

Buddha's Brain:

The Practical Neuroscience of Happiness, Love, and Wisdom

Oxford Mindfulness, November 1, 2010

Rick Hanson, Ph.D.

The Wellspring Institute for Neuroscience and Contemplative Wisdom

www.WiseBrain.org

www.RickHanson.net

drh@comcast.net

Topics

- **Self-directed neuroplasticity**
- **“Doing” and “Being”**
- **Taking in the Good**
- **No self, no problem**

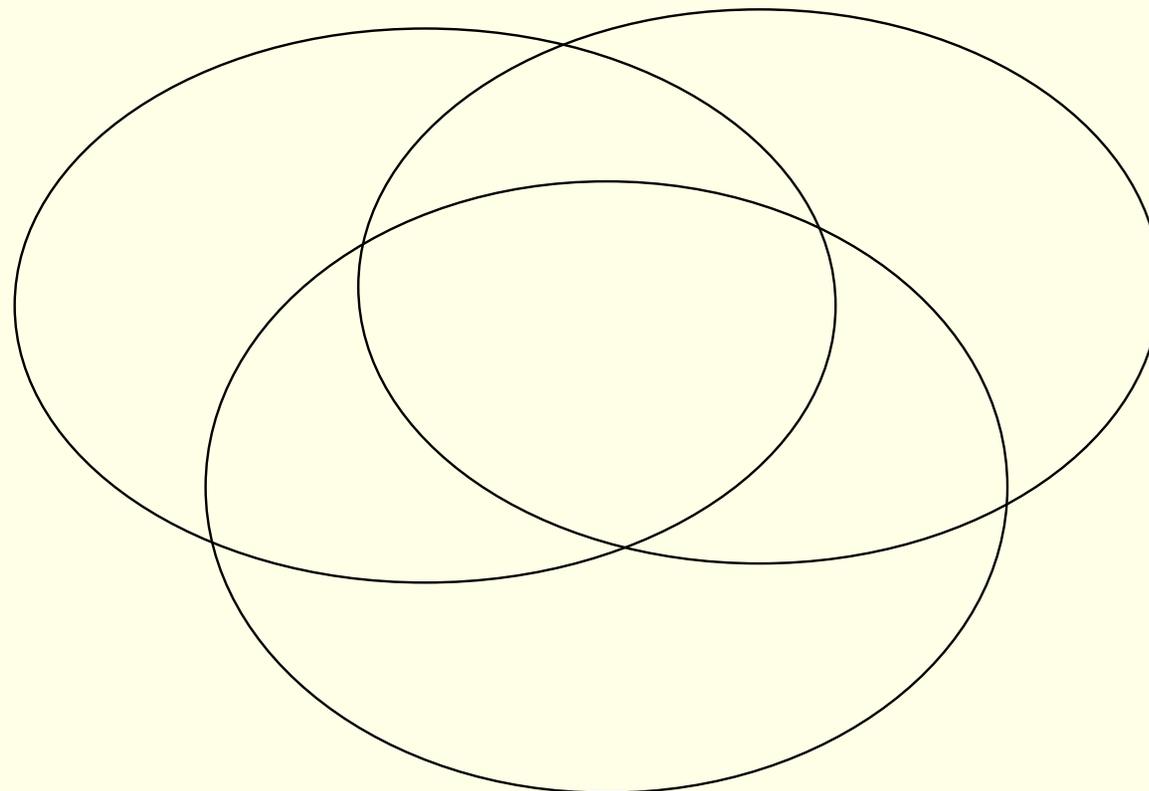


Perspectives

Common - and Fertile - Ground

Neuroscience

Psychology



Contemplative Practice

*The history of science is rich in the example
of the fruitfulness of bringing
two sets of techniques, two sets of ideas,
developed in separate contexts
for the pursuit of new truth,
into touch with one another.*

J. Robert Oppenheimer

Do not go by oral tradition, by lineage of teaching, by hearsay, by a collection of texts, by logic, by inferential reasoning, by reasoned cognition, by the acceptance of a view after pondering it, by the seeming competence of a speaker, or because you think, “this . . . is our teacher.”

But when you know for yourselves, “these things are wholesome, these things are blameless; these things are praised by the wise; these things, if undertaken and practiced, lead to welfare and happiness,” then you should engage in them.

The Buddha

"We ask, 'What is a thought?'"

We don't know,

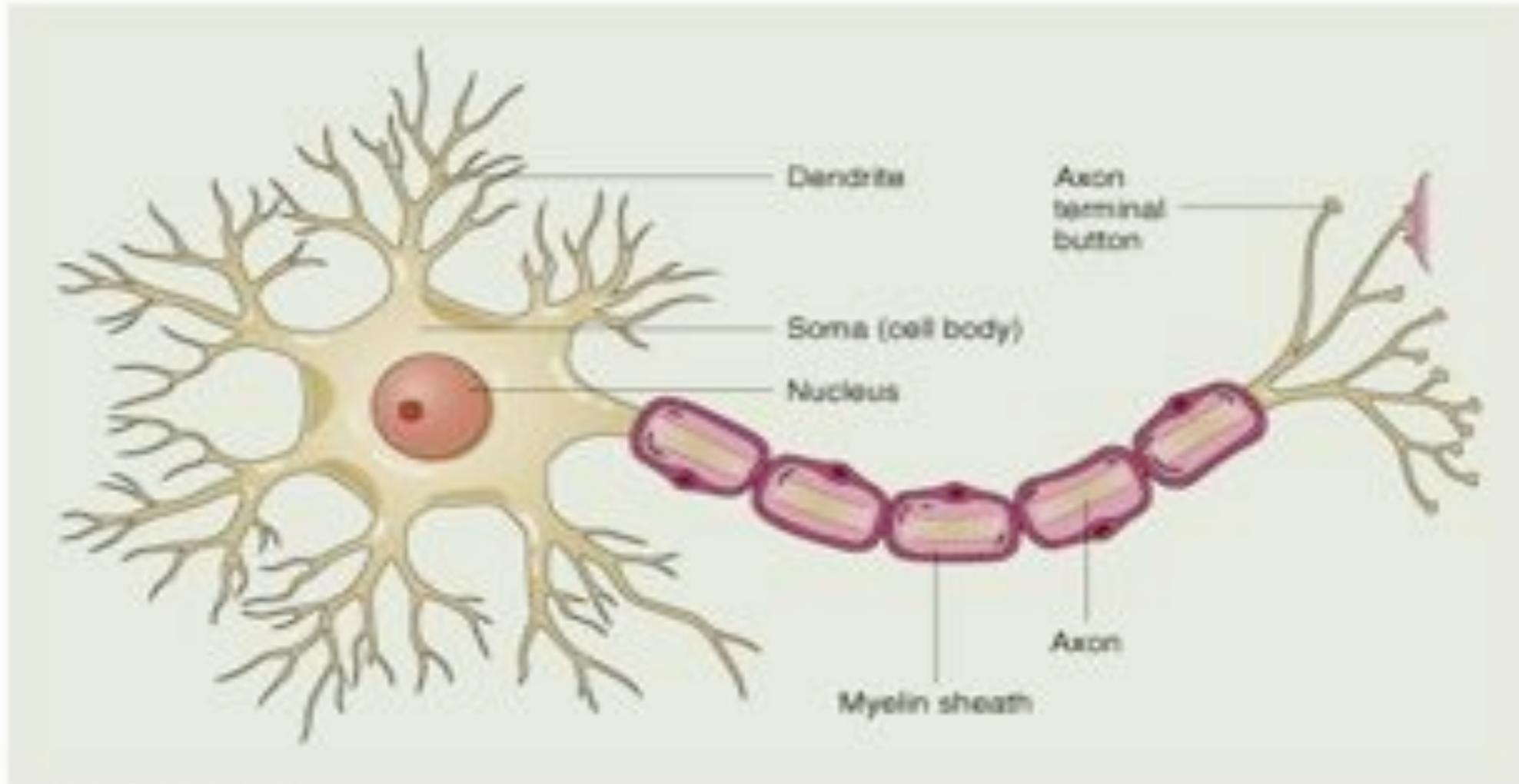
yet we are thinking continually."

Venerable Ani Tenzin Palmo

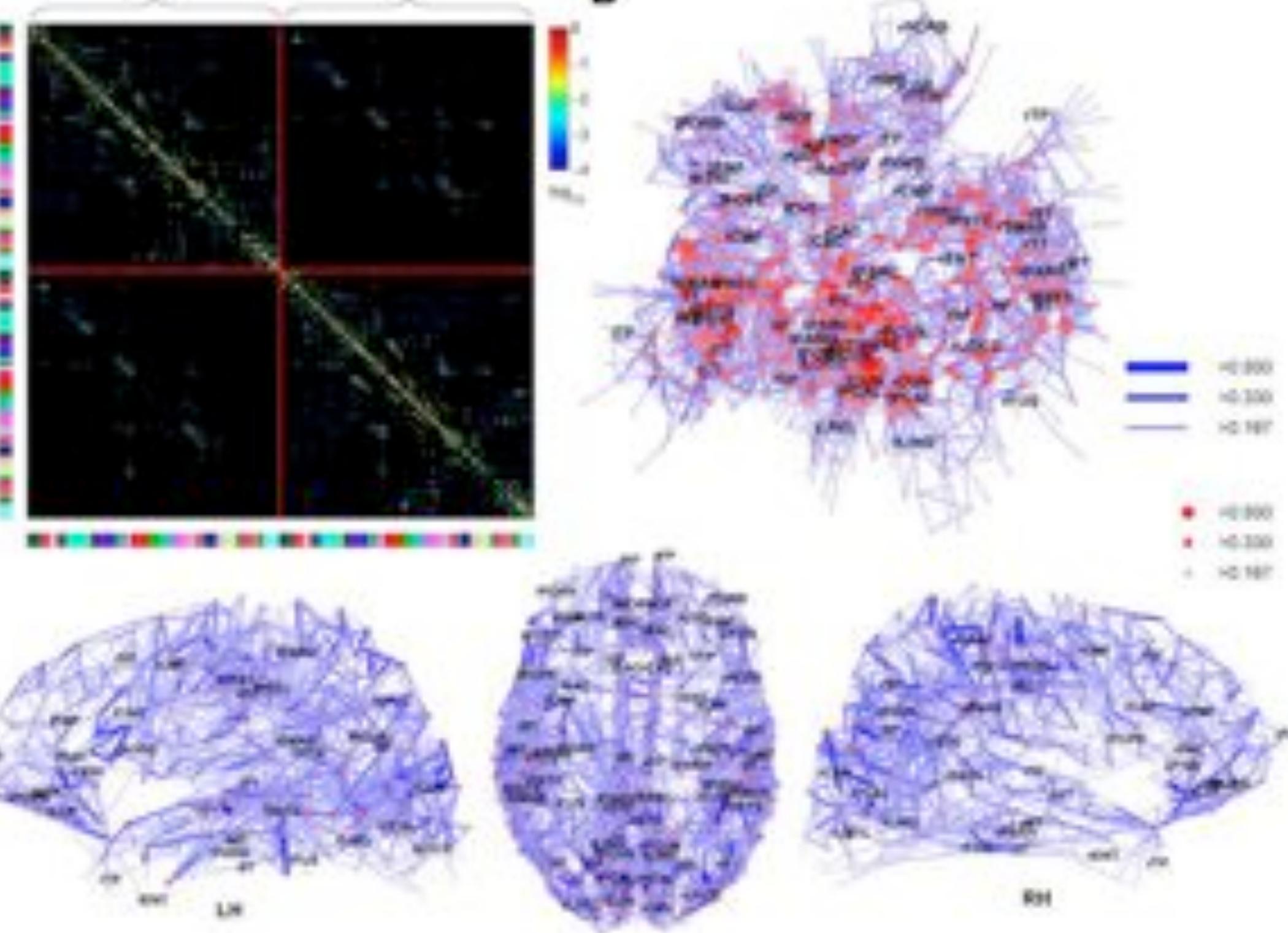


Self-Directed Neuroplasticity

A Neuron



© 2000 John Wiley & Sons, Inc.



As your mind changes, your brain changes.

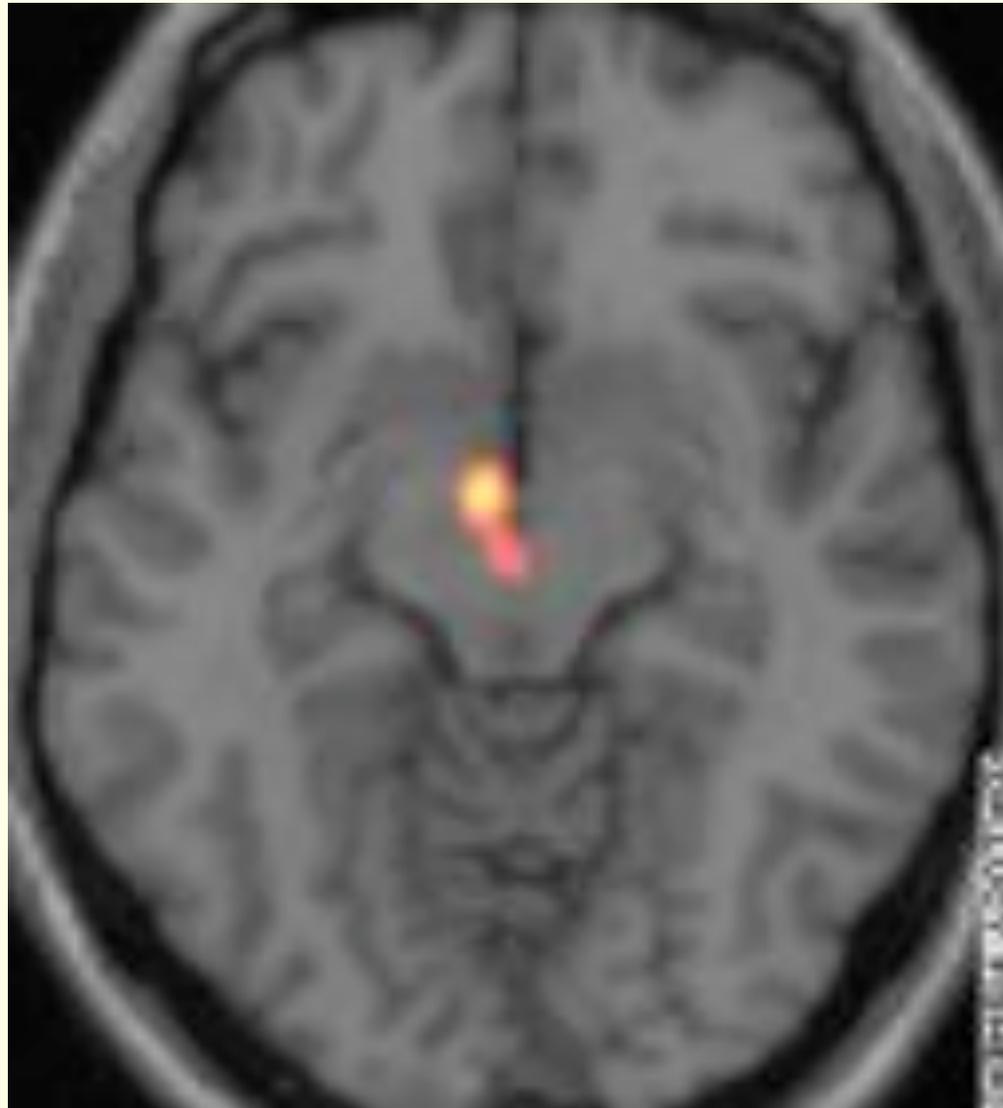
Immaterial mental activity maps to material neural activity.

This produces temporary changes in your brain and lasting ones.

Temporary changes include:

- Alterations in brainwaves (= changes in the firing patterns of synchronized neurons)
- Increased or decreased use of oxygen and glucose
- Ebbs and flows of neurochemicals

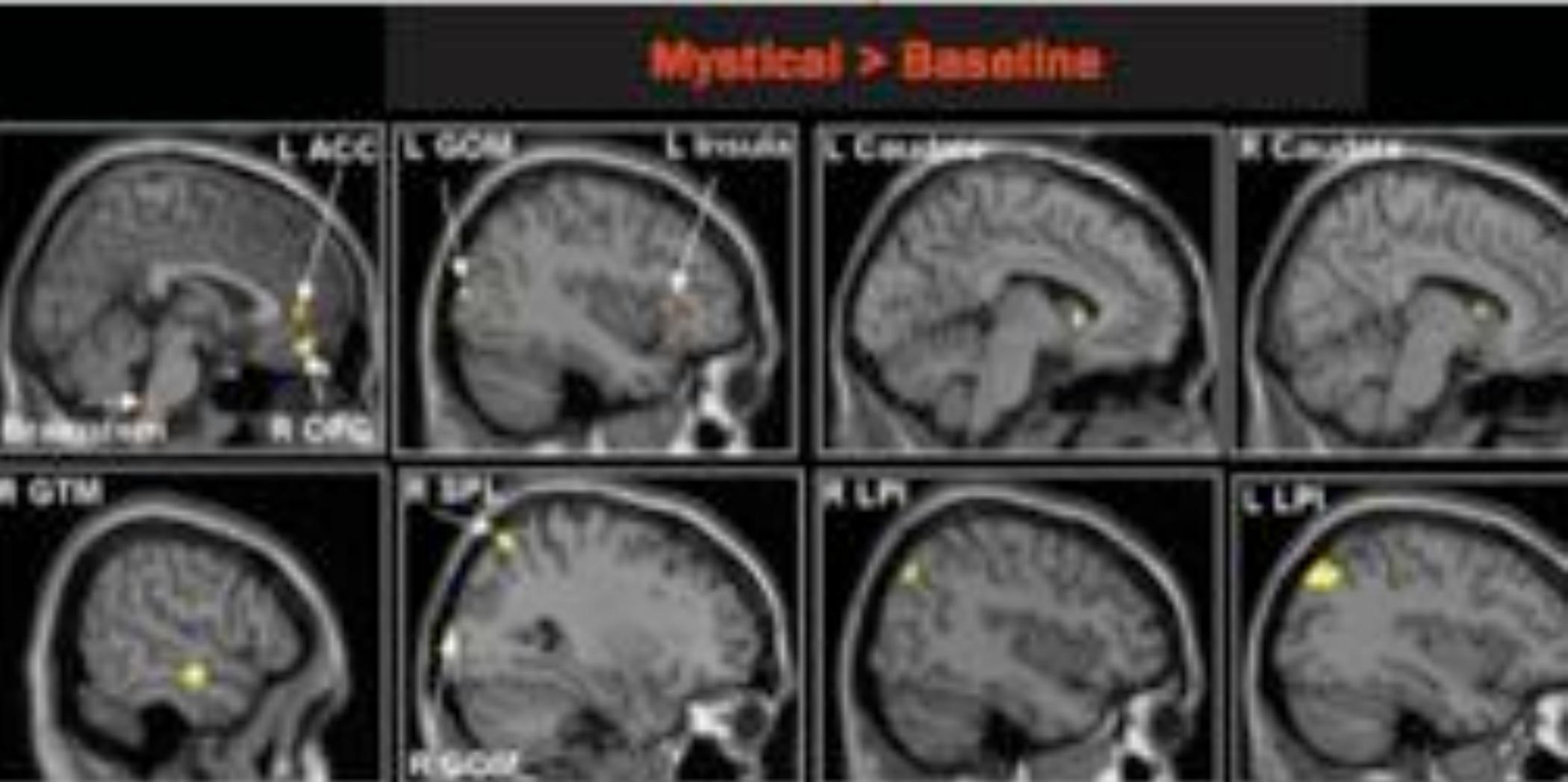
The Rewards of Love



Tibetan Monk, Boundless Compassion



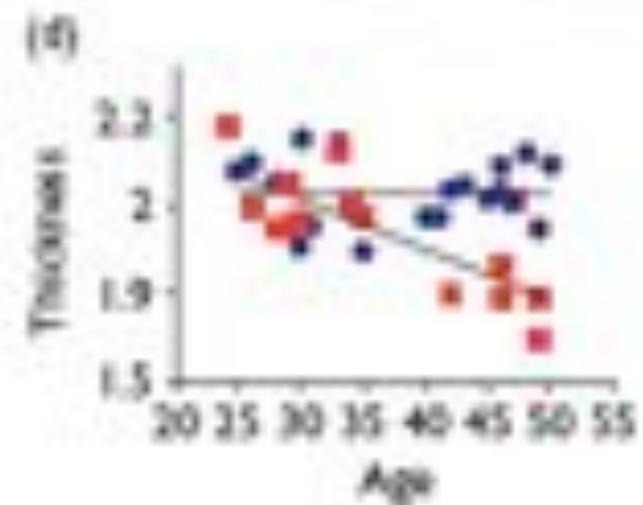
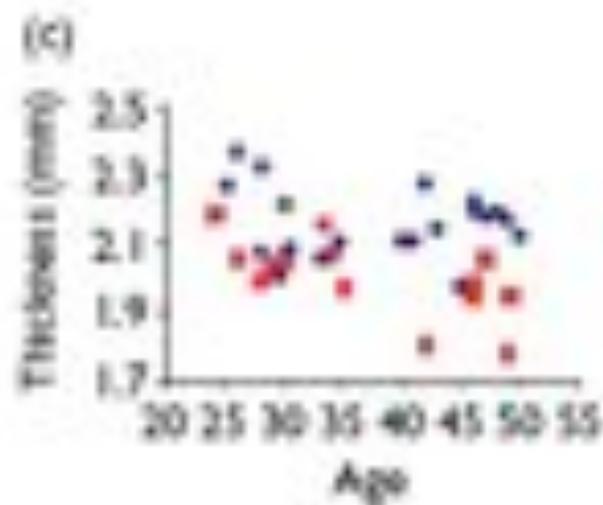
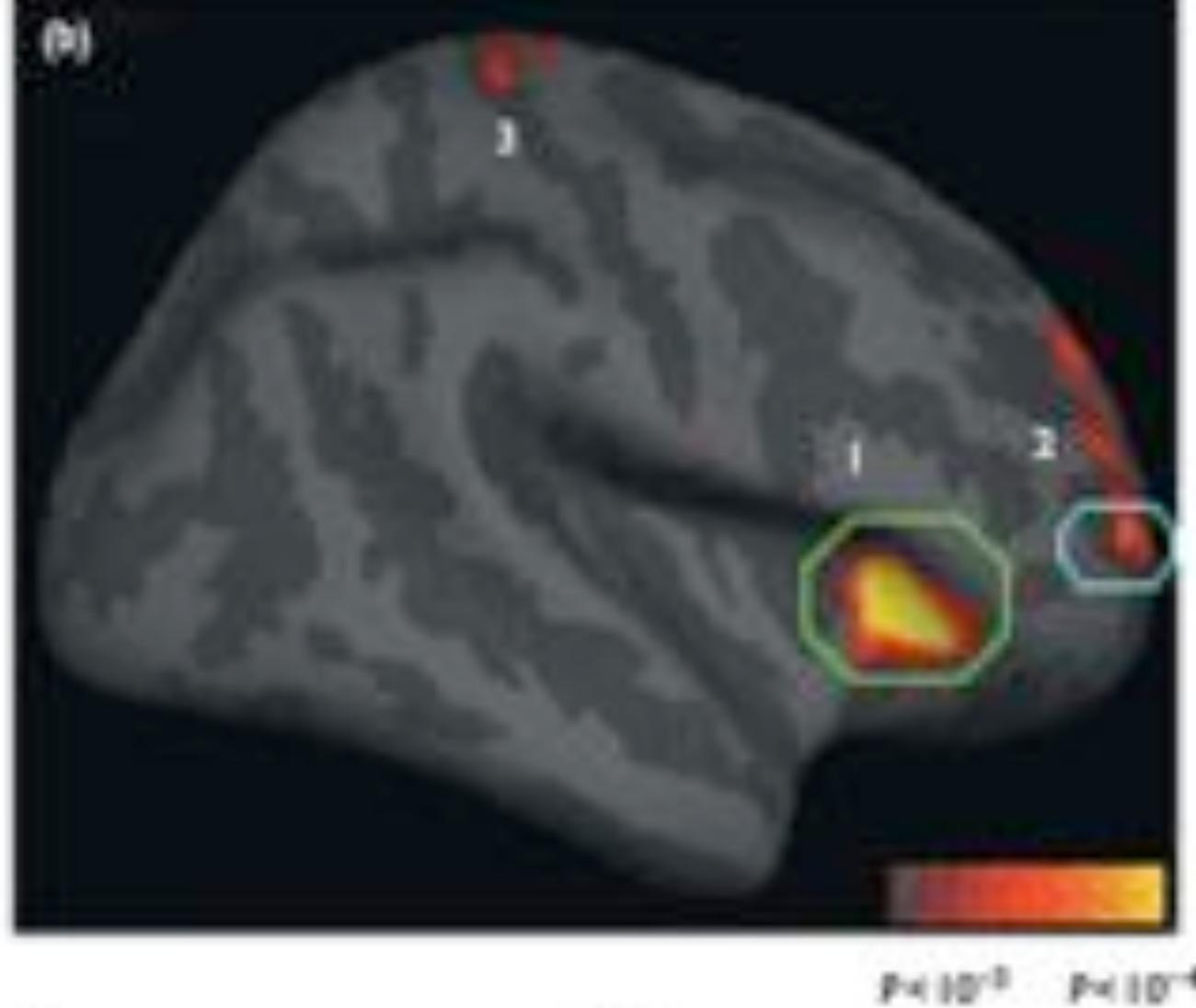
Christian Nuns, Recalling Profound Spiritual Experiences



Mind Changes Brain in Lasting Ways

- What flows through the mind sculpts your brain. Immaterial experience leaves material traces behind.
- Increased blood/nutrient flow to active regions
- Altered epigenetics (gene expression)
- “Neurons that fire together wire together.”
 - Increasing excitability of active neurons
 - Strengthening existing synapses
 - Building new synapses; thickening cortex
 - Neuronal “pruning” - “use it or lose it”

Lazar, et al. 2005.
Meditation
experience is
associated
with increased
cortical thickness.
Neuroreport, 16,
1893-1897.



Physical Effects of Meditation

- Strengthens anterior (frontal) cingulate cortex and insula - for improved attention, empathy, and compassion
- Reduces cortical thinning with aging in activated regions
- Increases activation of left frontal regions, which lifts mood
- Increases power and reach of gamma-range brainwaves
- Decreases stress-related cortisol
- Strengthens immune system

The Power of Mindfulness

- Attention is like a spotlight, illuminating what it rests upon.
- Because neuroplasticity is heightened for what's in the field of focused awareness, attention is also like a vacuum cleaner, sucking its contents into the brain.
- Directing attention skillfully is therefore a fundamental way to shape the brain - and one's life over time.

*The education of attention
would be an education par excellence.*

William James

Neuroplasticity in Context

- Neuroplasticity is not breaking news. It's been long presumed that mental activity changed neural structure: what else is learning?
- The news is in how the mind changes the brain.
- Most neuroplasticity is incremental, not dramatic.
- Neuroplasticity is ethically neutral.

Grounding in the Brain - Benefits

- Organizing framework
 - Evolutionary neuropsychology
 - Common ground across theories and methods
- Motivating to clients, clinicians, policy-makers
 - Concrete, in the body, *physical*
 - Status of medicine, hard science
- Highlighting key principles and practices
 - Implicit memory
 - Nonverbal processes
- Innovating with truly new methods
 - Neurofeedback
 - Fear extinction

Grounding in the Brain - Pitfalls

- Adding little new meaning
 - Replacing psych terms with neuro (“amygdala made me do it”)
- Over-simplifying
 - Over-localizing function (e.g., empathy = mirror neurons)
 - Exaggerated terms (“God-gene,” “female brain”)
 - Materialistic reductionism, though brain and mind co-arise
- Claiming authority
 - Using neuro data to argue a political or cultural case
 - Using the secular religion of science to elevate status
- Underestimating the mind
 - Most big changes in psyche involve tiny changes in soma; mental plasticity holds more promise than neural plasticity.
 - Overlooking the insights and effectiveness of psychology
 - Ducking existential choices in values

Foundations of Meditation

- **Setting an intention** - “top-down” frontal, “bottom-up” limbic
- **Relaxing the body** - parasympathetic nervous system
- **Feeling safer** - inhibits amygdala/ hippocampus alarms
- **Evoking positive emotion** - dopamine, norepinephrine
- **Whole body and panoramic awareness** - lateral networks
- **Absorbing the benefits** - positive implicit memories



Medial and Lateral Networks

Dual Modes

“Doing”

Focused attention
Goal-directed
Sense of craving
Personal, self-oriented perspective
Lost in thought, mind wandering
Conceptual
Future- or past-focused
Much verbal activity
Firm beliefs
Evaluative
Looping contents of mind
Tightly connected experiences
Focal view
Prominent self-as-object
Prominent self-as-subject

“Being”

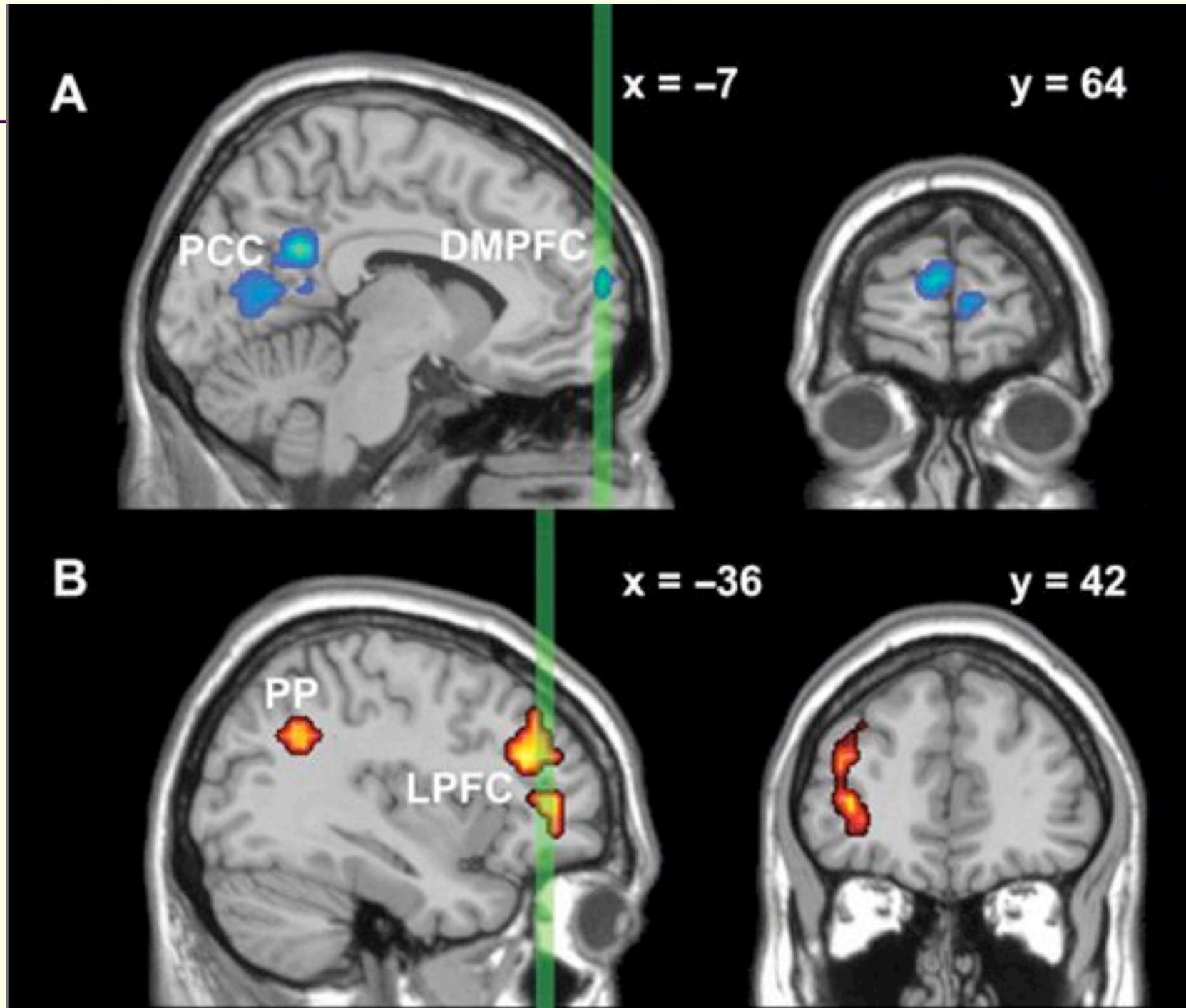
Open awareness
Nothing to do, nowhere to go
Sense of peace
Impersonal, 3rd person perspective
Mindful presence
Sensory
Now-focused
Little verbal activity
Uncertainty, not-knowing
Nonjudgmental
Transient contents of mind
Loosely connected experiences
Panoramic view
Minimal or no self-as-object
Minimal or no self-as-subject

Increased Medial PFC Activation Related to Self-Referencing Thought

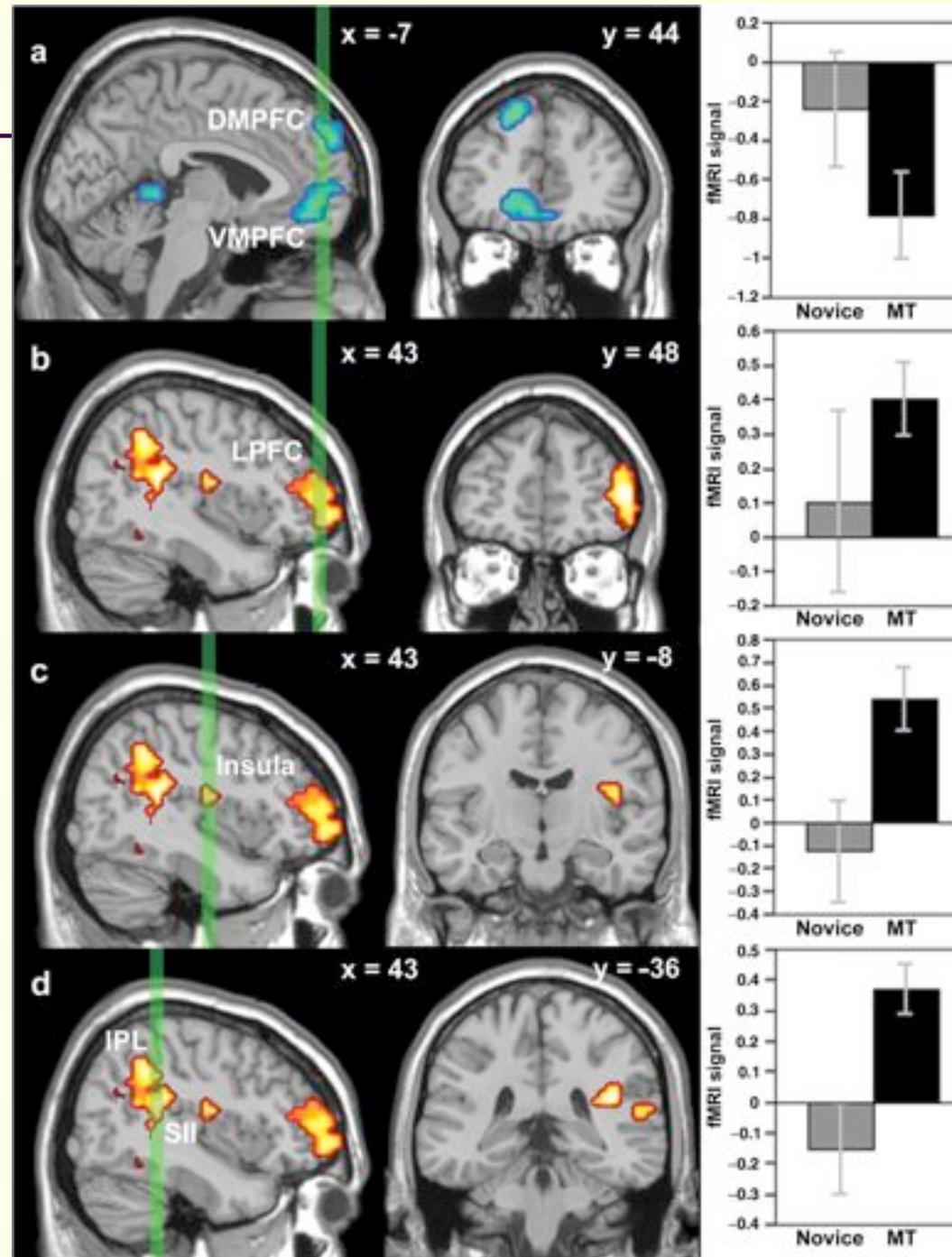


Gusnard D. A., et.al. 2001. *PNAS*, 98:4259-4264

Self-Focused (blue) and Open Awareness (red) Conditions (in the novice, pre MT group)



Self-Focused (blue) and Open Awareness (red) Conditions (following 8 weeks of MT)



Dual Modes

“Doing”

Focused attention
Goal-directed
Sense of craving
Personal, self-oriented perspective
Lost in thought, mind wandering
Conceptual
Future- or past-focused
Much verbal activity
Firm beliefs
Evaluative
Looping contents of mind
Tightly connected experiences
Focal view
Prominent self-as-object
Prominent self-as-subject

“Being”

Open awareness
Nothing to do, nowhere to go
Sense of peace
Impersonal, 3rd person perspective
Mindful presence
Sensory
Now-focused
Little verbal activity
Uncertainty, not-knowing
Nonjudgmental
Transient contents of mind
Loosely connected experiences
Panoramic view
Minimal or no self-as-object
Minimal or no self-as-subject

Ways to Activate “Being” Mode

- Relax.
- Focus on bare sensations and perceptions.
- Sense the body as a whole.
- Take a panoramic, “bird’s-eye” view.
- Engage “don’t-know mind”; release judgments.
- Don’t try to connect mental contents together.
- Let experience flow, staying here now.
- Relax the sense of “I, me, and mine.”

Whole Body Awareness

- Sense the breath in one area (e.g., chest, upper lip)
- Sense the breath as a whole: one gestalt, percept
- Sense the body as a whole, a whole body breathing
- Sense experience as a whole: sensations, sounds, thoughts . . . all arising together as one unified thing
- It's natural for this sense of the whole to be present for a second or two, then crumble; just open up to it again and again.

Panoramic Awareness

- Recall a bird's-eye view (e.g., mountain, airplane).
- Be aware of sounds coming and going in an open space of awareness, without any edges: boundless.
- Open to other contents of mind, coming and going like clouds moving across the sky.
- Pleasant or unpleasant, no matter: just more clouds
- No cloud ever harms or taints the sky.

*Trust in awareness, in being awake,
rather than in transient and unstable conditions.*

“Bahiya, you should train yourself thus.”

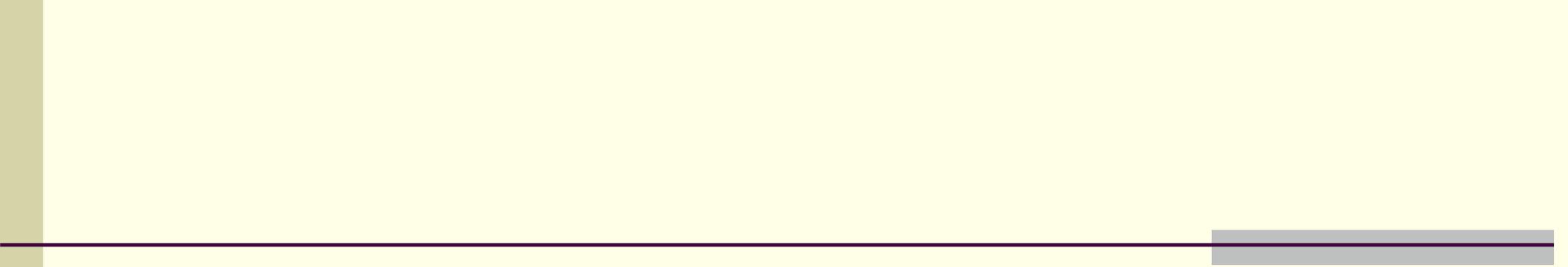
In reference to the seen, there will be only the seen. To the heard, only the heard. To the sensed, only the sensed. To the cognized, only the cognized.

When for you there will be only the seen in reference to the seen, only the heard in the heard, only the sensed in the sensed, only the cognized in the cognized, then, Bahiya, there's no you in that.

When there's no you in that, there's no you there. When there's no you there, you are neither here nor yonder nor between the two.

This, just this, is the end of all suffering.

The Buddha



Taking in the Good

Negativity Bias: Causes in Evolution

- “Sticks” - Predators, natural hazards, social aggression, pain (physical and psychological)
- “Carrots” - Food, sex, shelter, social support, pleasure (physical and psychological)
- During evolution, avoiding “sticks” usually had more effects on survival than approaching “carrots.”
 - Urgency - Usually, sticks must be dealt with immediately, while carrots allow a longer approach.
 - Impact - Sticks usually determine mortality, carrots not; if you fail to get a carrot today, you’ll likely have a chance at a carrot tomorrow; but if you fail to avoid a stick today - whap!³⁴
no more carrots forever

Negativity Bias: Some Consequences

- Negative stimuli get more attention and processing; we generally learn faster from pain than pleasure.
- People work harder to avoid a loss than attain an equal gain (“endowment effect”).
- Easy to create learned helplessness, hard to undo
- Negative interactions: more powerful than positive
- Implicit memory: the brain is like Velcro for negative experiences, but Teflon for positive ones.

Key Consequence of the Negativity Bias: Threat Reactivity

- Two mistakes:
 - Thinking there is a tiger in the bushes when there isn't one.
 - Thinking there is no tiger in the bushes when there is one.
- We evolved to make the first mistake a hundred times to avoid making the second mistake even once.
- This evolutionary tendency is intensified by temperament, personal history, culture, and politics.
- Threat reactivity affects individuals, couples, families, organizations, nations, and the world as a whole.

Results of Threat Reactivity (Personal, Organizational, National)

- Our initial appraisals are mistaken:
 - Overestimating threats
 - Underestimating opportunities
 - Underestimating inner and outer resources
- We update these appraisals with information that confirms them; we ignore, devalue, or alter information that doesn't.
- Thus we end up with views of ourselves, others, and the world that are ignorant, selective, and distorted.

Costs of Threat Reactivity

(Personal, Organizational, National)

- Feeling threatened feels bad, and triggers stress consequences.
- We over-invest in threat protection.
- The boy who cried tiger: flooding with paper tigers makes it harder to see the real ones.
- Acting while feeling threatened leads to over-reactions, makes others feel threatened, and creates vicious cycles.
- The Approach system is inhibited, so we don't pursue opportunities, play small, or give up too soon.
- In the Attach system, we bond tighter to "us," with more fear and anger toward "them."

A Poignant Truth

Mother Nature is tilted toward producing gene copies.

But tilted against personal quality of life.

And at the societal level, we have caveman/cavewoman brains armed with nuclear weapons.

What shall we do?

*We can deliberately use the mind
to change the brain for the better.*

The Importance of Inner Resources

■ Examples:

- Character virtues
- Positive introjects
- Corrective emotional experiences in psychotherapy
- Learned optimism
- Brahmaviharas; Paramittas; awakening factors

■ Benefits

- Increase positive emotions: physical and mental health
- Improve self-soothing
- Improve outlook on world, self, and future
- Increase resilience, determination
- Promote prosocial behaviors

Mindfulness, Virtue, Wisdom

- **Mindfulness** (or “concentration”), **virtue**, and **wisdom** are identified in Buddhism and other contemplative traditions as the pillars of practice.
- In Western psychology, these are the foundations of mental health and well-being.
- These three pillars map to three core functions of the nervous system:
 - Receiving/learning
 - Regulating
 - Prioritizing/selecting

“Know the Mind, Shape the Mind, Free the Mind”

- **Mindfulness, virtue, and wisdom** - and their neural correlates - also map to three phases of practice:
 - Be aware of the garden, pull weeds, plant flowers.
 - Be mindful of, release, replace.
 - Let be, let go, let in.
- People vary in their inclinations and strengths with the phases.
- Sometimes we need to take in resources in the third phase in order to bear our own experience.
- Mindfulness is key to the second and third phase, sometimes curative on its own, and always beneficial in strengthening its neural substrates. But often it is not enough by itself.

Just having positive experiences is not enough.

They pass through the brain like water through a sieve, while negative experiences are caught.

We need to engage positive experiences actively to weave them into the brain.

Thus making the brain like Velcro for positive experiences, and Teflon for negative ones.

How to Take in the Good

1. Look for positive **facts**, and let them become positive experiences.
2. Savor the positive experience:
 - Sustain it for 10-20-30 seconds.
 - Feel it in your body and emotions.
 - Intensify it.
3. Sense and intend that the positive experience is soaking into your brain and body - registering deeply in emotional memory.

Why It's Good to Take in the Good

- In general, adds positive contents to implicit memory
- Internalizes psychological growth (e.g., it usually feels good and goes well to speak from my heart)
- Associates rewards to good steps; boosts motivation
- Brings in missing “supplies” (e.g., love, worth) to help remedy deficits and heal painful experiences
- Encourages prosocial experiences and actions

Potential Synergies of TIG and MBSR

- Improved mindfulness from MBSR enhances TIG.
- TIG increases general resources for MBSR (e.g., heighten the PNS activation that promotes stable attention).
- TIG increases specific factors of MBSR (e.g., self-acceptance, self-compassion, tolerance of negative affect)
- TIG heightens internalization of key MBSR experiences:
 - The sense of stable mindfulness itself
 - Confidence that awareness itself is not in pain, upset, etc.
 - Presence of supportive others (e.g., MBSR groups)
 - Peacefulness of realizing that experiences come and go

The Fourth Step of TIG

- When you are having a positive experience:
 - Sense the current positive experience sinking down into old pain, and soothing and replacing it.
- When you are having a negative experience:
 - Bring to mind a positive experience that is its antidote.
- In both cases, have the positive experience be big and strong, in the forefront of awareness, while the negative experience is small and in the background.
- You are not resisting negative experiences or getting attached to positive ones. You are being kind to yourself and cultivating positive resources in your mind.

Psychological Antidotes

Approaching Opportunities

- Satisfaction, fulfillment --> Frustration, disappointment
- Gladness, gratitude --> Sadness, discontentment, “blues”

Affiliating with “Us”

- Attunement, inclusion --> Not seen, rejected, left out
- Recognition, acknowledgement --> Inadequacy, shame
- Friendship, love --> Abandonment, feeling unloved or unlovable

Avoiding Threats

- Strength, efficacy --> Weakness, helplessness, pessimism
- Safety, security --> Alarm, anxiety
- Compassion for oneself and others --> Resentment, anger

*Penetrative insight
joined with calm abiding
utterly eradicates
afflicted states.*

Shantideva



No Self, No Problem

Definitions

- **Person** - The body-mind as a whole
 - Contains knowledge, personal memories, skills, temperament, personality tendencies, mood, etc.
 - Has considerable consistency over time
 - Deserves kindness and justice; is morally culpable
- **Self** - “I, me, and mine”
 - Psychological self; the “I” in “I am happy, I want a cookie, I know $2+2=4$, I am for justice”; the “me” in “Do you love me?”
 - The apparent owner of experiences and agent of actions
- **Awareness** - The field in which the mind (as yet mysteriously) represents aspects of the mind to itself
 - “Global workspace” in which representations of the person, self-related functions, and subjectivity arise and pass away

Conventional Notions of “Self”

- **Unified** - coherent; just one; a being, an entity; some one looking out through your eyes.
- **Stable** - unchanging in its fundamentals; the core self as a child still feels present in you today
- **Independent** - things happen to the self, but it remains free of their effects in its essence.
- **Identity** - That which one is; that with which there is the greatest identification

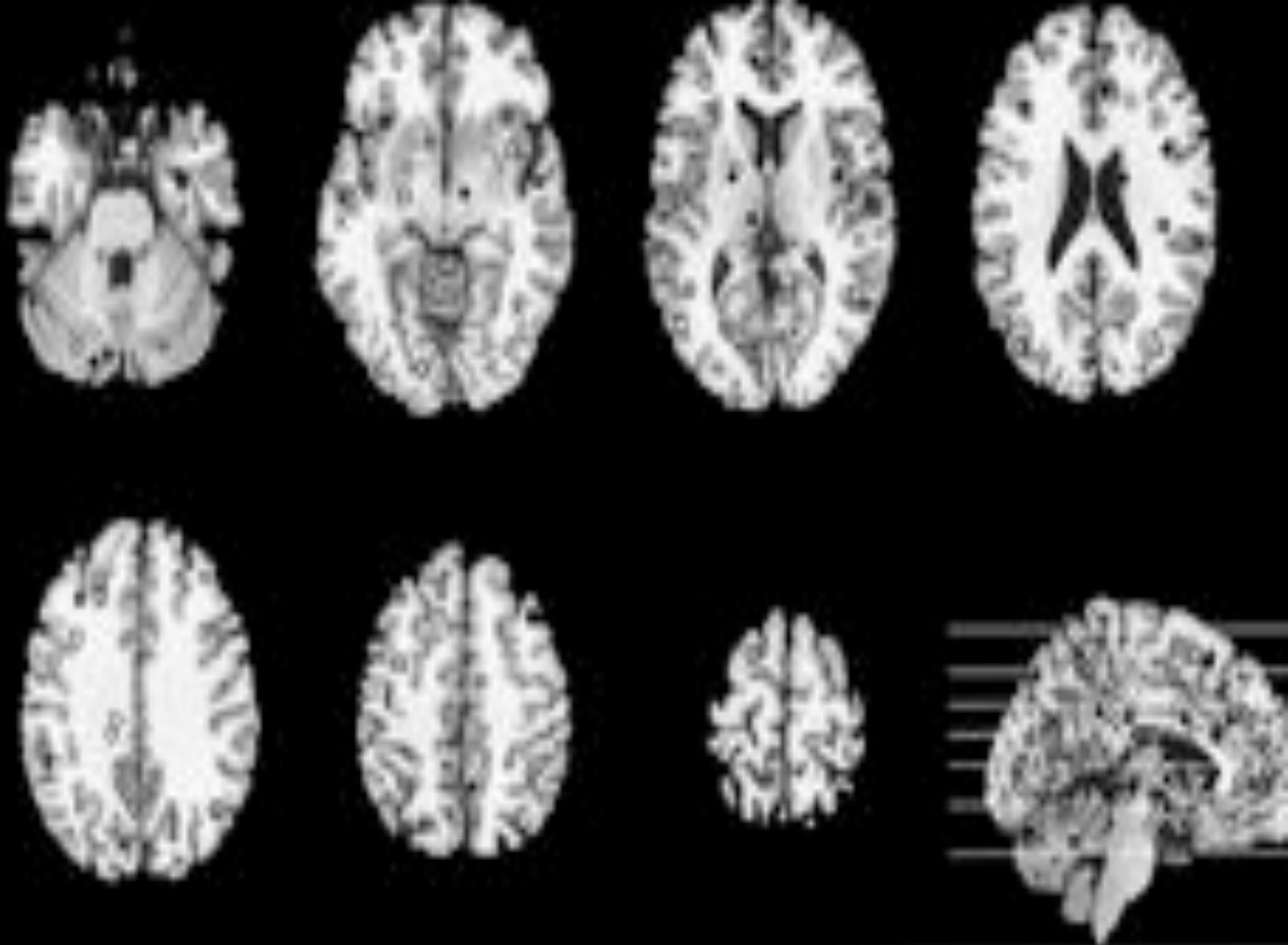
The dualistic ego-mind is essentially a survival mechanism, on a par with the fangs, claws, stingers, scales, shells, and quills that other animals use to protect themselves.

By maintaining a separate self-sense, it attempts to provide a haven of security.

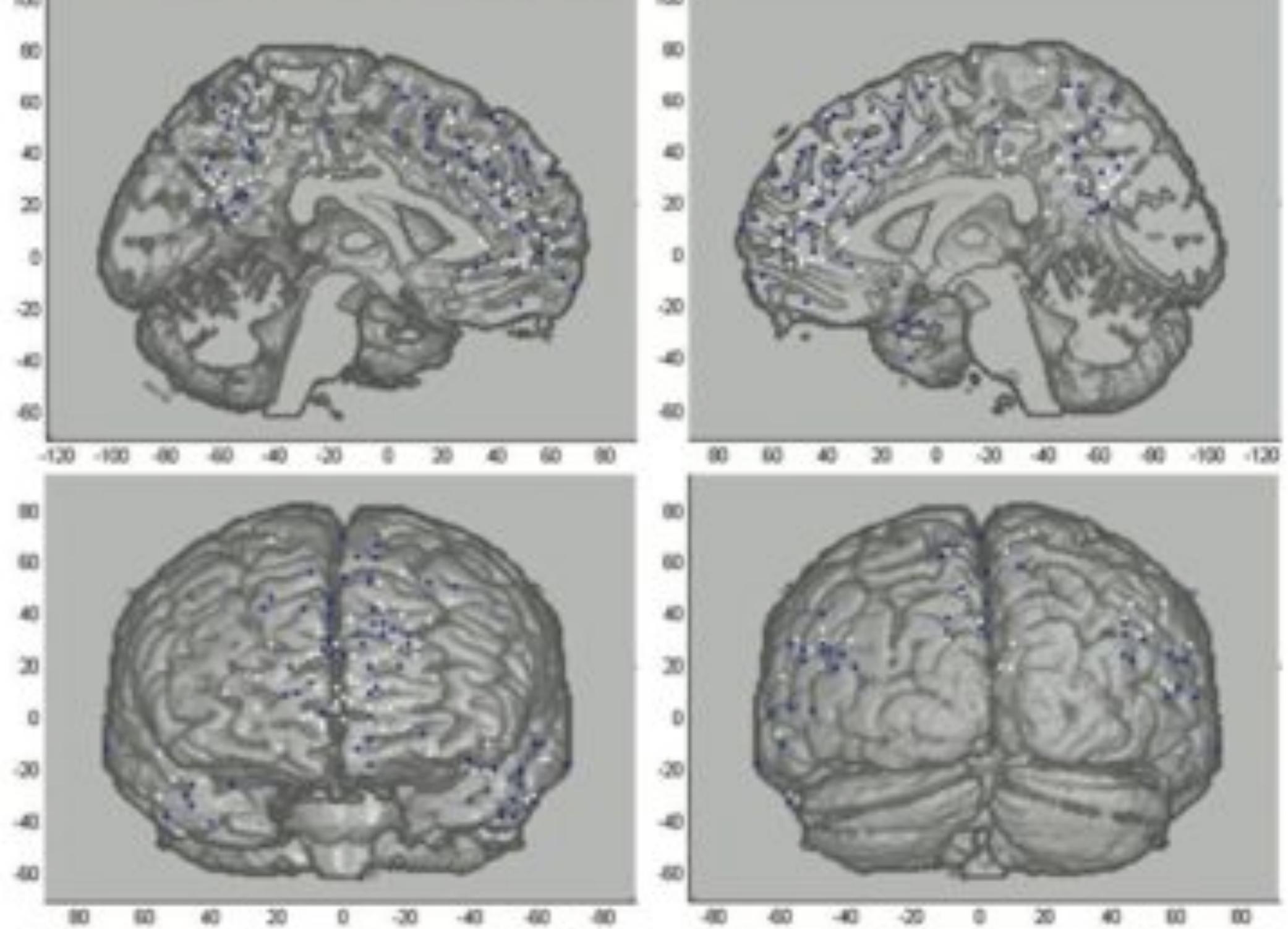
Yet the very boundaries that create a sense of safety also leave us feeling cut off and disconnected.

Actual Experience of “Self”

- **Compounded** – Made up of many parts; one self vows to exercise early, another self turns off the alarm clock.
- **Impermanent** – More or less present at different times; different aspects come forward at different times; there is a process of *selfing* rather than a static, fixed, unchanging entity.
- **Dependent** – Developed in interactions with caregivers and peers and encounters with the world; grounded in evolution; activating and deactivating as a means to the ends of the organism; especially responsive to opportunities and threats; self organizes around clinging.
- **Part of the person** – There is awareness of aspects of self as contents within awareness like any others.



Brain activations of “selfing” - Gillihan, et al., Psych Bulletin, 1/2005



Legrand and Ruby, 2009. What is self-specific? [White = self; blue = other]

Properties of Self in Your Brain

- **Compounded** – Distributed systems and sub-systems; no homunculus looking through your eyes
- **Impermanent** – Circuits light up and deactivate; fluid, transient
- **Dependent** – Dependent on neural structures and processes; dependent on the evolution of specialized neural tissues (e.g., spindle cells); responsive to stimuli;
- **Part of the person** – Self-related activations in neural circuitry are just a tiny fraction of the total activations in the brain
 - The neural circuitry associated with self representations or functions also performs many other activities unrelated to self.
 - In the brain, self is not special.

Subjectivity Doesn't Equal a Subject

- Ordinary awareness has an inherent subjectivity, a localization to a particular perspective (e.g., to my body, not yours).
- The brain indexes across experiences of subjectivity to create an apparent subject.
- That apparent subject is elaborated and layered through the maturation of the brain, notably regions of the prefrontal cortex.
- But there is no subject *inherent* in subjectivity!
- Awareness requires subjectivity, but not a subject

What Self?

In sum, from a neurological standpoint, the everyday feeling of being a unified self is an utter illusion:

- The apparently coherent and solid “I” is actually built from many neural subsystems, with no fixed center.
- The apparently stable “I” is produced by variable and transient activations of neural circuits.
- The apparently independent “I” depends on neural circuitry, the evolutionary processes that built them, critical interactions with others to shape those circuits, and the stimuli of the moment.

Neurologically, self is “empty” - without absolute, inherent existence.

Selflessness is not a case of something that existed in the past becoming nonexistent. Rather, this sort of “self” is something that never did exist.

What is needed is to identify as nonexistent something that always was nonexistent.

The Dalai Lama

When we recognize that the things we identify as our self are impermanent and bound up with suffering, we realize they lack the essential marks of authentic selfhood and we thereby stop identifying with them.

Bhikkhu Bodhi

Self Is Like a Unicorn

- Self-related patterns of information and neural activity are as real as those that underlie the smell of roses.
- But that which they point to – a unified, enduring, independent “I” – just doesn’t exist.
- Just because we have a sense of self does not mean that we are a self. The brain strings together heterogenous moments of self-ing and subjectivity into an illusion of homogenous coherence and continuity.
- Real representations in the brain of a horse point to something that is also real. But the real representations of a unicorn in the brain point to something that is not real.
- The real representations of the self in the brain point to another mythical creature: the apparent self⁶²

“Self” Has Its Uses

- A convenient way to distinguish one person from another
- Brings a sense of continuity to life’s experiences
- Adds verve and commitment to relationships
- People without self structures have impaired relationships.
- Self-related processes helped our ancestors succeed in increasingly social hunter-gatherer bands in which interpersonal dynamics played a strong role in survival.
- The evolution of relationships fostered the evolution of self and vice versa; the benefits of self have thus been a factor in the evolution of the brain.
- Self has been stitched into human DNA by reproductive advantages slowly accumulating across a hundred thousand generations.

Selfing Leads to Suffering

- When “I, me, and mine” are mental objects like any other, there’s no problem.
 - For example, the Buddha routinely used “I” and “you.”
- But when we privilege self-representations through identifying with them or defending or glorifying them . . . Then we suffer, and create suffering for others.
- The key is to be able to move dextrously into and back out of self-representations; that’s skillful means.

*Blissful is passionlessness in the world,
The overcoming of sensual desires;
But the abolition of the conceit I am --
That is truly the supreme bliss.*

The Buddha, Udāna 2.11

To study the Way is to study the self.

To study the self is to forget the self.

*To forget the self is
To be enlightened by all things.*

Dogen

Great Books

See www.RickHanson.net for other great books.

- Austin, J. 2009. *Selfless Insight*. MIT Press.
- Begley, S. 2007. *Train Your Mind, Change Your Brain*. Ballantine.
- Carter, C. 2010. *Raising Happiness*. Ballantine.
- Hanson, R. (with R. Mendius). 2009. *Buddha's Brain: The Practical Neuroscience of Happiness, Love, and Wisdom*. New Harbinger.
- Johnson, S. 2005. *Mind Wide Open*. Scribner.
- Keltner, D. 2009. *Born to Be Good*. Norton.
- Kornfield, J. 2009. *The Wise Heart*. Bantam.
- LeDoux, J. 2003. *Synaptic Self*. Penguin.
- Linden, D. 2008. *The Accidental Mind*. Belknap.
- Sapolsky, R. 2004. *Why Zebras Don't Get Ulcers*. Holt.
- Siegel, D. 2007. *The Mindful Brain*. Norton.
- Thompson, E. 2007. *Mind in Life*. Belknap.

Key Papers - 1

See www.RickHanson.net for other scientific papers.

- Atmanspacher, H. & Graben, P. 2007. Contextual emergence of mental states from neurodynamics. *Chaos & Complexity Letters*, 2:151-168.
- Baumeister, R., Bratlavsky, E., Finkenauer, C. & Vohs, K. 2001. Bad is stronger than good. *Review of General Psychology*, 5:323-370.
- Braver, T. & Cohen, J. 2000. On the control of control: The role of dopamine in regulating prefrontal function and working memory; in *Control of Cognitive Processes: Attention and Performance XVIII*. Monsel, S. & Driver, J. (eds.). MIT Press.
- Carter, O.L., Callistemon, C., Ungerer, Y., Liu, G.B., & Pettigrew, J.D. 2005. Meditation skills of Buddhist monks yield clues to brain's regulation of attention. *Current Biology*. 15:412-413.

Key Papers - 2

- Davidson, R.J. 2004. Well-being and affective style: neural substrates and biobehavioural correlates. *Philosophical Transactions of the Royal Society*. 359:1395-1411.
- Farb, N.A.S., Segal, Z.V., Mayberg, H., Bean, J., McKeon, D., Fatima, Z., and Anderson, A.K. 2007. Attending to the present: Mindfulness meditation reveals distinct neural modes of self-reflection. *SCAN*, 2, 313-322.
- Gillihan, S.J. & Farah, M.J. 2005. Is self special? A critical review of evidence from experimental psychology and cognitive neuroscience. *Psychological Bulletin*, 131:76-97.
- Hagmann, P., Cammoun, L., Gigandet, X., Meuli, R., Honey, C.J., Wedeen, V.J., & Sporns, O. 2008. Mapping the structural core of human cerebral cortex. *PLoS Biology*. 6:1479-1493.
- Hanson, R. 2008. Seven facts about the brain that incline the mind to joy. In *Measuring the immeasurable: The scientific case for spirituality*. Sounds True.

Key Papers - 3

- Lazar, S., Kerr, C., Wasserman, R., Gray, J., Greve, D., Treadway, M., McGarvey, M., Quinn, B., Dusek, J., Benson, H., Rauch, S., Moore, C., & Fischl, B. 2005. Meditation experience is associated with increased cortical thickness. *Neuroreport*. 16:1893-1897.
- Lewis, M.D. & Todd, R.M. 2007. The self-regulating brain: Cortical-subcortical feedback and the development of intelligent action. *Cognitive Development*, 22:406-430.
- Lieberman, M.D. & Eisenberger, N.I. 2009. Pains and pleasures of social life. *Science*. 323:890-891.
- Lutz, A., Greischar, L., Rawlings, N., Ricard, M. and Davidson, R. 2004. Long-term meditators self-induce high-amplitude gamma synchrony during mental practice. *PNAS*. 101:16369-16373.
- Lutz, A., Slager, H.A., Dunne, J.D., & Davidson, R. J. 2008. Attention regulation and monitoring in meditation. *Trends in Cognitive Sciences*. 12:163-169.

Key Papers - 4

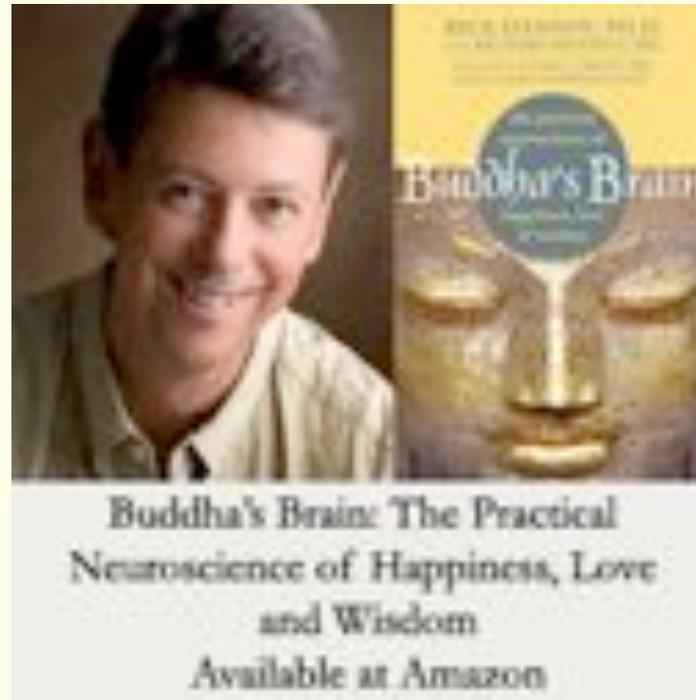
- Rozin, P. & Royzman, E.B. 2001. Negativity bias, negativity dominance, and contagion. *Personality and Social Psychology Review*, 5:296-320.
- Takahashi, H., Kato, M., Matsuura, M., Mobbs, D., Suhara, T., & Okubo, Y. 2009. When your gain is my pain and your pain is my gain: Neural correlates of envy and schadenfreude. *Science*, 323:937-939.
- Tang, Y.-Y., Ma, Y., Wang, J., Fan, Y., Feng, S., Lu, Q., Yu, Q., Sui, D., Rothbart, M.K., Fan, M., & Posner, M. 2007. Short-term meditation training improves attention and self-regulation. *PNAS*, 104:17152-17156.
- Thompson, E. & Varela F.J. 2001. Radical embodiment: Neural dynamics and consciousness. *Trends in Cognitive Sciences*, 5:418-425.
- Walsh, R. & Shapiro, S. L. 2006. The meeting of meditative disciplines and Western psychology: A mutually enriching dialogue. *American Psychologist*, 61:227-239.

Where to Find Rick Hanson Online



<http://www.youtube.com/BuddhasBrain>

<http://www.facebook.com/BuddhasBrain>



www.RickHanson.net
www.WiseBrain.org