Our brain is like a wild, raging electrical storm that wondrously enables us to make our way. Yet a lot of mindfulness literature makes it sound like a very simple machine. Two leading neuroscientists suggest better ways to think and talk about the brain and the mind.

Illustrations by Aaron Piland

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FOR SOME TIME AT MINDFUL, we’ve been concerned that discussions of the brain—particularly in the context of mindfulness and meditation—have become simplified to the point of distorting the truth. They often present the brain as a set of building blocks or Lincoln Logs, each with its own function. The goal of meditation in this model is to strengthen certain parts and suppress others. When we asked neuroscientists doing actual research about these notions, the answer ranged from “that’s very, very simplistic” to “that’s nonsense.”

We are in the middle of an epidemic spread of BS about the brain. Something new comes up just about every week that grossly oversimplifies both what science currently knows about the brain and how the brain might actually work. Trainers and coaches and keynote speakers frequently make extravagant claims about “brain change,” “growing the brain,” or “adding gray matter.” Forbes recently published “6 Brain-Based Leadership Game-Changers for 2018,” by an author who writes about “leveraging neuroscience to create remarkable leadership.” The first diagram illustrates the reptilian brain, the mammalian brain, and the supposed new part of the brain, the neocortex, where “meaning is made.” A quick internet search will let you know that this hypothesis, known as the Triune Brain, “is no longer espoused by the majority of comparative neuroscientists in the post-2000 era.” It’s been debunked for almost two decades.

A newsstand publication called Mindfulness Made Simple contains a two-page spread on “How Mindfulness Physically Changes Your Brain” that points to mindfulness causing growth in the presumed good parts of the brain and shrinkage in the bad parts. It takes some preliminary research out of all context and states it pretty much as fact. Any honest neuroscientist will tell you that we simply do not know this much about how the brain is affected by mindfulness, since we don’t even have a single definition of what mindfulness means. And what we feel we know today will be eclipsed by findings after our lifetime. Humbleness is the watchword when it comes to assertions about how the brain and the mind work.

A book from a major publisher sells itself as “Mind-Hacker’s Guide to Shifting into Brain 3.0.” It promises that you can use science to rewire your brain. Among its claims: You can “overcome PTSD without medication by strengthening neural circuits in Brain 3.0, making your emotional immune system stronger.”

Let’s be clear. This is not science. It is snake oil. The problem, scientists and educators point out, is not that people are being coached and coaxed to “use their brains better.” The problem is using pseudo-science as evidence for the effectiveness of a practice or to present outdated models of the brain and mental experience. These models are often taught to children in school, who go home and tell mommy and daddy that the amygdala is bad and the prefrontal cortex is good. Is it fair to reduce something so wondrous as the brain to a couple of parts—even if this mythology helps children to notice their reactivity and calm down? To delve into the state of the brain science surrounding meditation, we invited two neuroscientists to join in conversation with Mindful about how to effectively talk about the brain when presenting mindfulness and meditation.

Amishi Jha, PhD, is associate professor of psychology and the founder and head of the Jha Lab at the University of Miami. His pioneering work, much of it funded by the Department of Defense and carried out with the military, students, and athletes, shows how mindfulness can protect attention and working memory. The lab is also working on how to scale up mindfulness for larger populations and make its effects long-lasting. She is working to find accessible training that can be broadly adopted by high-performance and high-demand groups, including first responders, police, and firefighters.

Cliff Saron, PhD, is a researcher at the Center for Mind and Brain and director of the Saron Lab at the University of California, Davis. He is known for directing the Shamatha Project, a multiyear investigation of long-term intensive meditation. Findings so far indicate that the practice sharpens and sustains attention, enhances well-being and empathy, and improves physiological markers of health. Saron is interested in not just what the brain is doing when attending to a task, but what’s happening on a moment-by-moment basis as we construct reality.

While Saron and Jha are separated by a continent and different research goals, they see eye-to-eye on the need to be cautious in making assertions about long-term alterations to the brain. They collaborated with a few others on an important paper that provided a preliminary model for distinguishing a variety of mental factors involved in a range of meditation practices. Their several conversations lasted many hours and ranged far and wide. Here are some of the highlights of our exploration of brain and mind.
BARRY BOYCE: Many mindfulness teachers like to use a model of the brain that pits the so-called emotional center deep inside the brain, the amygdala, against the reasoning center of the brain up front, the prefrontal cortex, which carries out our “executive function.” In the battle between these two, mindfulness is on the side of the executive function, coming in to help when the amygdala is out of control. How do you feel about this characterization?

Amishi Jha: I understand the good intentions of smart and kind-hearted people when they use overly simple models of the brain in an attempt to make brain functions broadly accessible, even to small children. They’re trying to help people understand something about problems they’re encountering with their emotions or their attention. I’m trying to do the same thing when I work with first responders or soldiers. No one wants to make costly mistakes. However, we can do better than using a misleading model that implies that a part of the brain, the amygdala, misbehaves or “goes bad,” causing us to freak out, and that to control this reactivity—fear, anxiety, inappropriate behavior—we need to use the “good” part of the brain up front that comes in and tamps down the bad guy.

Cliff Saron: The “good brain, bad brain” idea gets things off on the wrong foot completely. You can err on the side of complexity or simplicity. If you’re trying to simplify things, you want to do it in such a way that you’re still on the side of accuracy. Amishi is exemplary at getting to the essence while still being truthful, using a model that scales up to something that represents a better understanding. Locating all emotion in the amygdala belies what we know about the powerful interconnectedness of the brain. Pictures of the anatomical connections of the amygdala to other parts of the brain, even from 25 years ago, show an incredibly dense level of interconnectivity with almost all parts of the cortex. Huge amounts of the brain are involved in even the simplest of tasks.

Barry Boyce: These models are meant to provide children with a way to think about emotionality as a natural brain process—to help them depersonalize it and find calm and composure. Is it such a problem if it’s a cartoon-like oversimplification?

Jha: It’s an open question whether using a model of brain function actually helps them calm down. These kinds of models are not limited to presentations to children. I’ve heard Mindfulness-Based Stress Reduction teachers talk about the reptilian brain needing to be overcome by the modern-day frontal lobes. That’s the “triume brain hypothesis”—a 1960s-era story of a battle between the older and newer brain not widely accepted in neuroscience today. It’s not part of the curriculum for MBSR, but it’s a kind of freelancing that people do. We don’t really have any evidence that you would get any less benefit if you didn’t use a model of the brain in teaching people meditation. Why mislead if you don’t need to? The modular view of the brain—with a specific function separately housed within a particular chunk of the cortex—is like a holdover from phrenology, when people thought brain functions were tied to bumps on the skull—a bumpy forehead meant someone was more intelligent. We can do better than this.

Barry Boyce: Why does it matter if we’re using notions of the brain that make it easier for us to understand what this thing inside of us is doing?

Saron: As someone who tries to think and teach carefully about the brain, one of the things I grapple with is the difference between feeling like you understand something and having the experience that something is beyond one’s grasp. Fully understanding the human brain falls into the latter category. To think otherwise is a caricature of what neuroscience is about.
A few “facts” about the brain that are misleading or downright false.

**WE ONLY USE 10% OF OUR BRAINS**

Amishi Jha says she still hears this all the time. Yet it is entirely made up and has, in fact, never been espoused by any scientist.

**I MUST BE “RIGHT-BRAINED” SINCE I HAVE A CREATIVE PERSONALITY**

While lateralized brain regions are involved in specific processes such as aspects of language, and it is well known that certain brain structures differ in size on the right and left sides of our brain, the idea of the brain being left-brained or right-brained or “left-brained” “right-brained” dominance remains unsupported. The brain’s hemispheres are highly interconnected and work together for complex processing.

**CROSSWORD PUZZLES WILL KEEP MY BRAIN FROM AGING**

Crossword puzzles may be fun for some, anyway, but doing them is not protective for the brain. This is because the puzzles engage only a specific set of processes. While doing crosswords may make you better at them, there is no evidence that there will be broader benefits to other processes, such as memory or problem solving.

**THE BRAIN DEVELOPS INTO ADULTHOOD, AND THEN YOUR BRAIN CELLS JUST DIE OUT**

More than 100 years of neuroscience failed to find brain cell birth and growth in adult humans. Then, in 1998, the discovery was made that newborn brain cells do form in specific brain structures within the adult brain, such as the hippocampus, a structure involved in storing memories of new things. This seems to suggest that at least some parts of the brain continue to grow, and neuroplasticity still occurs in response to environments or situations, such as learning a new skill.

**NEUROPLASTICITY ONLY OCCURS WITH MEDITATION**

Neuroplasticity refers to the brain’s ability to reorganize itself in response to changes in behavior, neural activity, or other internal or external conditions and functions. This can occur in response to physical injury to the brain, such as trauma, tumor, stroke, or disease, as connections between brain cells may change to compensate for missing or compromised brain function. Neuroplasticity also occurs in response to changes in one’s environment or situations.

**MRI IMAGES PRESENT PICTURES OF HOW THE BRAIN WORKS**

Magnetic resonance imaging is a breakthrough technology that has allowed more precise anatomical pictures for use in medicine. Functional MRI is imaging that moves through time and has been used extensively in brain activity research. While the image itself may be rather direct methods, such as measuring electrical activity, the data is extremely tricky to interpret, requiring a lot of complex statistics. It also opens the door to a trap in thinking called “reverse inference,” looking at apparent brain activity shown by the fMRI in a particular region and making an assumption about what is going on there based on what other research has shown about that region. It’s an educated guess, but it does not qualify as conclusive evidence for a particular kind of brain activity. In short, it cannot be interpreted cautiously: “What you see is not what you get.”

**Not So Fast!**

I’ve developed a six-day workshop called “The Buddha, the Brain, and Bach” with senior meditation teacher Sylvia Boorstein and my wife, Barbara Bogatin, a cellist with the San Francisco Symphony. We explore the intersection of contemplative practice, neuroscience, and musical creativity. We touch upon fundamentals of brain structure and function as well as complex dynamical aspects. It’s a curriculum designed to use the deep awareness cultivated in contemplative practice to foster a sense of knowing and wonder, showing that it doesn’t make sense to rely on narratives that tie things up neatly.

Jha: I agree with that, but in my work I also find it helpful to orient people to what’s happening with their attention when they get off task and bad things result. Naturally, one of the first things we think in trying to keep something simple is how would you explain that to a child?

Coincidentally, that occurred for me with my daughter. She was seven at the time. She jumped up on my lap while I was working on my computer. She ended up picking up a model brain I had sitting around. Not surprisingly she took the whole thing apart. She lifted up one piece after another and asked, “What does this do?”

With the occipital lobe, I said something like “it helps you to see”; for the temporal lobe, it helps you hear; for the cerebellum, it helps you coordinate what’s coming from all your senses, and so on. I was just giving her simple answers, because I was trying to work. At some point, though, I said, “No, let’s not do it this way. Let’s talk about how this actually happens.”

Then, I talked to her about how all of these parts never work alone. They always work together, but they work in specific ways together. As an analogy, I asked her to think about what body parts she would use to do a cartwheel. She said, “I need my hand, and that’s connected to my arm, and that’s connected to the rest of my body.” As I coached her through this investigation, she realized she needed all those parts and more, and she needed them to move together in a pattern that results in a cartwheel.

That’s a pretty good way to think about how the brain works. All of these different parts talk to each other and they need to act together for us to accomplish something we’re trying to do. She seemed to get that you can’t just think of the parts in isolation; you always have to think of how they work together with other parts and with the whole. So I think you can be simple and accessible and also correct, with introducing a lot of distortion.

Barry Boyce: I appreciate that, since it is supposed to be an honest exploration of what’s going on, not simply a way to find easy explanations for things that are hard to understand. In that regard, let’s talk about “executive function.”

As discussed above, strengthening this function—the inhibition, problem solving, decision making, reasoning activities identified as the work of the “upper brain,” the central lobes—is an attribute often ascribed to mindfulness. Is that a fully accurate story?

Jha: You get into trouble when you imply that what some people call the “upstairs brain”—referring to executive function—does all this beneficial regulation and balancing. Treating the frontal lobes almost like a character in a story—the good guy, the white knight—can lead to the view that everything that flows from strong executive control is beneficial. The reality is that someone with high working memory capacity and very good executive control could do some very bad things. Just because a particular brain network can do “good things” doesn’t mean that what it does is always for the good.

Sarson: I would like to drill down a little deeper and ask what’s implied by “executive function.” We need to foster a critical perspective and always pay close attention to the narratives that emerge from the words we use. In the history of science, •
Evolution resulted in attention as a solution to the brain’s problem of information overload. How do we best utilize this resource? What do we do when it’s hijacked? Does meditation have a role to play?

when there is no integrated theory, someone comes up with a term that simplifies understanding. That’s how a phrase like “executive function” is born and comes to mean our capacity to maintain behaviors in line with a goal. It becomes a convenient construct in institutionalized education, which began with an agenda of an individualist society needing workers. You wind up with this fuzzy warm feeling about accomplishing goals and being productive. And what’s the important thing we need to teach kids?

To do what they’re told!
To attain goals someone else sets!
Contemplating, examining—those may go by the wayside.

Barry Boyce: So, when we choose to call this brain activity “executive function,” it’s loaded with all sorts of assumptions that go beyond what’s going on in the brain.

Saron: Yes. “Executive function” is not a fixed thing. It could be called by many names that would take your imagination to different places. It’s fractal. Labels and handles can sometimes obscure as much as elucidate. Science is a human social activity that undergoes changes based on the zeitgeist of the time. And the less and less we know about something, the more room people have to fantasize.

Barry Boyce: But don’t models also have a role to play?
Jha: I understand what Cliff is getting at, and I agree that as scientists we need that kind of awareness of the big picture and a humble acceptance of the limitations of what we’re embarking on, but I also want to be clear about why I think it’s useful to describe the brain to people at all. My attempts are not an abstract educational exercise. They’re always meant to help people address the way they’re suffering right now. I recently met with a military leader who was trying to understand what was going on with his own mind wandering. He had a clear and present need, because the wandering was causing problems.

My interest in attention speaks to when people hold goals in their mind. How does the brain create goals and hold those goals? We can start by saying that the brain has an attention system because there’s far more in the environment than the brain can fully process. Evolution resulted in attention as a solution to the brain’s problem of information overload. It constrains what we deal with so we can more fully process it.

Given that, how do you best utilize this resource and what do you do when it’s being hijacked by rumination, mind wandering, or distraction? When we talk about the brain networks involved in being on- or off-task, we’re leaning on findings from my home field of cognitive neuroscience. Many studies have found that the brain organizes itself into functional networks that vary in their activity and in their interactions over time.

For example, we have the central executive network, which has to do with the ability to harness our resources to control what we’re processing more fully.

The salience network involves being aware of what’s happening, internally and in the environment.

The default mode network we think of as what the brain defaults to when you’re not attending to a task. (See sidebar on page 53.)

These three networks—and specific networks within these networks, and other networks as well—are part of the landscape we’re going to have to deal with when we consider how our brain’s information-processing resources are utilized for the task at hand—and what might be going on when someone experiences rumination, worry, or flashbacks due to PTSD. It’s not about good guys and bad guys. It’s about the dynamic, interactive ways various networks function in relation to each other as we experience and navigate the present moment.

Saron: That’s very clear, and I can see how that can be helpful. It’s several →
The investigation has only just begun, and the tools we have, while relatively advanced, are still too primitive to definitively measure achievement in mind training.

Barry Boyce: What’s your view on using brain measurement equipment to assess meditation, to detect when we’re in a good meditation zone?

Saron: These attempts present big problems for me. There was a plan for a program in Taiwan whose mission was to find brain signatures for compassion and then measure how well participants in a contemplative training program were achieving that. To rely on neuroimaging to assess what is essentially our humanity is preposterous and scarcely misguided. I also find research using scans to assess meditation quality similarly suspect. Who decides exactly what is impermissible in meditations? How do we know which forms of mental activity in an individual are deleterious and which are not? Let’s say the machine determines you’re having self-referential thoughts. If that is true, perhaps you internalized many different representational stances toward reality—ways you think about yourself to yourself—and because there’s nothing to do as you sit on your meditation cushion, these thought patterns start bubbling up in awareness. All the ways you’ve avoided psychological issues in your life start to emerge in consciousness. You have a memory, and that memory causes associations. Do we now label that bad meditation? Or is it merely a part of the introspective terrain being traversed in that sitting session? When you give yourself over to the full depth of the intention behind your meditation practice—what motivated you to do it in the first place— it’s not likely about scoring points for being on your breath. A rich view of the “present moment” encompasses the ways we work with the temporal and spatial aspects of experience: times and places that are not in our immediate sensory field but are nonetheless very significant for our sense of well-being and connection to the world.

Jha: We’re nowhere near to understanding the many facets of the suite of practices we are all introducing to people. The investigation has only just begun, and the tools we have—while advanced compared to decades ago—are still too primitive to serve as definitive measuring sticks for achievement in mind training. Furthermore, we don’t have any way of assessing a “mindful brain.” We don’t have brain signatures for something called “mindfulness.” There are just too many processes at play to have one simplistic label.

That doesn’t mean we can’t use current neuroscience to help people get some insight into processes in the brain that may be problematic for them. The goal is not to see what a mindful brain looks like but to determine how information processing (e.g., within systems like attention) may be altered and perhaps improved by training in mindfulness exercises over days, weeks, or years.

Saron: Why do we need empirical validation for meditative experience, anyway? When it comes to the benefits of stopping and pausing, why can’t common sense prevail? Do you really need brain imaging to tell you that if you stop and smell the roses, you may suffer less? Brain imaging results are loosely coupled to individuals’ actual experience. They can’t be used as a promise for what outcomes will result from practice. My 44 years of exposure to meditation teachings and practices has been essential to my understanding of myself, the ways I connect with others and engage in research. And that didn’t require any scientific data.

Barry Boyce: We commonly hear that “mindfulness changes the brain.” Don’t lots of things change the brain, since neurons that “fire together, wire together”? Saron: That’s the fundamental law of neuroplasticity. Repeated activity makes it easy for the same activity to happen again. You could say the brain only works by changing. So if you repeatedly do something crappy, you get better at that, too.

Jha: If you keep ruminating about your worst experience, your brain will be very efficient at calling to mind that episode. Throughout the history of neuroscience, we’ve known brains alter and transform. The seminal studies of brain damage tell us the brain changes when you destroy parts of it through stroke or injury. These patients recover in some cases, meaning reorganization enables brain function to adapt in a better direction. What’s novel and innovative about brain training in general—and in particular for us, mindfulness meditation—is that beneficial changes don’t always have to be in response to some insult or injury. You may actually be able to engage in training to help optimize certain abilities.

We often hear people say that one sub-organ of the brain is responsible for x function and another for y. However, observations of brain activity have shown that this idea that different parts of the brain work independently to perform a given function—the modular paradigm—is inaccurate. The story we frequently hear that the amygdala is the emotion center and the prefrontal cortex performs executive functions unfairly depicts the brain almost as a collection of machine parts. It may have some usefulness as a metaphor for how different types of brain function might interrelate, but it presents a very limited mechanical view of the brain—which misses the dynamic quality of brain activity and is not good science education.

A metaphor that’s more prevalent among neuroscientists today is the network view of the brain: “dynamic interconnected sets of systems (subsystems, and neural nodes) that work together to carry out certain kinds of activity.” In Amishi Jha’s words, “The networks consist of relationships between an array of brain regions formed through repeated communi- cation among the parts as we navigate through life. These large-scale brain networks are talked about in the literature today as they relate to meditation.”

SALIENCE NETWORK (SN)

The SN has been likened to an air traffic controller. Our nervous system is bombarded with a massive volume of sensory inputs. The SN filters and sorts the input, operating at two levels. The first, described as “fast, automatic, bottom-up,” processes features of our environment we’ve learned or instinctively know are important (i.e., salient). For example, quickly noticing ice on a sidewalk that might cause us to fall down. At the second level, the salience network allows us to focus our attention in order to achieve a goal.

CENTRAL-EXECUTIVE NETWORK (CEN)

The CEN’s role has to do with higher-order cognition and attentional control. It’s what we do at work when we make decisions about focusing and sustaining attention, what we choose to place in working memory (what we need to hold in mind to stay on task), and problem solving. When we say we’re “feeling hard” about something, there is major involvement from this network.

networks vs. machine parts

HOW IT WORKS

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When you mind-wander with awareness, you value the content that emerges—discovering things you didn’t know you were looking for.

**Barry Boyce:** How is training your attention with meditation different from an off-the-shelf brain training program designed to help you pay daily better attention? Or from engaging in a psychotherapy program to help you with your emotion regulation, such as anger management?

**Jha:** Right now there are no established brain training programs that have been able to overcome a really big problem: generalizability. You play a "brain-training" video game over and over again to improve memory, right? What seems to happen is people just get better at that game, but no one has shown that it increases general memory capacity, for example.

**Jha:** That’s why when we’re developing meditation, we don’t just put people in concentration training, but we also think there are styles of practice that are not as performance oriented. Mindfulness is about being present, in the moment.

**Barry Boyce:** You say that emergence—what you didn’t know you were doing—is important. I think that’s really true. It’s why practice goals: There’s a whole term called "mind wandering" that is where science and contemplative practice can meet: as complementary practices. In that emergent process, you develop neuroplasticity that is important for learning.

**Barry Boyce:** So you say that mindfulness training is not just about the exploration of your mind. It’s about the exploration of the world around you.

**Saron:** That's a principle that should become widespread.

**Barry Boyce:** Some people say mind wandering is our biggest problem; others say it's just our mind at play.

**Jha:** We need to be careful with the terminology. When I refer to mind wandering, I mean having off-task thoughts during an ongoing task. That can certainly have deleterious effects. The other definition is when you’re trying to complete a particular task at hand, but rather you are allowing the free flow of conscious experience. That can look an awful lot like what I just referred to, but there is a critical difference: It’s consciously engaged and doesn’t have the kind of negative outcomes that can occur when you’re asleep at the switch.

**Saron:** This is where creativity comes in. You’re allowing for the emergence of that unconscious intelligence I referred to earlier. You don’t cut off access to it. That’s mind wandering with awareness. You value the content that emerges along the way—discovering things you didn’t know you were looking for. It gets back to the awes I was talking about earlier. I encourage everyone to look at something National Geographic did with the work of Jeff Leibert and his lab at Harvard. It’s very high-resolution 3-D images of teeny tiny portions of mouse visual cortex. It’s breathtaking to look at all that’s going on there in a 4-minute video narrated by Jeff. He talks the viewer to a point where you relax and say “OK. I don’t get it!”

When Leibert asked his students to consider if knowing everything possible about the brain is a mile, how far have we traveled? Their answers tended to range from a quarter-mile to three-quarters of a mile. His answer: 3 inches. Our mandate in life as scientists is to be drenched in the illusion of and the ways we interact with each other.