychologist, Functional Neuroimaging Laboratory, Brigham and Women's Hospital

About the Speakers:

John Denninger, MD, PhD

John Denninger is an instructor in psychiatry at Harvard Medical School and serves as the director of research at the Benson-Henry Institute for Mind-Body Medicine at Massachusetts General Hospital. He is the associate director of the Mass General-McLean Hospital Adult Psychiatry Residency Training Program. Denninger's work overseeing the Benson-Henry Institute for Mind Body Medicine's research program explores the relationship between stress reduction, resiliency enhancement and health in both clinical and basic domains. His research focuses on two aspects of mind-body medicine interventions: first, assessing how well these interventions can help promote wellness in a broad range of people, and next, determining how these interventions work by exploring details of mechanism from genes to biochemistry to physiology to brain activity.

Sara Lazar, PhD

Sara Lazar is an assistant professor of psychology at Harvard Medical School and associate researcher in the Department of Psychiatry at Massachusetts General Hospital. She discovered the benefits of yoga in 1994 after she sustained an injury to her knee and back. After only a few weeks of practice she started to notice an improvement to her injuries. She has since made breakthrough discoveries using neuroimaging to examine the impact of yoga and meditation on brain activity and structure. The focus of Lazar's research is to elucidate the neural mechanisms underlying the beneficial effects of yoga and meditation, both in clinical settings and in healthy individuals. Numerous news outlets including *The New York Times*, *USA Today*, CNN, and WebMD have covered her research, and her work has been featured in a display at the Museum of Science in Boston.

David Vago, PhD

David Vago is an instructor in psychiatry at Harvard Medical School and associate psychologist in the Functional Neuroimaging Laboratory at Brigham and Women's Hospital. He has completed post-doctoral fellowships in the Department of Psychiatry at Brigham and Women's, the Utah Center for Exploring Mind-Body Interactions within the University of Utah School of Medicine, and the Stuart T. Hauser Research Training Program in Biological and Social Psychiatry at Judge Baker Children's Center. Vago's research interests broadly focus on utilizing translational models to identify and characterize neurobiological substrates mediating psychopathology in order to better predict outcomes and potential biologically-based diagnostic and therapeutic strategies for those suffering with mental illness. He aims to clarify adaptive mind-brain-body interactions and their therapeutic relevance in psychiatric settings. Vago has been specifically focusing on the study of mindfulness-based interventions in clinical settings and the basic cognitive and neuroscientific mechanisms by which mindfulness-based practices function.

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Yoga and meditation offer health care savings—and you can do them at home

Posted November 18, 2015

Marlynn Wei, MD, JD
Contributing Editor

A new research study shows that a little yoga or meditation a day might just keep the doctor away.

Stress-related health problems are responsible for up to 80% of visits to the doctor and account for the third highest health care expenditures, behind only heart disease and cancer. But as few as 3% of doctors actually talk to patients about how to reduce stress.

Mind-body practices like yoga and meditation have been shown to reduce your body's stress response by strengthening your relaxation response and lowering stress hormones like cortisol. Yoga has been shown to have many health benefits, including improving heart health and helping relieve depression and anxiety.

But the cost-effectiveness of these therapies has been less well demonstrated — until now.

The study

Dr. James E. Stahl and his team of Harvard researchers studied a mind-body relaxation program offered through the Benson-Henry Institute for Mind Body Medicine at Massachusetts General Hospital. The 8-week program taught participants several different mind-body approaches, including meditation, yoga, mindfulness, cognitive behavioral skills, and positive psychology. The study volunteers participated in weekly sessions and practiced at home as well.

The researchers found that people in the relaxation program used 43% fewer medical services than they did the previous year, saving on average $2,360 per person in emergency room visits alone. This means that such yoga and meditation programs could translate into health care savings of anywhere from $640 to as much as $25,500 per patient each year.

"There are many ways to get to the well state — many gates to wellness, but not every gate is open to every person. One of the strengths of the program is that it draws upon many different tools that reinforce each other and allow many gates to be opened to a wide array of people," says principal

investigator Dr. Stahl, who is now section chief of general internal medicine at Dartmouth-Hitchcock Medical Center.

Yoga and meditation are soaring in popularity — but will insurance pay?

Yoga and meditation programs are gaining wide appeal. Nearly one in 10 Americans practices yoga, and 45% of adults who don't practice yoga say they are interested in trying it. Americans are also using other forms of complementary health therapies, such as meditation (8%) and deep breathing (11%).

Many health care plans do not cover yoga or meditation, although some provide discounts for fitness programs including yoga or tai chi. States like Washington require private health insurers to cover licensed complementary health care providers, but the majority of states do not. However, that may soon change.

A recent article in the *Harvard Business Review* recommends that health insurers cover wellness and prevention-oriented therapies that are both low-cost and evidence-based, as both yoga and meditation are. The article discusses a study of Aetna employees who participated in the company's mindfulness program and enjoyed a 28% reduction in stress, 20% better sleep, and 19% less pain, as well as an increase in worker productivity worth an estimated $3,000 per employee per year. The company offers free yoga and meditation programs to its employees.

"There are a lot of great studies on the biologic side, just not enough on the economics," notes Dr. Stahl, who is looking to change that with his ongoing research. As the evidence for the health benefits and cost-effectiveness of yoga and meditation programs continues to grow, we can expect to see more interest from health care insurers.

"If I have a tool that works in clinical medicine that has very little side effects and considerable benefit, why would I not use the tool?" Dr. Stahl says.

Keep reading for a guide that will help you incorporate mindfulness skills into your daily life.

To learn more…
This information was prepared by the editors of the Harvard Health Publications division of Harvard Medical School. It is excerpted from our Harvard Health Blog, available at health.harvard.edu/blog.

You can practice mindfulness in as little as 15 minutes a day

By Marlynn Wei, MD, JD

In the research conducted by Dr. James E. Stahl and his team of Harvard researchers, study volunteers participated in an 8-week mind-body relaxation program offered through the Benson-Henry Institute for Mind Body Medicine at Massachusetts General Hospital. The program taught a range of mind-body skills.

Dr. Stahl, who is now at Dartmouth-Hitchcock Medical Center, teaches his own patients mindfulness and meditation skills in his internal medicine practice and encourages people to practice daily. He says that you don't need to enroll in a formal program, or even spend a lot of time practicing — 10 to 15 minutes a day will do. Consistency is the key.

Here are just a few ways to incorporate mindfulness skills into your daily life:

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Relax at the end of your day with a 15-minute guided meditation.
Keep guided meditations or podcasts on your phone or tablet for easy access. Guided meditations are available through:

- apps like Headspace (http://hvrd.me/YFb38) or Meditation Oasis (http://hvrd.me/YFbe3)
- the UCLA Mindful Awareness Research Center (http://hvrd.me/YFbip)
- the Chopra Center (http://hvrd.me/YFboO)
- meditation teachers like Tara Brach (http://hvrd.me/YFbsR)

Start your day with a basic Sun Salutation yoga sequence: http://hvrd.me/YFc2b
(If you're a beginner, try the modifications listed below and shown in this video: http://hvrd.me/YFbW3)

- Step back into Plank pose (http://hvrd.me/YFc8l) one foot at a time, instead of jumping back.
- Drop your knees to the floor in Low Plank (Four-limbed Staff) Pose (http://hvrd.me/YFcdY) to support and build your core muscles.
- Substitute Cobra Pose (http://hvrd.me/YFciB) instead of Upward Facing Dog Pose (http://hvrd.me/YFcmw) for the first few salutation cycles to warm up your lower back.

Check in with your breath for 10 to 15 minutes for a midday break. Close your eyes and notice where you store stress in your body. As your breath becomes slower and smoother, imagine sending your breath to that area on your inhalation. Imagine a knot loosening as you exhale. Repeat this cycle with each inhalation and exhalation.

Do a body scan for 10 to 15 minutes. Find a comfortable seat or lie down. Close your eyes and breathe more deeply and slowly. First, focus your attention on your feet. Notice any tension, pain, or stress. Take deep, slow breaths as you focus your awareness on that area of your body. As if you are scanning your body with light, move your attention slowly upward. Notice how each section of your body feels as you continue to breathe slowly: your shins and knees, thighs and hips, lower back and abdomen, chest and upper back, neck and shoulders, and finally your head.

Try a variety of approaches to find what sticks. Daily practice works best, but if you have a busy schedule, aim to practice at least three or four times a week. And don't give up if you feel like it's not working right away. These techniques are like any other skill or workout — the more you do it, the stronger you will get.

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Harvard Women's Health Watch

What meditation can do for your mind, mood, and health

Dr. Anne Fabiny
Former Editor in Chief, *Harvard Women's Health Watch*

August 2014

Taking a few minutes to focus your mind each day can reduce stress, pain, depression, and more.

You can't see or touch stress, but you can feel its effects on your mind and body. In the short term, stress quickens your heart rate and breathing and increases your blood pressure. When you're constantly under stress, your adrenal glands overproduce the hormone cortisol. Overexposure to this hormone can affect the function of your brain, immune system, and other organs. Chronic stress can contribute to headaches, anxiety, depression, heart disease, and even premature death.

Though you may not be able to eradicate the roots of stress, you can minimize its effects on your body. One of the easiest and most achievable stress-relieving techniques is meditation, a program in which you focus your attention inward to induce a state of deep relaxation.

Although the practice of meditation is thousands of years old, research on its health benefits is relatively new, but promising. A research review published in *JAMA Internal Medicine* in January 2014 found meditation helpful for relieving anxiety, pain, and depression. For depression, meditation was about as effective as an antidepressant.

Meditation is thought to work via its effects on the sympathetic nervous system, which increases heart rate, breathing, and blood pressure during times of stress. Yet meditating has a spiritual purpose, too. "True, it will help you lower your blood pressure, but so much more: it can help your creativity, your intuition, your connection with your inner self," says Burke Lennihan, a registered nurse who teaches meditation at the Harvard University Center for Wellness.

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Types of meditation

Meditation comes in many forms, including the following:

- **Concentration meditation** teaches you how to focus your mind. It's the foundation for other forms of meditation.
- **Heart-centered meditation** involves quieting the mind and bringing the awareness to the heart, an energy center in the middle of the chest.
- **Mindfulness meditation** encourages you to focus objectively on negative thoughts as they move through your mind, so you can achieve a state of calm.
- **Tai chi and qigong** are moving forms of meditation that combine physical exercise with breathing and focus.
- **Transcendental meditation** is a well-known technique in which you repeat a mantra — a word, phrase, or sound — to quiet your thoughts and achieve greater awareness.
- **Walking meditation** turns your focus to both body and mind as you breathe in time with your footsteps.

Lennihan suggests trying different types of meditation classes to see which technique best suits you. "Meditating with a group of people is a much more powerful experience, and having a teacher talk you through the technique will make it much easier at first," she says. Many meditation classes are free or inexpensive, which is a sign that the teacher is truly devoted to the practice.

Starting your practice

The beauty and simplicity of meditation is that you don't need any equipment. All that's required is a quiet space and a few minutes each day. "Start with 10 minutes, or even commit to five minutes twice a day," Lennihan says. "Preferably meditate at the same time every morning. That way you'll establish the habit, and pretty soon you'll always meditate in the morning, just like brushing your teeth."

The specifics of your practice will depend on which type of meditation you choose, but here are some general guidelines to get you started:

- Set aside a place to meditate. "You'll build up a special feeling there, making it easier to get into a meditative state more quickly," Lennihan says. Surround your meditation spot with candles, flesh flowers, incense, or any objects you can use to focus your practice (such as a photo, crystal, or religious symbol).
- Sit comfortably in a chair or on the floor with your back straight.
- Close your eyes, or focus your gaze on the object you've chosen.
- Breathe slowly, deeply, and gently.
- Keep your mind focused inward or on the object. If it wanders, gently steer it back to center.

- Breathe peace and quiet into your heart and mind. “While you’re breathing out, imagine your breath as a river or a tide that’s carrying your thoughts away,” Lennihan says.

You can also chant out loud. Many people use the Sanskrit word “shanti,” which means “peace.” Or choose a word from your own religious tradition. “Chanting out loud can help drown out thoughts,” Lennihan says.

Within just a week or two of regular meditation, you should see a noticeable change in your mood and stress level. “People will start to feel some inner peace and inner poise, even in the midst of their busy lives,” says Lennihan.

To learn more…
This information was prepared by the editors of the Harvard Health Publications division of Harvard Medical School. It is excerpted from the August 2014 issue of the *Harvard Women’s Health Watch*, available at http://hvrd.me/YFhaD.

Understanding the stress response

Stress is an unavoidable part of life. But learning to manage it successfully can do much to improve your mental and physical health.

That's why it helps to understand just how your body reacts to stressful situations — and why the so-called fight-or-flight response, which can be life-saving in the case of an immediate physical threat, becomes detrimental when stress is a chronic feature of daily life.

What is stress?

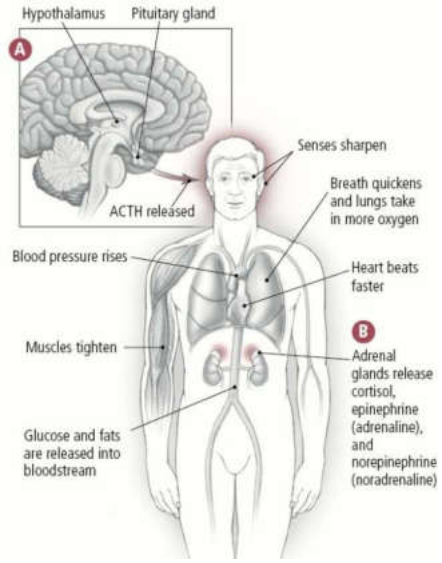
We all encounter stress in our lives, though we might use different examples to describe it. But whether the particular stressor you're confronting is a sudden car crash, a loud argument, or the ache of arthritis, each potential or actual threat triggers a cascade of stress hormones that produce well-orchestrated physiological changes.

You know these sensations well. Your heart pounds. Muscles tense. Breathing quickens, and beads of sweat appear. But although the physical effects may seem simple, these reactions — collectively dubbed the "fight or flight" response — require an intricate coordination of many different body systems.

A look inside the stress response

Our response to threats begins in the brain, which receives and processes information — perhaps the sight of your boss bearing down with an ominous expression, or the sound of an explosion. Instantly, a signal from the motor cortex in the brain speeds down nerve pathways to muscles, which tense and tighten, bracing for trouble. Another signal comes from the hypothalamus, a portion of the brain perched above the brainstem. It relays the warning to the nearby pituitary gland, which sends a chemical messenger via the bloodstream to the adrenal glands. In response, the adrenal glands secrete a series of stress hormones, including epinephrine, better known as adrenaline. (You're probably familiar with the so-called "adrenaline rush" that helps rev up your body. This is part of the stress response.)

The stress response



Collectively, the hypothalamus, pituitary gland, and adrenal glands make up the HPA axis, which plays a pivotal role in triggering the stress response. The hypothalamus sends a chemical messenger (corticotropin-releasing factor, or CRF) to the nearby pituitary gland, which then releases its own chemical messenger (adrenocorticotropic hormone, or ACTH) into the bloodstream **(A)**. ACTH travels to the adrenal glands, which respond by releasing a number of stress hormones into the bloodstream **(B)**.

At the same time, the sympathetic nervous system releases stress hormones, too (not shown). The combined effects of these hormones are widespread, as this illustration reveals. Senses become sharper, muscles tighten, the heart beats faster, blood pressure rises, and breathing quickens. All of this prepares you to fight or flee in the face of danger.

Simultaneously, the hypothalamus fires up the autonomic nervous system. This network of nerves relays the warning down through the spinal cord and from there to nerves throughout the body. In response, nerve endings in organs, blood vessels, the skin, and even sweat glands release epinephrine and norepinephrine.

This tandem surge of hormones primes your body to react to the imminent threat. In the case of an immediate physical danger, such as the sudden appearance of a prowling wild animal or an armed enemy, you respond by either preparing to stand your ground and fight, or else fleeing to safety. Either way, you need to gear up for action, which is precisely what stress hormones enable you to do.

Your breath quickens as your body takes in extra oxygen to help fuel your muscles. Likewise, energy-boosting glucose and fats are released from storage sites into your bloodstream. Sharpened senses, such as sight and hearing, make you more alert.

Your heart pounds — beating up to two to three times as quickly as normal — and your blood pressure rises. Certain blood vessels constrict, which helps direct blood flow to your muscles and brain and away from your skin and other organs.

Blood cells called platelets become stickier, so clots can form more easily to minimize bleeding from potential injuries. Immune system activity picks up. Your muscles — even the tiny hair-raising muscles beneath your skin — tighten, preparing you to spring into action.

Body systems not needed for the immediate emergency are suppressed in order to focus energy where it's needed. The stomach and intestines cease operations. Sexual arousal lessens. Repair and growth of body tissues slows.

Defusing the stress response

The autonomic nervous system, it turns out, is divided into two parts with opposite effects. The sympathetic nervous system revs up the body in response to perceived dangers, as described above. Its counterpart, the parasympathetic nervous system, calms the body after the danger has passed. But in today's society, stressors often pile up one after another in a combination of traffic jams, deadlines, money woes, and a host of other challenges that fill our days, rather than passing rapidly, like the wild animal that eventually lumbers away. As a result, the sympathetic system often remains engaged long after it should have yielded to the soothing influence of the parasympathetic system. The results can be damaging in many ways.

When your body repeatedly experiences the stress response, or when arousal following a terrible trauma is never fully switched off, your body's stress response can be described as maladaptive, or unhealthy. In this situation, the stress response kicks in sooner or more frequently than normal, increasing the burden your body must handle. Maladaptive stress responses can lead to worrisome health problems. A prime example of this is high blood pressure, or hypertension, which is a major risk factor for coronary artery disease. Another is suppression of the immune system, which increases susceptibility to colds and other common illnesses.

Even faced with chronic stress, however, you can benefit from stress management techniques. Regular use of these techniques can help you tamp down the sympathetic nervous system when it is not truly needed and restore balance.

The importance of stress reduction

Skeptics have long believed that meditation and other stress reduction techniques are nice but ineffectual practices that do little for you. Nothing could be further from the truth — and now we have the science to prove it.

Intriguing new research suggests that regularly eliciting the relaxation response — a natural counterbalance to the stress response — can act on our genes in ways that may evoke multiple health benefits and help reduce the harmful effects of stress. Small studies of various stress reduction techniques, as well as comprehensive programs, suggest that it's quite possible to improve many measures of health by making the strong mind-body connection work in your favor.

Genes and the relaxation response

Exciting new research from the Benson-Henry Institute for Mind Body Medicine at Massachusetts General Hospital suggests that the simple act of eliciting the relaxation response (and thereby dialing back the stress response) temporarily changes the activity of certain genes in ways that may benefit health. For starters, it switches off genes associated with chronic inflammatory responses. Many experts believe these inflammatory responses stress the body, possibly contributing to a host of chronic ailments, such as heart disease, inflammatory bowel disease, and diabetes. At the same time, it switches on genes linked with a variety of functions: the use of energy in the body, the release of insulin (which helps regulate blood sugar), the maintenance of telomeres (protective end-caps on our chromosomes that erode with age until a cell dies), and the functions of tiny cellular powerhouses called mitochondria. The researchers speculate that the latter may create energy reserves that help the body counter oxidative stress that can harm cells.

For this study, the researchers recruited two small groups of healthy subjects: long-term practitioners of techniques like yoga, meditation, and repetitive prayer that elicit the relaxation response; and novices who hadn't used these techniques before. The novices learned a sequence of relaxation response techniques, which they practiced for 20 minutes a day, guided by a CD, over eight weeks. This sequence included diaphragmatic breathing (also known as breath focus), body scan, mantra repetition, and mindfulness meditation.

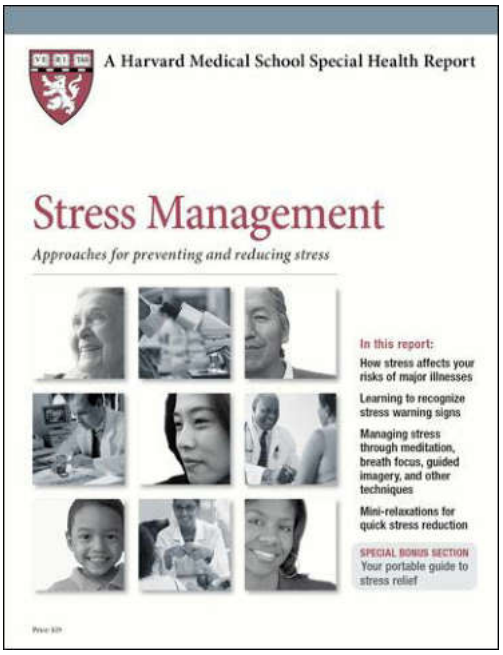
To gauge the changes in gene activity, the researchers obtained blood samples from the groups immediately before a single relaxation response session, immediately afterward, and 15 minutes afterward. While the long-term practitioners had the most profound changes in gene activity, the group with eight weeks of training also experienced significant changes in gene activity compared with the results they'd posted as complete novices.

These results built on the findings of an earlier study conducted by the Genomics Center at Beth Israel Deaconess Medical Center and the Benson-Henry Institute for Mind Body Medicine that found similar results, with changes in the activity of genes controlling how the body handles free radicals,

inflammatory processes, and cell death. Once again, greater changes were seen in the long-term practitioners than in the novices.

Aiming for lasting benefits

Gene activity isn't altered forever by yoga or repetitive prayer. One lesson gleaned from these studies is that the relaxation response must be regularly elicited in order to make beneficial changes persist. Additional research needs to be done to learn whether similar changes occur in people who use relaxation response techniques to help treat stress-related illnesses. Already, studies examining the effects of relaxation techniques on hypertension, inflammatory bowel syndrome, and multiple myeloma are under way.



To learn more…

This information was prepared by the editors of the Harvard Health Publications division of Harvard Medical School. It is excerpted from our Special Health Report *Stress Management*, available at http://hvrd.me/YFn9u.

Health problems that are linked to stress

Stress may contribute to or exacerbate health problems from A to Z (or at least to U). Among them:

- allergic skin reactions
- anxiety
- arthritis
- constipation
- cough
- depression
- diabetes
- dizziness
- gum disease
- headaches
- heart problems, such as angina (chest pains), arrhythmias, heart attack, and palpitations (pounding heart)
- heartburn
- high blood pressure
- infectious diseases, such as colds or herpes
- insomnia and resulting fatigue
- irritable bowel syndrome
- menopausal symptoms, such as hot flashes
- "morning sickness," the nausea and vomiting of pregnancy
- nervousness
- pain of any sort, including backaches, headaches, abdominal pain, muscle pain, joint aches, postoperative pain, and chronic pain caused by many conditions
- Parkinson's disease
- postoperative swelling
- premenstrual syndrome (PMS)
- side effects of AIDS
- side effects of cancer and cancer treatments
- slow wound healing
- ulcers

To the extent that stress worsens these ailments, the relaxation response (a state of profound rest) and other stress management methods can be healing.

Adapted from The Relaxation Revolution*, Herbert Benson, M.D., and William Proctor, J.D. (Scribner, 2010).*

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.

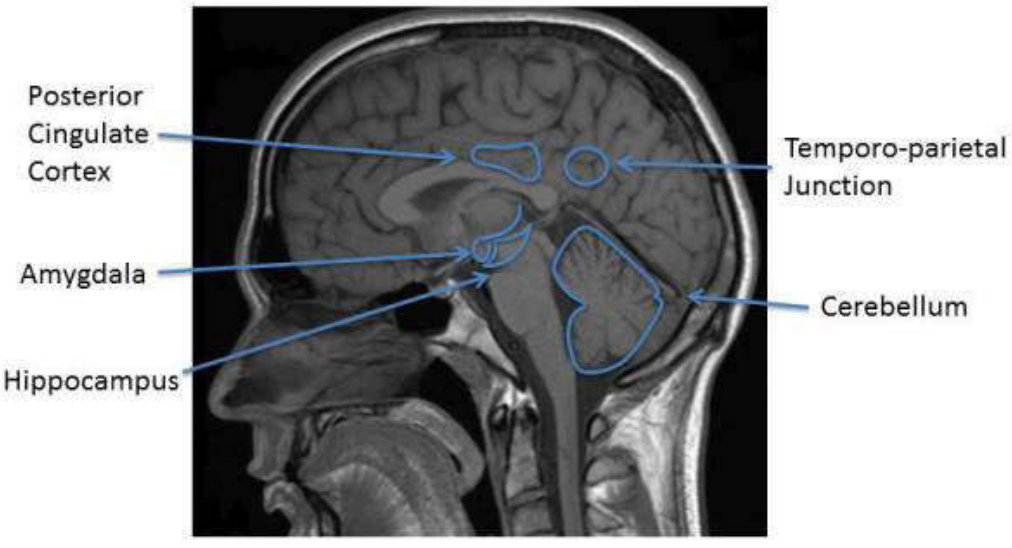


Figure 1*. Profile of a human brain using an MRI. Regions outlined that change after eight weeks of mindfulness meditation training. Original image by Helmut Januschka, modified.*

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.

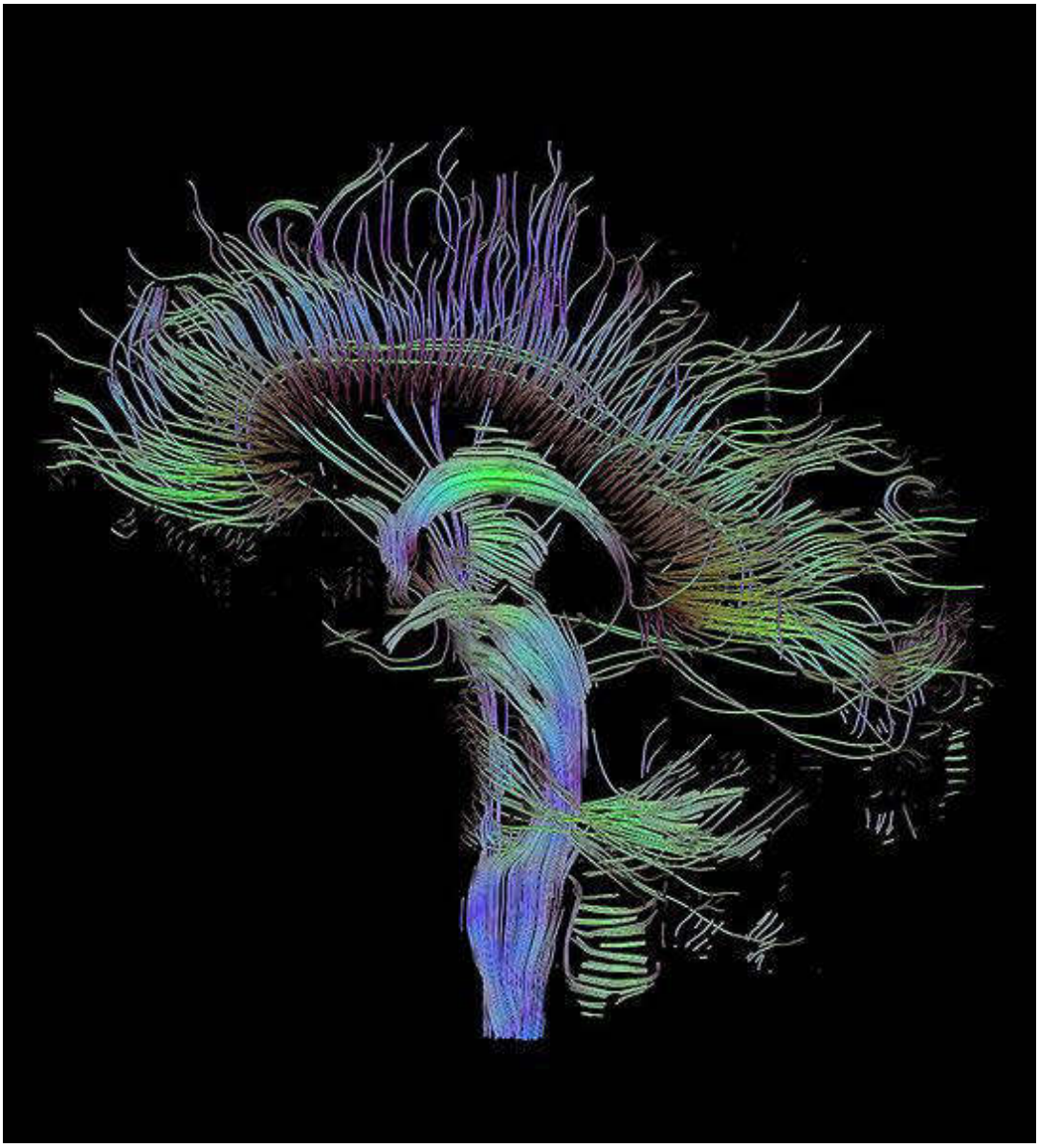


Figure 2*. Profile of a human brain using diffusion tensor imaging, showing the white matter connections of the brain. Image by Thomas Schultz, http://www.sci.utah.edu/~gk/DTI-data/.*

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.

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

Meditation may relieve IBS and IBD

May 5, 2015

By Sue McGreevey, Massachusetts General Hospital Public Affairs
(From *Harvard Gazette*)

A pilot study has found that participating in a nine-week training program including elicitation of the relaxation response had a significant impact on clinical symptoms of the gastrointestinal disorders irritable bowel syndrome (IBS) and inflammatory bowel disease (IBD) and on the expression of genes related to inflammation and the body's response to stress.

The report from investigators at the Benson-Henry Institute for Mind Body Medicine at Massachusetts General Hospital (MGH) and at Beth Israel Deaconess Medical Center (BIDMC), both Harvard affiliates, is the first to study the use of the relaxation response in these disorders and the first to investigate the genomic effects of the relaxation response in individuals with any disorder. The report was published in the open-access journal PLOS ONE. "Our results suggest exciting possibilities for further developing and implementing this treatment in a wider group of patients with gastrointestinal illness," said Braden Kuo of the gastrointestinal unit in the MGH Department of Medicine, co-lead author of the report.

"Several studies have found that stress management techniques and other psychological interventions can help patients with IBS, at least in the short term; and while the evidence for IBD is less apparent, some studies have suggested potential benefits. What is novel about our study is demonstration of the impact of a mind/body intervention on the genes controlling inflammatory factors that are known to play a major role in IBD and possibly in IBS," said Kuo, who is also a Harvard Medical School assistant professor of medicine.

Both IBS and IBD are chronic conditions that produce related symptoms, including abdominal pain and changes in bowel function such as diarrhea. But while IBD — which includes Crohn's disease and ulcerative colitis — is characterized by severe inflammation in all or part of the gastrointestinal tract, no inflammation or visible abnormality is present in IBS. Stress appears

to exacerbate both conditions, and since the symptoms themselves can increase stress in patients, finding ways to break that vicious cycle could have significant clinical benefits.

The relaxation response — a physiologic state of deep rest induced by practices such as meditation, yoga, and prayer — was first described more than 40 years ago by Herbert Benson, director *emeritus* of the Benson-Henry Institute and a co-author of the current paper. Many studies have shown that regular practice of the relaxation response not only alleviates stress and anxiety but also directly affects physiologic factors such as blood pressure, heart rate, and oxygen consumption. In reports published in 2008 and 2013, Benson, along with Towia Libermann and Manoj Bhasin — both of the BIDMC Genomics, Proteomics, Bioinformatics and Systems Biology Center — described how elicitation of the relaxation response in healthy individuals affected the expression of genes in pathways involved with the body's response to stress, inflammation, and energy metabolism. Libermann is co-senior author and Bhasin is co-lead author of the current study.

The current study was designed to investigate whether a relaxation-response-based intervention could improve the quality of life in patients with IBS or IBD and to analyze the intervention's effects on inflammatory markers and gene expression. The study enrolled 48 adult participants — 19 of whom had been diagnosed with IBS and 29 with IBD — who participated in a nine-week group program focused on stress reduction, cognitive skills, and health-enhancing behaviors. Each of the weekly sessions included relaxation response training, and participants were asked to practice relaxation response elicitation at home for 15 to 20 minutes each day. Along with aspects featured in other group programs offered at the Benson-Henry Institute, this program included a session specifically focused on gastrointestinal health.

Study participants were assessed at the outset, midway through, and at the end of the program, and then three weeks later. The assessments used standardized tools for measuring symptoms common to both disorders, assessing anxiety and pain, and determining the effects of the disorders on participants' quality of life. Blood samples were taken at baseline and a week after the study period's conclusion for purposes of profiling gene expression and measuring known inflammatory factors.

Both in patients with IBS and those with IBD, participation in the mind/body program appeared to have significantly improved disease-related symptoms, anxiety, and overall quality of life, not only at the end of the study period but also three weeks later. While there were no significant changes in inflammatory markers for either group of participants, changes in expression were observed in almost 200 genes among participants with IBS and more than 1,000 genes in those with IBD. Many of the genes with altered expression are known to contribute to pathways involved with stress response and inflammation.

"In both IBS and IBD, the pathway controlled by a protein called NF-κB emerged as one of those most significantly affected by the relaxation response, which confirms the findings of our previous genomic studies," said Libermann. "Indeed the relaxation response reduced the expression of a number of genes directly linked to the key inflammatory processes of IBD. While the mechanisms behind IBS are less well-defined, they most likely involve stress response, which also could be improved by relaxation response practice."

Co-senior author John Denninger of the Benson-Henry Institute at MGH noted, "One interesting clinical impact was a decrease in both IBS and IBD patients in what is called pain catastrophizing — a negative cognitive and emotional response to pain or the anticipation of pain. In other words, participants became more resilient in the face of the pain they were experiencing. But before we can offer a program like this to patients with these disorders, we'll need to conduct a longer, randomized trial with a control group and enough participants for statistically significant results."

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http://news.harvard.edu/gazette/story/2015/05/meditation-may-relieve-ibs-and-ibd/

Meditation found to increase brain size

February 2, 2006

By William J. Cromie, Harvard News Office
(From *Harvard Gazette*)

People who meditate grow bigger brains than those who don't. Researchers at Harvard, Yale, and the Massachusetts Institute of Technology have found the first evidence that meditation can alter the physical structure of our brains. Brain scans they conducted reveal that experienced meditators boasted increased thickness in parts of the brain that deal with attention and processing sensory input.

In one area of gray matter, the thickening turns out to be more pronounced in older than in younger people. That's intriguing because those sections of the human cortex, or thinking cap, normally get thinner as we age.

"Our data suggest that meditation practice can promote cortical plasticity in adults in areas important for cognitive and emotional processing and well-being," says Sara Lazar, leader of the study and a psychologist at Harvard Medical School. "These findings are consistent with other studies that demonstrated increased thickness of music areas in the brains of musicians, and visual and motor areas in the brains of jugglers. In other words, the structure of an adult brain can change in response to repeated practice."
The researchers compared brain scans of 20 experienced meditators with those of 15 nonmeditators. Four of the former taught meditation or yoga, but they were not monks living in seclusion. The rest worked in careers such as law, health care, and journalism. All the participants were white. During scanning, the meditators meditated; the others just relaxed and thought about whatever they wanted.

Meditators did Buddhist "insight meditation," which focuses on whatever is there, like noise or body sensations. It doesn't involve "om," other mantras, or chanting.

"The goal is to pay attention to sensory experience, rather than to your thoughts about the sensory experience," Lazar explains. "For example, if you

suddenly hear a noise, you just listen to it rather than thinking about it. If your leg falls asleep, you just notice the physical sensations. If nothing is there, you pay attention to your breathing." Successful meditators get used to not thinking or elaborating things in their mind.

Study participants meditated an average of about 40 minutes a day. Some had been doing it for only a year, others for decades. Depth of the meditation was measured by the slowing of breathing rates. Those most deeply involved in the meditation showed the greatest changes in brain structure. "This strongly suggests," Lazar concludes, "that the differences in brain structure were caused by the meditation, rather than that differences in brain thickness got them into meditation in the first place."

Lazar took up meditation about 10 years ago and now practices insight meditation about three times a week. At first she was not sure it would work. But "I have definitely experienced beneficial changes," she says. "It reduces stress [and] increases my clarity of thought and my tolerance for staying focused in difficult situations."

Controlling random thoughts

Insight meditation can be practiced anytime, anywhere. "People who do it quickly realize that much of what goes on in their heads involves random thoughts that often have little substance," Lazar comments. "The goal is not so much to 'empty' your head, but to not get caught up in random thoughts that pop into consciousness."

She uses this example: Facing an important deadline, people tend to worry about what will happen if they miss it, or if the end product will be good enough to suit the boss. You can drive yourself crazy with unproductive "what if" worry. "If, instead, you focus on the present moment, on what needs to be done and what is happening right now, then much of the feeling of stress goes away," Lazar says. "Feelings become less obstructive and more motivational." The increased thickness of gray matter is not very much, 4 to 8 thousandths of an inch. "These increases are proportional to the time a person has been meditating during their lives," Lazar notes. "This suggests that the thickness differences are acquired through extensive practice and not simply due to differences between meditators and nonmeditators."

As small as they are, you can bet those differences are going to lead to lots more studies to find out just what is going on and how meditation might better be used to improve health and well-being, and even slow aging.
More basic questions need to be answered. What causes the increased thickness? Does meditation produce more connections between brain cells, or more blood vessels? How does increased brain thickness influence daily behavior? Does it promote increased communication between intellectual and emotional areas of the brain?

To get answers, larger studies are planned at Massachusetts General Hospital, the Harvard-affiliated facility where Lazar is a research scientist and where these first studies were done. That work included only 20 meditators and their brains were scanned only once.

"The results were very encouraging," Lazar remarks. "But further research needs to be done using a larger number of people and testing them multiple times. We also need to examine their brains both before and after learning to meditate. Our group is currently planning to do this. Eventually, such research should reveal more about the function of the thickening; that is, how it affects emotions and knowing in terms of both awareness and judgment."

Slowing aging?

Since this type of meditation counteracts the natural thinning of the thinking surface of the brain, could it play a role in slowing – even reversing – aging? That could really be mind-boggling in the most positive sense.
Lazar is cautious in her answer. "Our data suggest that one small bit of brain appears to have a slower rate of cortical thinning, so meditation may help slow some aspects of cognitive aging," she agrees. "But it's important to remember that monks and yogis suffer from the same ailments as the rest of us. They get old and die, too. However, they do claim to enjoy an increased capacity for attention and memory."

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http://news.harvard.edu/gazette/story/2006/02/meditation-found-to-increase-brain-size/

Mindfulness Can Literally Change Your Brain

January 8, 2015

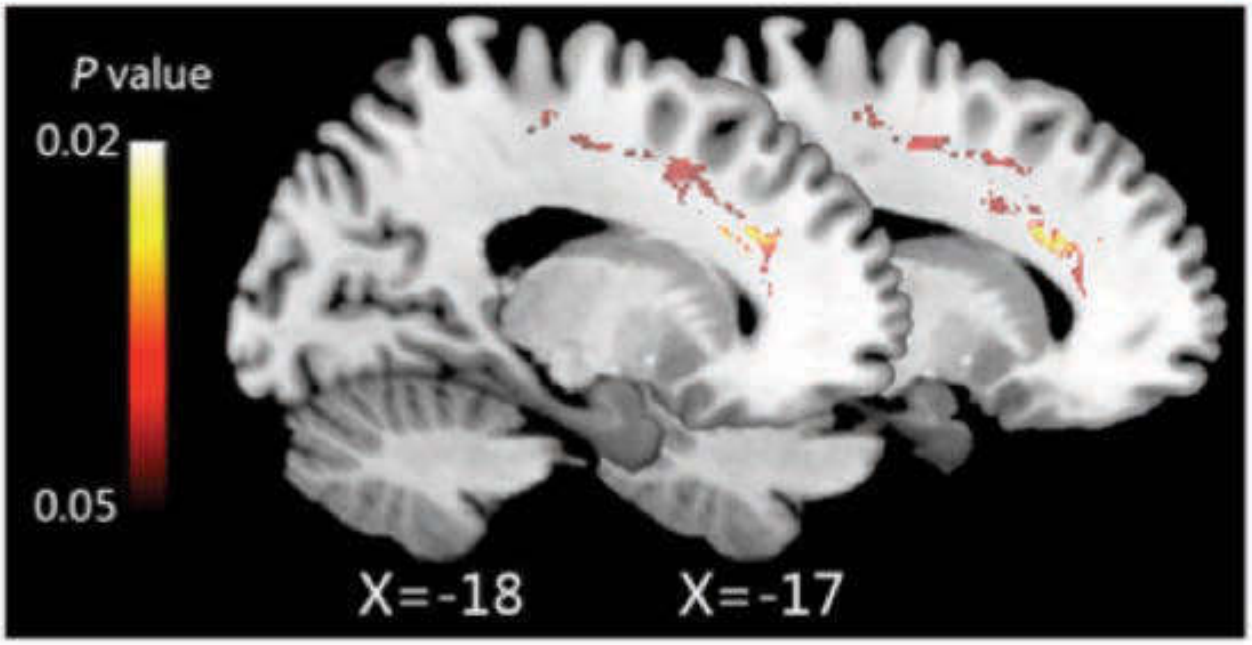
By Christina Congleton, Britta K. Hölzel and Sara W. Lazar
(From *Harvard Business Review*)

The business world is abuzz with mindfulness. But perhaps you haven't heard that the hype is backed by hard science. Recent research provides strong evidence that practicing non-judgmental, present-moment awareness (a.k.a. mindfulness) changes the brain, and it does so in ways that anyone working in today's complex business environment, and certainly every leader, should know about.

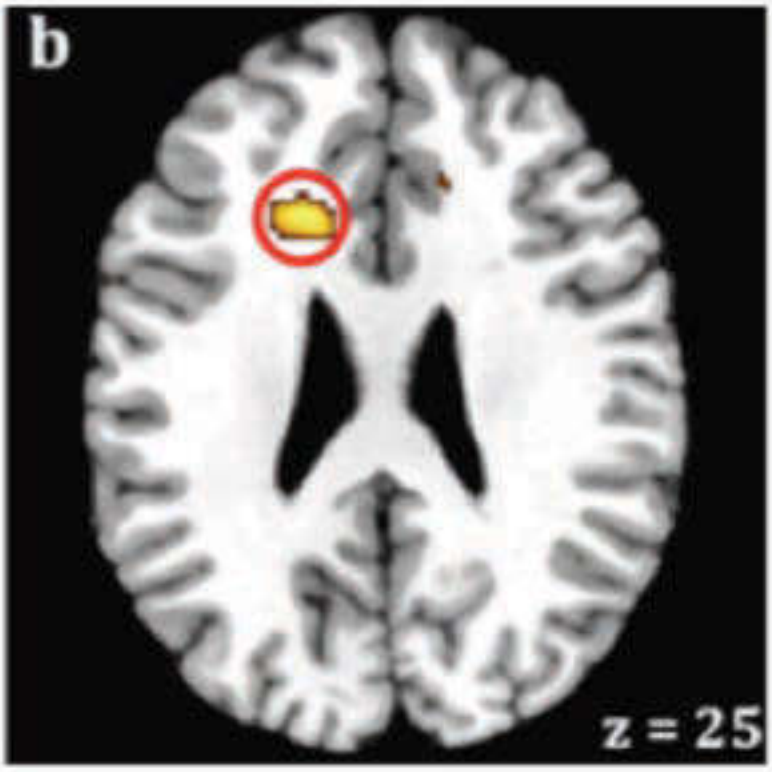
We contributed to this research in 2011 with a study on participants who completed an eight-week mindfulness program. We observed significant increases in the density of their gray matter. In the years since, other neuroscience laboratories from around the world have also investigated ways in which meditation, one key way to practice mindfulness, changes the brain. This year, a team of scientists from the University of British Columbia and the Chemnitz University of Technology were able to pool data from more than 20 studies to determine which areas of the brain are consistently affected. They identified at least eight different regions. Here we will focus on two that we believe to be of particular interest to business professionals.

The first is the anterior cingulate cortex (ACC), a structure located deep inside the forehead, behind the brain's frontal lobe. The ACC is associated with self-regulation, meaning the ability to purposefully direct attention and behavior, suppress inappropriate knee-jerk responses, and switch strategies flexibly. People with damage to the ACC show impulsivity and unchecked aggression, and those with impaired connections between this and other brain regions perform poorly on tests of mental flexibility: they hold onto ineffective problem-solving strategies rather than adapting their behavior. Meditators, on the other hand, demonstrate superior performance on tests of self-regulation, resisting distractions and making correct answers more often than non-meditators. They also show more activity in the ACC than non-meditators. In addition to self-regulation, the ACC is associated with learning from past experience to support optimal decision-making. Scientists point out that the

ACC may be particularly important in the face of uncertain and fast-changing conditions.

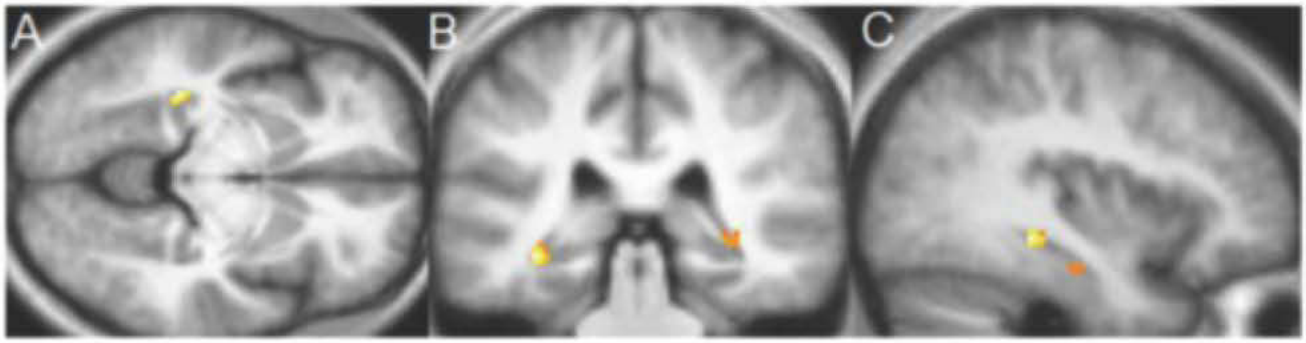


(Source: Tang et al.)



(Source: Fox et al.)

The second brain region we want to highlight is the hippocampus, a region that showed increased amounts of gray matter in the brains of our 2011 mindfulness program participants. This seahorse-shaped area is buried inside the temple on each side of the brain and is part of the limbic system, a set of inner structures associated with emotion and memory. It is covered in receptors for the stress hormone cortisol, and studies have shown that it can be damaged by chronic stress, contributing to a harmful spiral in the body. Indeed, people with stress-related disorders like depression and PTSD tend to have a smaller hippocampus. All of this points to the importance of this brain area in resilience—another key skill in the current high-demand business world.



(Source: Hölzel et al.)

These findings are just the beginning of the story. Neuroscientists have also shown that practicing mindfulness affects brain areas related to perception, body awareness, pain tolerance, emotion regulation, introspection, complex thinking, and sense of self. While more research is needed to document these changes over time and to understand underlying mechanisms, the converging evidence is compelling.

Mindfulness should no longer be considered a "nice-to-have" for executives. It's a "must-have": a way to keep our brains healthy, to support self-regulation and effective decision-making capabilities, and to protect ourselves from toxic stress. It can be integrated into one's religious or spiritual life, or practiced as a form of secular mental training. When we take a seat, take a breath, and commit to being mindful, particularly when we gather with others who are doing the same, we have the potential to be changed.

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Personal Blog
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