

Understanding how positive and negative emotions develop, and how they shape our ability to be happy, can be central to a fruitful spiritual practice. In the following essay, Dr. Rick Hanson focuses on the intersection between psychology, neurology, and Buddhism, reviewing seven significant, scientifically proven facts about the brain. He explores such questions as: Is the brain more inclined toward positive or negative emotions? Is it possible to train your brain to focus on positive emotions and experiences and, if so, can that heighten the joy in life? How does our brain change, and can you use your mind to change your brain to benefit your whole being, and other beings, too, even the whole wide world?

Seven Facts about the Brain That Incline the Mind to Joy

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*In a way, the methodologies of Buddhist thought
and science are essentially similar.*

—*The Dalai Lama*

We all want to be truly happy. The question is, *how*?

From the perspective of both Western psychology and the world's contemplative traditions, the “how” of happiness—and less anxiety, sorrow, frustration, disappointment, and anger—always involves changing the mind in some ways. For example, in Buddhist practice one sees into the mind, the seat of clinging in all its forms, ever more deeply, in order to

increase the causes of happiness and reduce the causes of suffering, ultimately to the point of complete Awakening.

But what does it mean, *actually*, to transform the mind? (I use the word “mind” in the ordinary sense, as the realm of awareness, thoughts, feelings, sensations, images, desires, personality patterns, etc.) It is very exciting these days that an integrated answer to that vital question is emerging from the growing intersection of three historically separated fields: psychology, neurology, and contemplative practice.

For example, in the past few years, scholars working in what’s called “contemplative neuroscience” have made discoveries about attention, cultivating positive emotions, and controlling craving that support the development of virtue, concentration, and wisdom; besides being sources of happiness and valuable in their own right, these are the three pillars of Buddhist practice. Further, the growing synergies between science and contemplative training are a vital resource for a world poised on the edge of the sword, since the way it tips will depend a lot on whether enough people become more skillful at managing the reactive patterns of their minds, and thus, their brains.

As one illustration of this synergy—and how it can help you personally, and those you care for and about—let’s explore seven facts about your brain, and how to use them to turn your mind increasingly toward peacefulness, contentment, and joy.

I: THE MIND AND THE BRAIN ARE MAINLY (PERHAPS ENTIRELY) A SINGLE SYSTEM.

Most neuroscientists think that our thoughts and feelings, darkest passions and loftiest dreams, poetry and imagery, chess gambits and baseball statistics and recipes and quilt patterns and earliest memories of snow—and all the other textures and aromas and shades of being alive—require and are produced by nervous system activity.

While there could well be a mysterious transcendental *Something* infusing objective and subjective reality, whose influence is subtle, profound, and full of grace (which is my personal belief), the wonders of the mind may not require an extraordinary (call it mystical) basis in addition to the brain itself.

To be sure, it is not unreasonable to think that an extraordinary phenomenon could require an extraordinary explanation. For example, seeing the extraordinary differences between humans and other animals, many people concluded that we must have been created by an extraordinary God. But today, it's understood that humans evolved by ordinary causes, notably DNA molecules and survival of the fittest, unfolding via zillions of organisms over several billion years. A *lot* of ordinary causes can produce an extraordinary result.

Similarly, when you take an ordinary synapse (basically, a simple on-off switch) but then multiply it by 500 trillion or so, usually firing many times a second, with tremendous interconnectivity . . . well, you can get extraordinary results, like understanding these sentences, or cultivating lovingkindness, or becoming aware of awareness itself. As the capabilities of the brain become even better understood over the next hundred years, most (if not all) of our experiences—the rich soil of the path of practice—will likely be revealed as entirely enabled by the physical brain, and not due in any way to extraordinary mystical factors.

For me, this view is not mechanistic or stifling. It makes you profoundly grateful for evolution's gift of the brain, sensitive to your responsibilities to shape it over time, and inspired by its potential for extraordinary goodness, love, and realization. So I bow to the Transcendental, but for the purposes of this essay, will stay inside the framework of Western science.

Within that frame, *everything* we are aware of, including our own sense of self, is considered to have a one-to-one correspondence with underlying physical brain structures and processes.

Just as a letter to friend or a picture of a sunset on your computer requires and represents an underlying pattern of magnetic charges on your hard drive.

This integration of mind and brain has three profound implications.

First, it means that *as your experience changes, your brain changes*. It changes both temporarily, millisecond by millisecond, and it changes in lasting ways. For example, researchers have found that:

- Different mental activities change brainwave patterns
- People who meditate have more of the vital neurotransmitter, serotonin
- The brains of pianists are thicker in the areas of fine motor function
- The brains of meditators are thicker in the regions engaged with sensory awareness and with the control of attention
- The brains of taxi drivers in London are thicker in the regions that are key to visual-spatial memories
- Repeated experiences of depression create marked changes in the brain that make a person more vulnerable to depression in the future

Second, *as your brain changes, your experience changes*. For example, as most of us have experienced in everyday life, caffeine makes you feel stimulated and alert while alcohol makes you feel relaxed and even sleepy. More technically, studies have found that:

- Activating the left frontal regions leads to a sunnier outlook and more positive mood, while strokes in those areas leave patients particularly irritable and depressed
- Surges of the neurotransmitter dopamine feel very pleasurable (why dopamine is associated with addictions)

- Damage to a cubic centimeter or so of tissue in a particular place on the left side of your brain can leave you able to understand language but incapable of generating it, while damage just a few centimeters away will have the opposite effect
- Electrically stimulating portions of the brain can trigger memories or even out-of-body experiences

And this research is mainly less than twenty years old. Consider how the invention of the microscope in the early 1600s opened up an entire new world in its revelation of all the “tiny beasts” found in a teardrop or a bit of pond water. Yet it still took four hundred years to develop the modern understanding of molecular biology and evolution.

Comparable technologies for peering into the brain have been around for only a few decades, and the scientific understanding of that organ is roughly comparable to the state of biology in, say, the early 1800s. Just imagine what will be understood four hundred years from now . . . or even forty.

This intimate intertwining of mind and matter, psyche and soma, self and brain, may seem off-putting and reductionistic at first. To put it a little graphically: “What do you mean? I’m just the *meat*?!”

Yet for me, this oneness of mind and brain actually provokes an incredible sense of awe, as well as gratitude that we have inherited the results of 3.5 billion years of evolutionary refinement of the machinery underlying the mind. That appreciation takes one to a sense of responsibility to make the most of one’s life, to not waste this incredible, jaw-dropping gift of human consciousness.

This is the third profound implication of the integration of mind and brain, a fantastic opportunity for well-being, psychological growth, and contemplative depth: in hundreds of ways, large and small, you can deliberately *use your mind to change your brain to benefit your whole being*—and everyone else whose life you touch.

2: “NEURONS THAT FIRE TOGETHER, WIRE TOGETHER.”

This famous saying, from the work of the Canadian psychologist Donald Hebb, explains how learning occurs in the brain, whether it’s a newborn rooting for the nipple, a toddler acquiring language, a schoolchild figuring out fractions, a manager getting better at running meetings, or anyone getting clearer about what causes suffering for oneself and others. Learning is *everything*. Humans have the longest childhood of any animal on the planet because we have so much to learn, and it doesn’t stop when we get out of high school. Even though our culture (and conventional education) idolizes words and verbal thought, most learning is nonverbal, emotional, or sensorimotor. For example, for someone starting to go deeper in meditation, there is a subtle learning of how to establish a steady awareness of attention itself, a growing competence and skillfulness at encouraging a gentle grounding in the body and quieting of the mind.

Hebb’s insight was that we learn through the strengthening of connections between simultaneously firing neurons in the extraordinary network of the brain. Neurons with synapses to each other—tiny gaps full of a rich soup of neurotransmitters where they come oh-so-close together—which fire at the same time, become more responsive to each other. It’s as if they’re saying: “We’re in synch with each other, so let’s get more connected.” This same process occurs in existing circuits, too. Every time one activates as a whole, the connections within it are reinforced.

This strengthening happens both during brief intervals of time through ephemeral electrochemical ebbs and flows and over longer periods, as physically observable changes occur in the brain. These include:

- Increased synaptic connections among neurons (synapses are the junctions between neurons: tiny gaps that function like microscopic switches, on/off)

- Increased thickening of the glial cells, the “scaffolding” tissues that support neurons
- Greater density of blood vessels bringing oxygen, glucose, etc. to neurons

3: FLEETING EXPERIENCES LEAVE LASTING TRACES IN THE BRAIN.

Since the mind and brain are one, the flow of information in the mind causes a corresponding flow of electrochemical activation through the neuronal circuitry of the brain. In other words, the fleeting “stream of consciousness” leaves behind lasting marks on your brain, much like a spring shower leaves a trail of little furrows on a hillside.

This means that your experiences are important: not just due to their brief effects on your momentary, subjective quality of life, but also because they produce enduring changes in the physical structures of your brain. And these alterations in your brain will then affect your well-being, functioning, and sometimes your physical health for days and decades to come. Which of course will affect others besides yourself.

Your experience really, really matters. Which is a scientifically substantiated rationale for being kind to yourself and creating the causes of more beneficial experiences for yourself and fewer harmful ones.

4: MOST CHANGES IN THE TISSUES OF THE BRAIN ARE IN IMPLICIT MEMORY.

There are two kinds of memory:

- Explicit: Recollections of specific events and factual knowledge
- Implicit: Emotions, body sensations, relationship paradigms, sense of the world, and behavioral strategies

Implicit memory is visceral, felt, powerful, and rooted in the fundamental and ancient—reptile and early mammal—structures

of your brain. The inner atmosphere of your mind (what living feels like for you) depends greatly on what is stored in your implicit memory.

If in a physical sense “we are what we eat,” in a psychological sense we are what we *remember*, especially *implicitly*—the slowly accumulating registration of lived experience. That’s what we have “taken in” to become a part of ourselves. Just as food becomes woven into the body, memory becomes woven into the self.

5: UNFORTUNATELY, THE BRAIN EMPHASIZES NEGATIVE EXPERIENCES.

It’s the negative experiences that signal the greatest threats to survival. So our ancient animal and human ancestors that lived to pass on their genes paid a *lot* of attention to negative experiences.

Consider 80 million years or so of mammal evolution, starting with little rodent-like creatures dodging dinosaurs to stay alive and have babies in a worldwide Jurassic Park. Constantly looking over their shoulders, alert to the slightest crackle of brush, quick to freeze or bolt or attack depending on the situation. Just like any mouse or squirrel you might see in the wild today: the quick and the dead.

Today, that same neurological circuitry is loaded and fully operational as you drive through traffic, argue with your mate, hear an odd noise in the night, or get an unexpected letter from the IRS.

First, the amygdala—the switchboard that assigns a feeling tone to the stimuli flowing through the brain (pleasant, unpleasant, and neutral) and initiates a response (approach, avoid, move on)—is physically primed to label experiences as frightening and negative. In other words, it’s built to *look* for the bad. For example, when someone—a parent, friend, lover, or boss—gives you feedback, doesn’t your mind go to the hint of criticism surrounded by praise? (Mine sure does.) It gets signals

from an adjacent node in the brain called the hippocampus, which compares current perceptual information to memories of previous threats and whenever it discerns a match—BOO! it shouts to the amygdala, “Warn the whole town!”

Second, when an event is flagged as negative, the amygdala and its neighbor in the brain, the hippocampus, store it carefully for future reference. Forever after, the hippocampus-amygdala circuit compares current perceptual information to the record of old painful events, and if there are any similarities, alarm bells start ringing. Once burned, twice shy. In short, your brain doesn’t just go looking for what’s negative; it’s built to grab that information and never let it go.

Sure, we can notice positive experiences and remember them. But unless you’re having a million-dollar moment, the brain circuitry for what’s positive is like a notepad compared to a high-speed computer hard-drive for what’s negative. When you look back on a typical day, what’s usually more prominent in memory: the dozens of mildly pleasant moments, or the one that was awkward or worrisome? When you look back on your life, what’s more memorable: the ten thousand pleasures and accomplishments, or the handful of losses and failures?

Third, the negative generally trumps the positive; consider how a single bad event with a dog is more memorable than a thousand good times. Speaking of dogs, the studies on learned helplessness from Martin Seligman and his colleagues illustrate this point in haunting ways: it took only a short time to induce a sense of helplessness in the dogs, whose brain circuitry for emotional memory is in some ways similar to our own. But it took an extraordinary effort to get them to unlearn that training. It’s as if mammals, including ourselves, are predisposed to believe the worst about the world and themselves, and to doubt the best.

As a result, your own personal training in the negative—whatever it’s been—can’t help but leave lasting changes in your brain

that shape your view of the world and yourself, and your personality and interpersonal style and approach to life. (In extreme cases, if a person has a serious history of trauma or depression, the hippocampus can actually shrink 10 to 20 percent, impairing the brain's capacity to remember positive experiences.) Your brain is like velcro for negative experiences and teflon for positive ones.

All that can lead to more of the negative showing up on your radar, either because you are scanning for it preferentially or unwittingly increasing the odds of it coming your way. Which, in a vicious cycle, can make you even more inclined to see or cause the negative in the future—even though the actual facts are that the vast majority of the events and experiences in your life are neutral or positive! Every day, the minds of most people render verdicts about their character, their life, and their future possibilities that are profoundly unfair.

Besides the implications for everyday life, the brain's built-in negativity bias wears on spiritual inclinations and activities. In terms of Buddhist practice, for instance, this bias feeds the Five Hindrances of greed, ill will, sloth and torpor, restlessness and remorse, and doubt. It also saps motivation for right effort, the spiritual equivalent of learned helplessness. And it undermines *bhavana*—the cultivation of wholesome qualities—by downplaying good lessons and experiences, by undermining their storage, and by making it harder to recollect positive states of mind so we can find our way back to them.

What to do about this?

6: YOU CAN HELP EMPHASIZE AND STORE POSITIVE EXPERIENCES THROUGH CONSCIOUS ATTENTION.

As you know from school (and this is corroborated by hundreds of studies) you remember something best when you make it as vivid as possible and then give it heightened attention over an extended period.

That's exactly how to register positive experiences in your implicit memory, which will slowly but surely change the interior landscape of your mind.

Three simple steps:

1. Help positive events become positive *experiences*:
 - Pay extra attention to the good things in the world and in yourself. For example, notice things that go well, or people who treat you kindly, or when you succeed at something. As we know, it is ignorance, fundamentally, that leads to suffering—and not seeing the good that is actually present is a kind of ignorance.
 - As a mindfulness practice, focus on the sensations and the feelings in a positive experience since they are the pathway to emotional memory.
 - Deliberately create positive experiences for yourself. Examples include acts of generosity, evoking compassion, or recalling a time when you were happy.
2. Savor the experience as a kind of concentration practice; keep your attention on it for many seconds while letting it fill your body and mind.
3. Sense that the experience is *soaking* into you, registering deeply in emotional memory. You could imagine that it's sinking into your chest and back and brainstem, or imagine a treasure chest in your heart.

These three steps usually take half a minute or less, and with practice you'll get even faster. Every day, there are many opportunities for noticing and absorbing good experiences. Any single instance won't make a big difference, but as the days and weeks add up, the mounting pile of positive implicit memories will provide more resources for coping—and practice—and brighten your inner landscape.

Because “neurons that fire together, wire together,” momentary *states* become enduring *traits*. These traits then become the causes of more wholesome states, which nourish your traits further in a positive cycle. To paraphrase Mathieu Ricard: if you take care of the minutes and the hours—the days and years will take care of themselves.

7: POSITIVE EXPERIENCES HAVE MANY IMPORTANT BENEFITS.

In general

- Emotions organize the mind as a whole, so positive feelings and their related body sensations, thoughts, and desires have global effects.
- Positive experiences lower the stress response in your body by dampening the arousal of the sympathetic nervous system (the “fight or flight” wing) and by activating the parasympathetic nervous system (relaxed and contented). For example, positive feelings reduce the impact of stress on your cardiovascular system.
- They increase psychological resilience.
- They lift mood and protect against depression.
- They promote optimism—another bulwark against depression.
- Over time, positive experiences help counteract the effects of trauma or other painful experiences. When you remember something painful from your past, your brain first reconstructs that memory (including its emotional associations) from a few key elements, and then it reconstitutes it in storage *with tinges of your state of mind when you recalled it the last time*. This means that if you recall an event repeatedly with a dour, glum cast of mind, then your recollection of it will be increasingly shaded negatively. Alternately, if you recall it repeatedly with a realistically upbeat state of being, then it will

gradually come to mind more and more with a more neutral quality: you will not forget the facts of whatever happened, but their emotional charge will slowly fade—and that can be a great relief.

- They highlight key states of mind so you can find your way back to them in the future. So you can more readily tap into peace, contentment, strength, well-being, lovingkindness, etc.
- They reward you for doing things that aren't always easy (like acting with unilateral virtue even when others are being difficult) and thus support your ongoing motivation.

For children

- All of the benefits above apply to kids as well.
- In particular, children who are in the spirited range of temperament really benefit from deliberately slowing down to take in positive experiences, since they tend to move along quickly to the next thing before the previous good feelings have had a chance to consolidate in the brain.
- Similarly, children in the anxious/rigid range of temperament also benefit from consciously soaking in good feelings, since they tend to ignore or downplay the evidence for those positive experiences.

For contemplative practice

- Positive experiences promote steadiness of mind, necessary for any fruitful meditation.
- They support the deep states of absorption that are both blissful and profoundly insightful. For example, the high levels of dopamine associated with joy help keep the “gate” of awareness shut to being flooded by new experience, and thus support concentration.

- They build confidence in the fruits of one's efforts. Conviction is a major engine of practice and perseverance; for example, in Buddhism, it is one of the factors of enlightenment.
- Fundamentally, you are cultivating wholesome qualities in your mind and heart, and both crowding out and replacing negative ones.

HOW BRAIN SCIENCE CAN SUPPORT SPIRITUAL PRACTICE

To be sure, scientific ideas and methods are not *necessary* to fulfill any path of awakening, including the one laid out by the Buddha—the one I know best. But the emerging map of the mind and the brain can *support* practice in numerous ways.

First, knowing more about the brain/mind deepens conviction (faith), which is one of the factors of enlightenment in Buddhism, since scientific developments confirm many ancient (and modern) spiritual teachings. For example, researchers have found that the activities of “self” are scattered throughout the brain, constructed from multiple sub-systems, and activated by many prior causes: there is no coherent, stable, independent self looking out through your eyes; in a neurological sense, self is truly “empty.” For many Westerners, science is the benchmark authority for what is true, and when it is in harmony with their spiritual or philosophical beliefs, that reduces the hindrance of doubt.

Second, neuropsychology can explain *why* traditional practices work, and help you focus on their key elements. For instance, rapture and joy, which are traditional factors of meditative absorption, involve high levels of the neurotransmitter dopamine. Your brain also uses pulses of dopamine to open the neuronal gate that allows new material into the field of attention. But when you're full of rapture and joy, any new surges of dopamine make little difference since their levels are *already* near their maximum. As a result, the gate of attention is harder to open, and you're more able to remain focused on the breath.

Third, brain science can highlight which of the hundreds of traditional methods are likely to be most effective for individual needs. This helps intensify practice, especially for householders who don't have the benefits of the all-surrounding environment and close guidance of monastic life.

The great variety of brains and thus minds is a diversity issue in its own right, which underscores the value of the appropriate individualization of practice. For example, there is a wide range of temperaments, and for a person who's naturally spirited, understanding and normalizing the hungry-for-stimulation systems in his or her brain can lead to emphasizing certain forms of meditation in the development of steadiness of mind (e.g., tracking the breath as a whole rather than at just one spot), and to becoming more self-accepting.

Fourth, the developing brain/mind map can suggest new and effective methods to build upon established practices. For instance, some teachers are drawing on the research literature in attachment theory, empathic attunement, and mirror neurons to refine the methods of interpersonal mindfulness. (For more examples, please see our website, www.wisebrain.org.)

Of course, any scientific enhancements of traditionally skillful means must be balanced by virtue and wisdom. Further, the ultimate fruit of practice—oneness with God, enlightenment, nirvana, or whatever it is for you—transcends all methods. Nonetheless, every contemplative tradition also teaches that the highest attainment always requires a dedicated training of mind and heart, which means a transformation of brain and body. Even if the apple falls by grace, its ripening comes from water, sunlight, and fertile ground.

PITFALLS

The meeting between science and contemplative practice brings many gifts and opportunities, but also some potential pitfalls,

and understanding these will help you sift out the information that is personally useful:

- *Getting neurologically reductionistic.* While simplifications are sometimes clarifying, they need to be held in perspective. If you find yourself reading about the amygdala and fear, mirror neurons and empathy, oxytocin and lovingkindness, high-frequency brain waves and meditative concentration, etc. . . . no matter how accurate that material is, it's always more complicated than that.
- *Glamorizing science.* As the Buddha said, “See for yourself.” The ultimate test of your practice is whether it *works*—and it probably has for millions of people for thousand of years. No contemplative tradition needs the endorsement of science to prove its validity.
- *Over-generalizing from group data to individuals.* In the press and even the scientific literature, you'll sometimes find statements like these: “Men have stronger visual-spatial abilities” or “Meditators react better to stress.” Yes, the average man could be slightly better at visual tasks than the average woman. But it's *not* correct to equate everybody in a group with its average, and then make categorical statements about all its members. Many women are more visually adept than many men . . . just as many meditators can get pretty stressed out!
- *Overvaluing the physical.* For example, genetic factors usually account for less than a third to a half of our personality, intelligence, happiness, satisfaction with relationships, lifetime earnings, or spiritual growth. The rest is due to the influences of our own self-direction and the ways we interact with our environments—which is very, very hopeful. And since the normal brain can hold both horrible and wonderful thoughts, emotions, and wants, it's the

contents of mind that usually count most, not the physical organ that enables them.

Further, appreciating the integration of mind and brain does not mean reducing mind *to* brain. To be unavoidably technical: mind is patterns of information represented by patterns of matter. Since much mental information can be represented by any suitable neural circuit—much as a picture can be represented by any available RAM on your computer—it is functionally independent of its physical substrate. Second, this independence enables thoughts (and other aspects of mind) to be the fundamental cause of other thoughts; the brain carries thoughts but it does not necessarily *cause* them. And third, mind can cause changes in matter through its representations in matter; for example, immaterial thoughts of gratitude are embodied in cascading physical processes which can trigger physical circuits that dampen the release of stress hormones.

KEY FEATURES AND FUNCTIONS OF YOUR BRAIN

- It's shaped by evolution; the main genetic differences between humans and chimpanzees focus on the brain, particularly its social, emotional, linguistic, and conceptual abilities
- 3 pounds, 1.1 trillion cells, including 100 billion “gray matter” neurons
- Always “on”: 2 percent of the body's weight uses about 25 percent of its oxygen
- Average neuron has about 1000 connections (synapses), 100 trillion in all
- Synapses firing 1 to 100 times a second
- Regions linked by brain waves synchronized within a few milliseconds
- Extremely interconnected network full of circular loops
- Number of possible brain states: 1 followed by a million zeros
- An organ that learns from experiences through lifelong changes in its structure
- The most complex object known in the universe

The underlying neurology of your mind is great for survival, but it poses a fundamental challenge to well-being: positive experiences typically roll through it while negative experiences get immediately flagged, stored carefully for quick access, and recalled with great power. But you can override those tendencies in simple and effective ways each day by focusing on positive experiences, valuing them, and helping them sink in. Through thought alone, you can create and strengthen wholesome circuits in your brain, for the benefit of yourself and all beings.

The deliberate internalization of positive experiences illustrates the oneness of the brain and the mind, and the power of using the mind to change the brain. It is a deeply wise and wonderful undertaking: *happiness is skillful means*. And happily for happiness, this undertaking is aligned with our deepest nature: always already awake, benign, and quietly inclined to joy.