
Buddha's Brain:
The Practical Neuroscience of Mindfulness

Networker Symposium
March 26, 2010

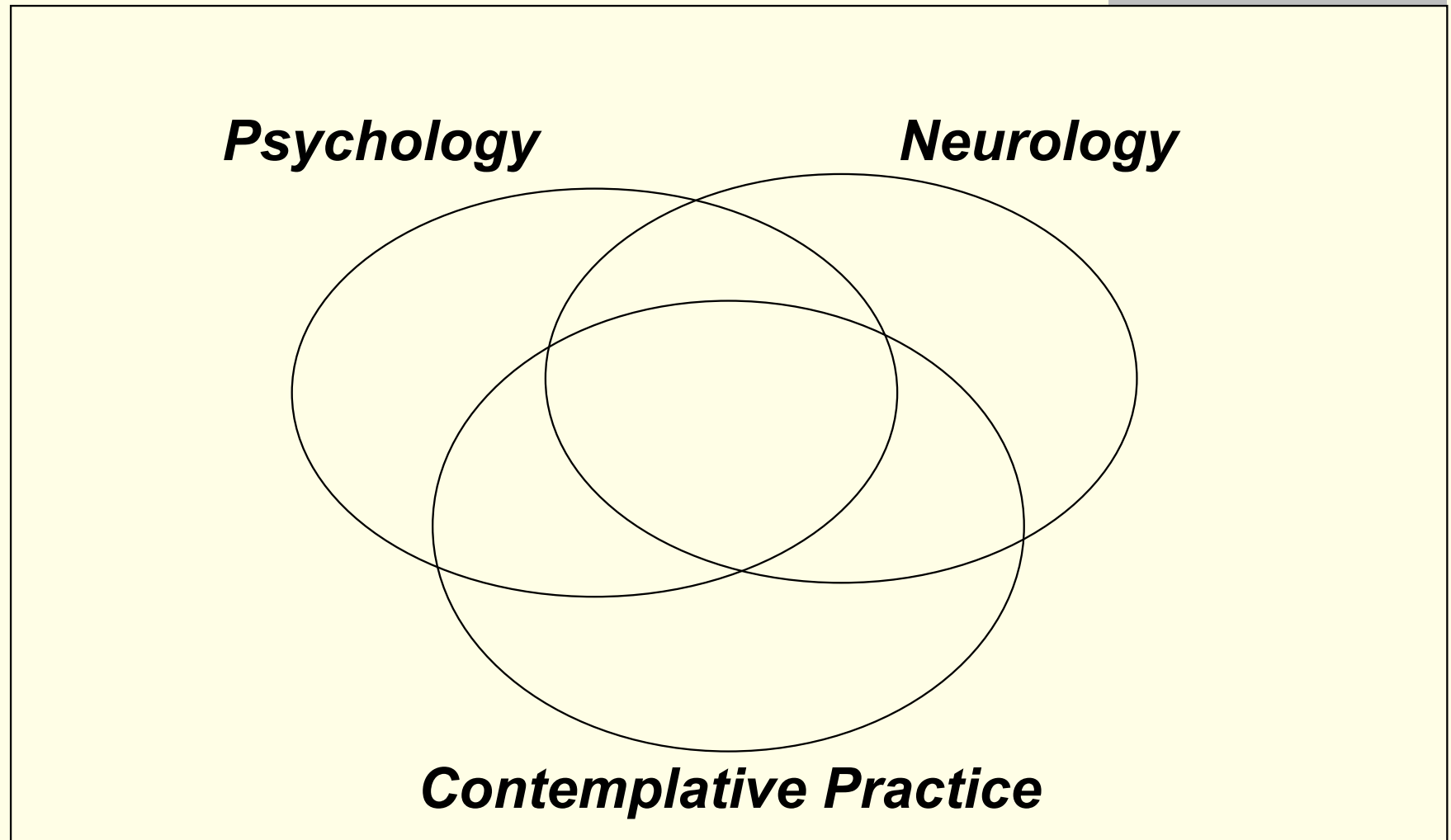
Rick Hanson, Ph.D.
Wellspring Institute for Neuroscience and Contemplative Wisdom

www.WiseBrain.org
www.RickHanson.net
drh@comcast.net

Main Topics

- **The mind-brain system and self-directed neuroplasticity**
- **Perspectives on applying neuroscience to psychotherapy**
- **How the brain pays attention, and factors of mindfulness**
- **“Dual-mode theory,” and how to activate lateral networks**
- **Taking in the good, for resilience, happiness, and healing**
- **The grateful, loving, peaceful brain**

Common - and Fertile - Ground



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

We don't know,

yet we are thinking continually."

Venerable Tenzin Palmo

The Mind/Brain System

- “Mind” = flow of information within the nervous system
 - Information is represented by the nervous system.
 - Most mind is unconscious; awareness is part of mind.
 - The headquarters of the nervous system is the brain.

- In essence then, apart from hypothetical transcendental factors, your mind *is* what your brain *does*.

- Brain = necessary, *proximally* sufficient condition for mind.
 - The brain depends on the nervous system, which intertwines with and depends on other bodily systems.
 - These systems in turn intertwine with and depend upon nature and culture, both presently and over time.
 - And as we’ll see, the brain also depends on the mind.

Self-Directed Neuroplasticity

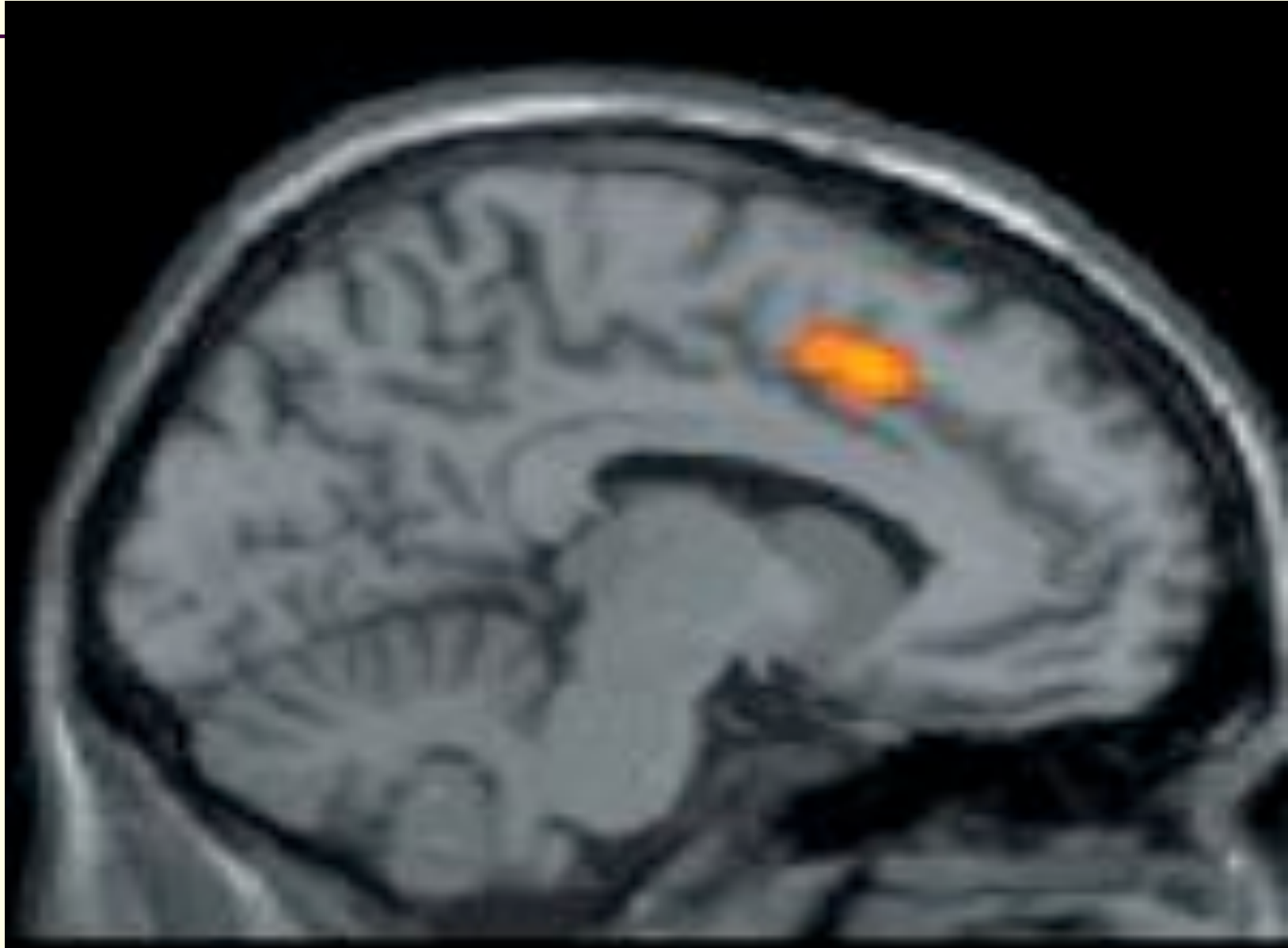
Three facts about the brain and the mind:

- As your brain changes, your mind changes.
 - e.g., concussion, stroke, caffeine, Zoloft

- As your mind changes, your brain changes.
 - In fleeting ways
 - In lasting ways

- *Therefore, you can use your mind to change your brain to change your mind for the better.*

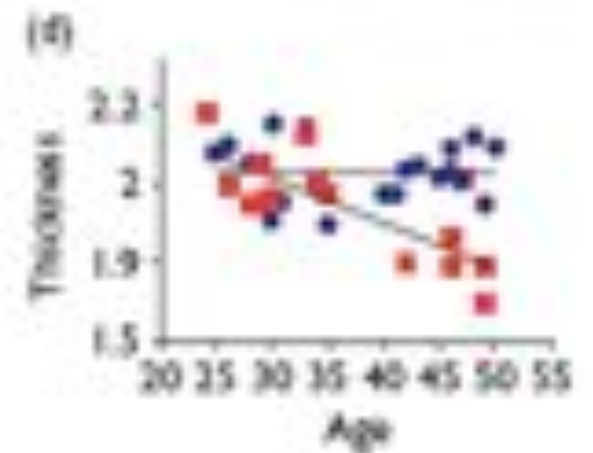
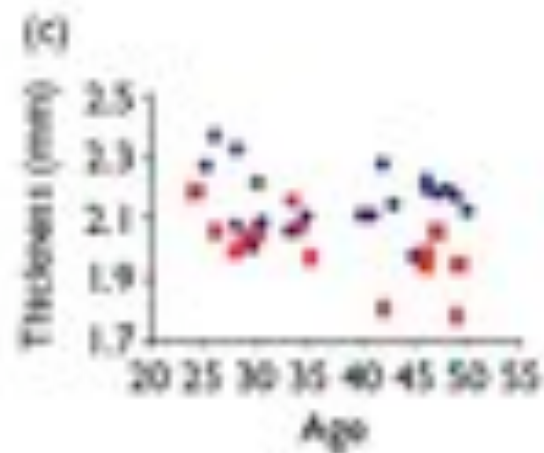
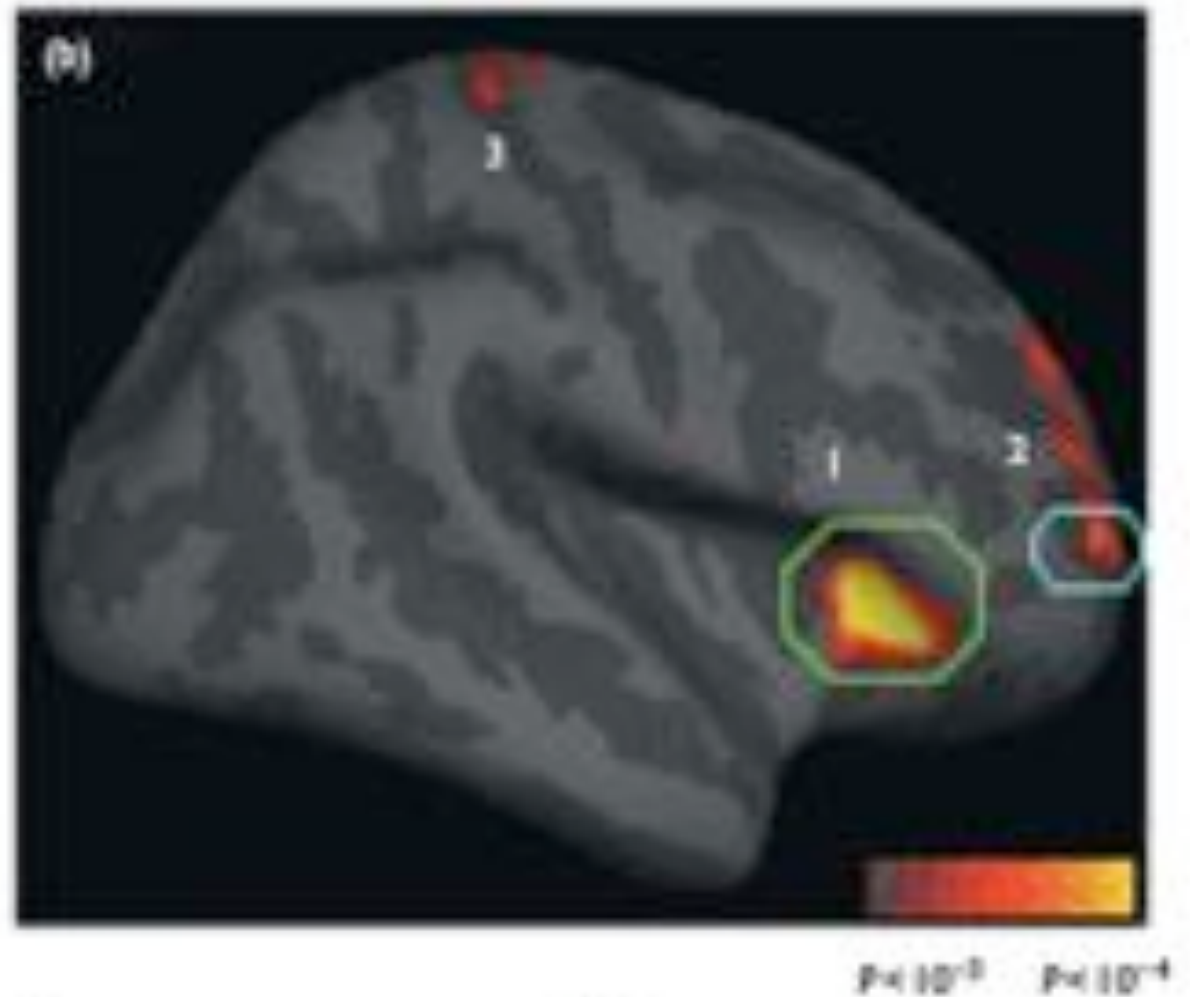
Fleeting Change: Paying Attention



Lasting Change: Mental Activity Shapes Neural Structure


- *What you think and feel changes your brain* in numerous ways:
 - 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 your cortex
 - Neuronal “pruning” - “use it or lose it”
- In effect, what flows through your mind sculpts your brain.

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



*The principal activities of brains
are making changes in themselves.*

Marvin L. Minsky



**But first some perspective on applying
neuroscience to psychotherapy . . .**

The Brain: So What?

(1)

*The **benefits** of applying neuroscience to psychotherapy . . .*

- Unifying framework
- Increasing motivation (client, therapist, policy-makers)
- Highlighting key factors and methods (that are already known) - e.g., arousal and positive emotion, implicit memory, nonverbal processes
- Developing truly new approaches:
 - Reverse engineering: how to use the mind in new ways to activate the neural substrate of targeted mental states
 - Neurofeedback
 - Taking in the good
 - Emerging protocols for trauma

The Brain: So What?


(2)

*The **pitfalls** of applying neuroscience to psychotherapy . . .*

- Over-simplifying:
 - Over-localizing (e.g., there's more to empathy than mirror neurons)
 - Over-stating (e.g., differences between male/female brains)
 - Reducing mind to brain

- Claiming authority:
 - Donning the lab coat
 - Using neural language that adds no information (e.g., “your amygdala made you do it”)
 - Offering old wine in new bottles (e.g., presenting familiar methods [sometimes with new labels] as if they were breakthroughs)

- Underestimating the mind:
 - Mental plasticity is much greater than structural neuroplasticity.
 - Most psychotherapy is not about structural neuroplasticity.
 - The “is” of the brain cannot resolve the “ought” of values.



With these perspectives in mind, how can we use brain science to promote the mindful cultivation of positive feelings and other resources in our clients?

A Spotlight and Vacuum Cleaner

- 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.
- Most people have relatively poor control of their attention
- Mindfulness training (e.g., MBSR, meditation) is the preeminent training of attention.

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

William James

Neural Dynamics of Attention

- Holding onto information in the neural substrates of “the global workspace of consciousness” (e.g., working memory)
- Updating those substrates
- Seeking optimal amounts of stimulation

Individual Differences in Attention

	<u>Holding Information</u>	<u>Updating Awareness</u>	<u>Seeking Stimulation</u>
High	Obsession Over-focusing	Porous filters Distractible Overloaded	Hyperactive Thrill-seeking
Mod	Concentrates Divides attention	Flexible Assimilation Accommodation	Enthusiastic Adaptive
Low	Fatigues w/Conc. Small WM	Fixed views Oblivious Low learning	Stuck in a rut Apathetic Lethargic

5 Factors of Mindfulness

- Setting an intention - top-down frontal lobes; bottom-up subcortical arousal and emotional valence; whole-brain embodied cognition
- Relaxing the body - parasympathetic nervous system
- Feeling safer - dials down amygdala/hippocampus vigilance circuits; reduces internal signals of anxiety and vicious cycles
- Evoking positive emotion - high stable dopamine steadies the mind; it and norepinephrine promote synaptic formation
- Absorbing the benefits - primes memory circuits; compensates for the negativity bias

Dual Modes of Being

[Medial]

Mainly representational

Much verbal activity

Abstract

Future- or past-focused

Goal-directed

Sense of craving

Personal, self-oriented perspective

Focal view

Firm beliefs

Evaluative

Lost in thought, mind wandering

Reverberation and recursion

Tightly connected experiences

Prominent self-as-object

Prominent self-as-subject

[Lateral]

Mainly sensory

Little verbal activity

Concrete

Now-focused

Nothing to do, nowhere to go

Sense of peace

Impersonal, 3rd person perspective

Panoramic view

Uncertainty, not-knowing

Nonjudgmental

Mindful presence

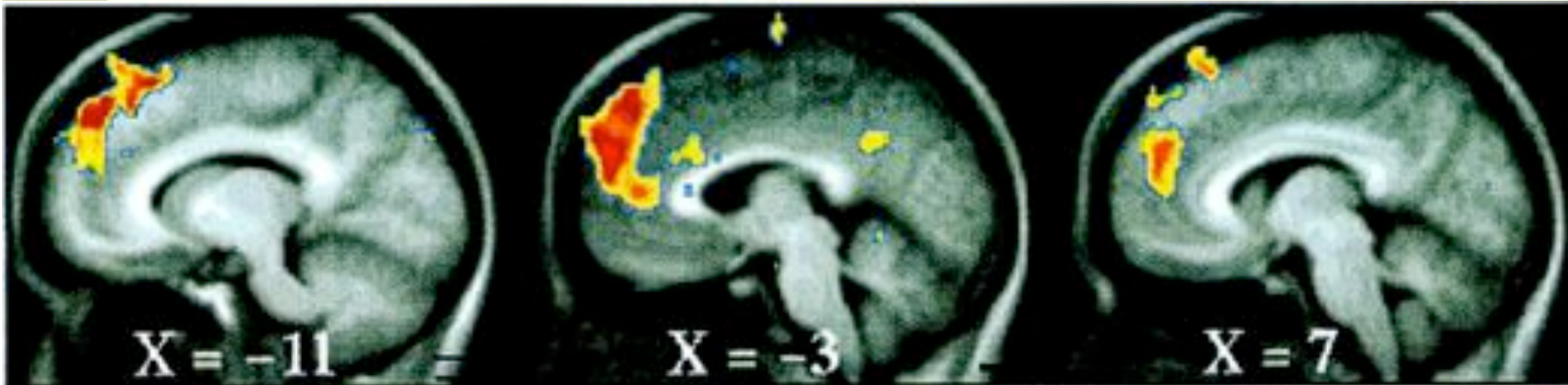
Immediate and transient;

Loosely connected experiences

Minimal or no self-as-object

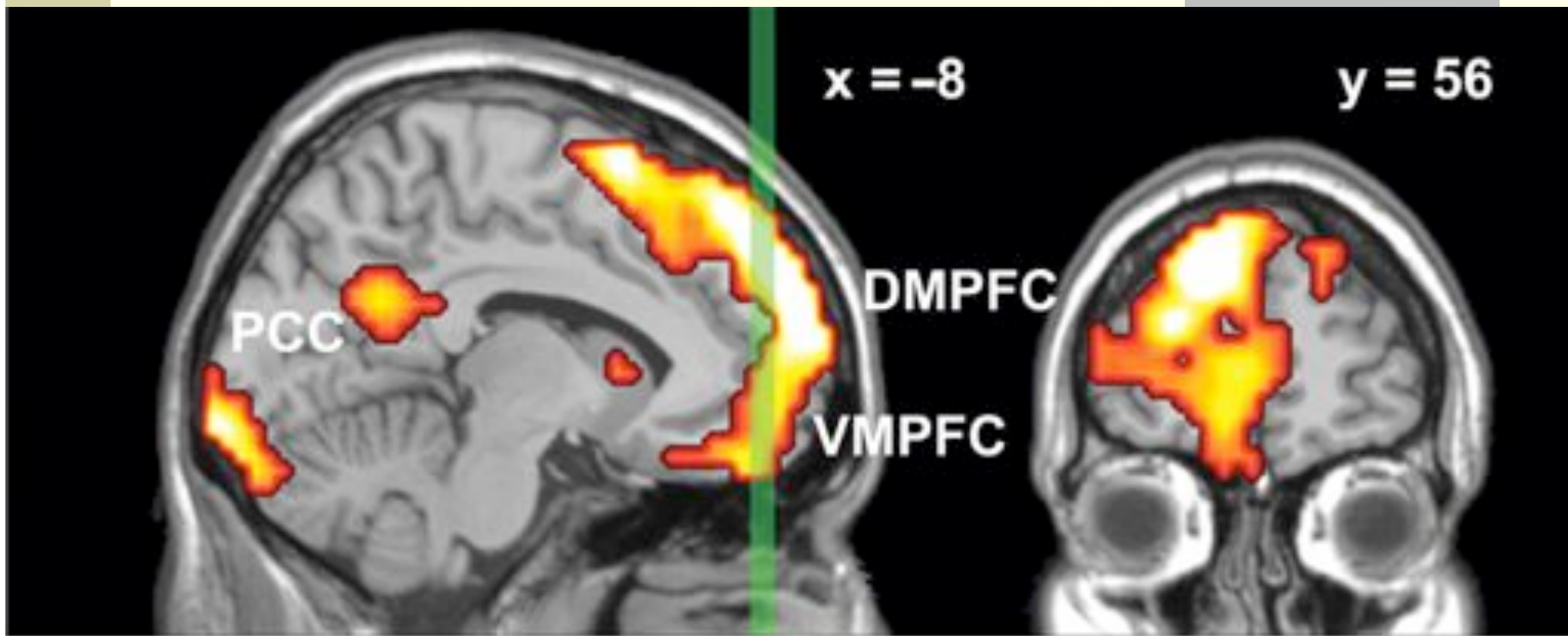
Minimal or no self-as-subject

Increased Medial PFC Activation Related to Self-Referencing Thought



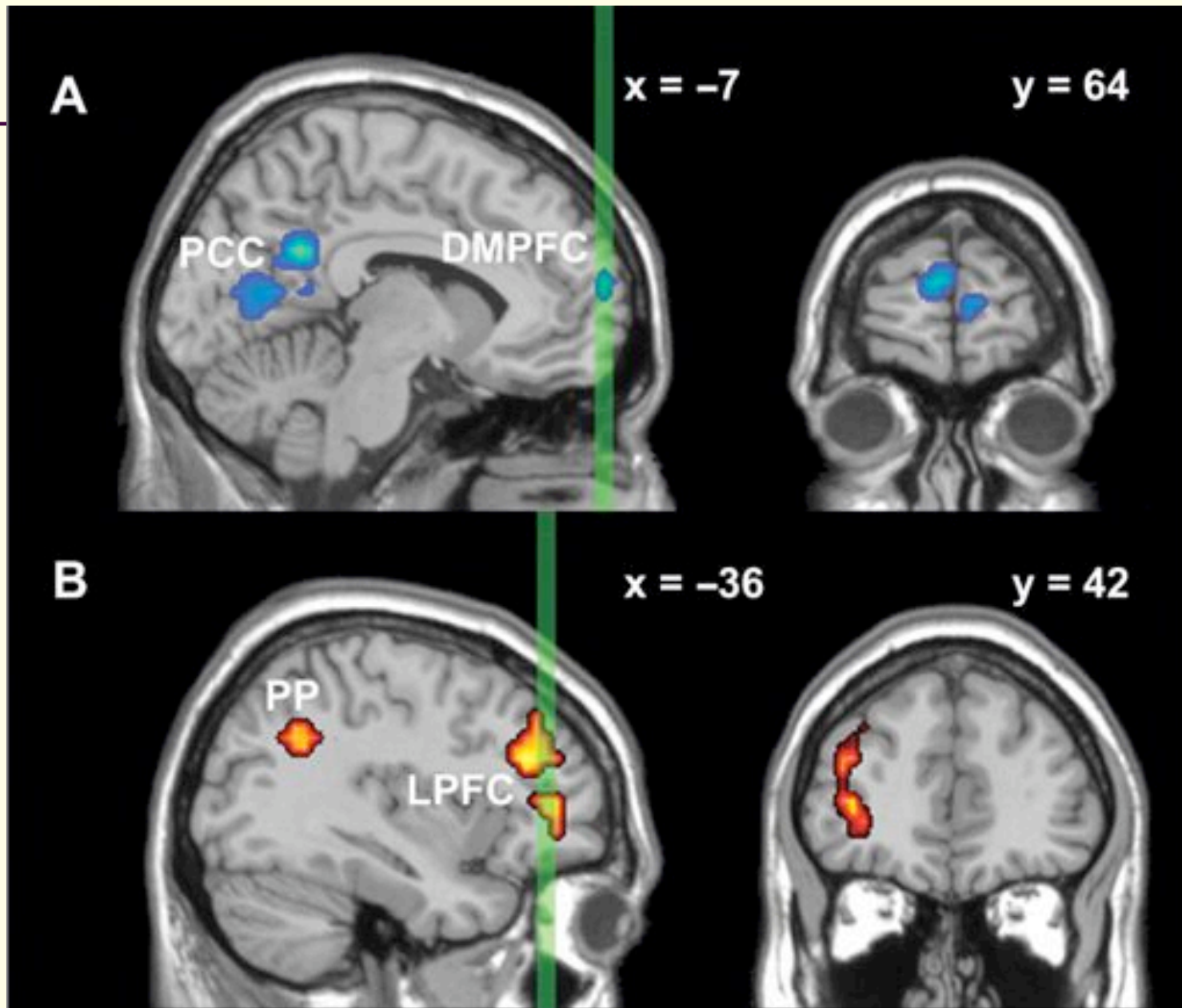
Gusnard D. A. et.al. PNAS 2001;98:4259-4264

Cortical Midline Areas for Self-Referencing Thought

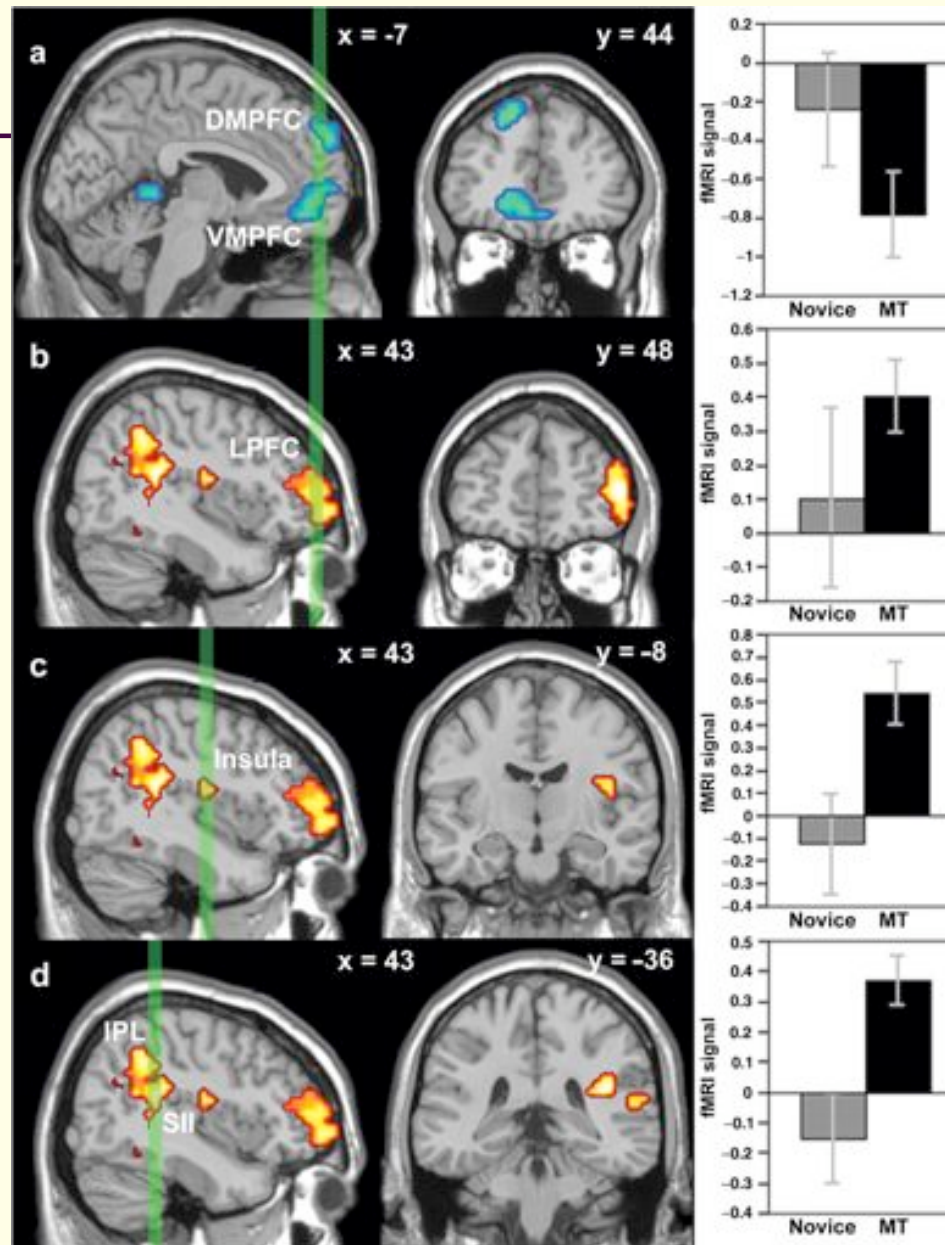


Farb, et al. Soc Cogn Affect Neurosci 2007 2:313-322

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



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



Farb, et al. Soc Cogn Affect Neurosci 2007 2:313-322

Ways to Activate the Two Modes

- Ways to shift into medial mode:
 - Verbal thought
 - Task focus
 - Sense of threat or opportunity
 - Mini-movies in the mental simulator

- Ways to shift into lateral mode:
 - Sensory awareness
 - Sense of the body as a whole
 - “Don’t-know mind”
 - Panoramic view
 - Open space awareness
 - Boundless compassion


Dual Modes of Being

[Medial]

Mainly representational
Much verbal activity
Abstract
Future- or past-focused
Goal-directed
Sense of craving
Personal, self-oriented perspective
Focal view
Firm beliefs
Evaluative
Lost in thought, mind wandering
Reverberation and recursion
Tightly connected experiences
Prominent self-as-object
Prominent self-as-subject

[Lateral]

Mainly sensory
Little verbal activity
Concrete
Now-focused
Nothing to do, nowhere to go
Sense of peace
Impersonal, 3rd person perspective
Panoramic view
Uncertainty, not-knowing
Nonjudgmental
Mindful presence
Immediate and transient;
Loosely connected experiences
Minimal or no self-as-object
Minimal or no self-as-subject



**Once there is greater mindfulness,
how can we use it?**

Three Aspects of Practice

Know the mind, shape the mind, free the mind.

Be with mental contents, work with mental contents, transcend mental contents.

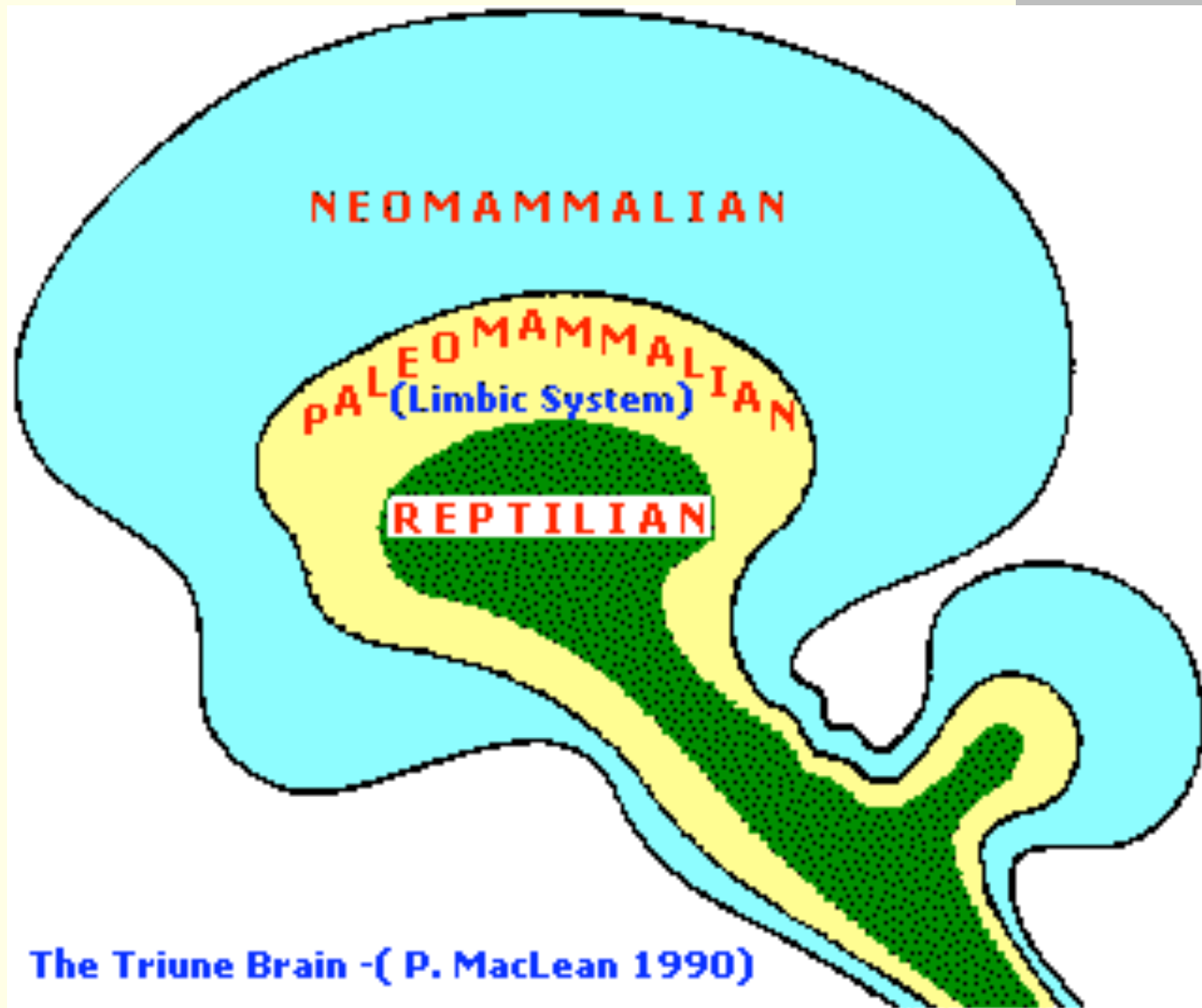
Be mindful of, release, replace.

Let be, let go, let in.

Let's explore the third phase of practice, letting in new positive experiences and gradually replacing old negative ones.

Which means addressing some of the “collateral damage” of biological evolution.

The “Triune Brain”



The Negativity Bias - Sources and Dynamics

- In evolution, threats had more impact on survival than opportunities. So sticks are more salient than carrots:
 - The amygdala is primed to label experiences negatively.
 - The amygdala-hippocampus system flags negative experiences prominently in memory.
 - The brain is like velcro for negative experiences and teflon for positive ones.
- Consequently, negative trumps positive:
 - It's easy to create learned helplessness, but hard to undo.
 - People will do more to avoid a loss than get a gain.
 - It takes five positive interactions to undo a negative one.
- Negative experiences create vicious cycles.

Negative Experiences Can Have Benefits

- There's a place for negative emotions:
 - Anxiety alerts us to inner and outer threats
 - Sorrow opens the heart
 - Remorse helps us steer a virtuous course
 - Anger highlights mistreatment; energizes to handle it

- Negative experiences can:
 - Increase tolerance for stress, emotional pain
 - Build grit, resilience, confidence
 - Increase compassion and tolerance for others

But is there really any shortage of negative experiences??

One Neural Consequence of Negative Experiences

- Amygdala initiates stress response (“alarm bell”)
- Hippocampus:
 - Forms and retrieves contextual memories
 - Inhibits the amygdala
 - Inhibits cortisol production
- Cortisol:
 - Stimulates and sensitizes the amygdala
 - Inhibits and can shrink the hippocampus
- Consequently, chronic negative experiences:
 - Sensitize the amygdala alarm bell
 - Weaken the hippocampus: this reduces memory capacities and the inhibition of amygdala and cortisol production
 - Thus creating vicious cycles in the NS, behavior, and mind

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.**

How can we defeat the negativity bias and build positive resources inside the mind/brain?

Learning and Memory

- The sculpting of the brain by experience is memory:
 - Explicit - Personal recollections; semantic memory
 - Implicit - Bodily states; emotional residues; “views” (expectations, object relations, perspectives); behavioral repertoire and inclinations; what it feels like to be “me”
- Implicit memory is much larger than explicit memory.
- Therefore, the key target is implicit memory.

How to internalize resources in implicit memory - making it like Velcro for positive experiences, but 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 10-2-30 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.

Kinds of “Good” to Take in

- The small pleasures of ordinary life
- The satisfaction of attaining goals or recognizing accomplishments - especially small, everyday ones
- Feeling grateful, contented, and fulfilled

- Things are alright; nothing is wrong; there is no threat
- Feeling safe and strong
- The peace and relief of forgiveness

- Being included, valued, liked, respected, loved by others
- The good feelings that come from being kind, fair, generous
- Feeling loving

- Recognizing your positive character traits
- Spiritual or existential realizations

Why It's Good to Take in the Good

- Rights an unfair imbalance, given the negativity bias
- Gives oneself today the caring and support one should have received as a child, but perhaps didn't get in full measure; an inherent, implicit benefit
- Increases positive resources, such as:
 - Positive emotions
 - Capacity to manage stress and negative experiences
- Can help bring in missing “supplies” (e.g., love, strength, worth)
- Can help heal painful, even traumatic experiences

Benefits of Positive Emotions

- The benefits of positive emotions are a proxy for many of the benefits of TIG.
- Emotions organize the brain as a whole, so positive ones have far-reaching benefits
- These include:
 - Stronger immune system; less stress-reactive cardiovascular
 - Lift mood; increase optimism, resilience
 - Counteract trauma
 - Promote exploratory, “approach” behaviors
 - Create positive cycles

*The good life, as I conceive it, is a happy life.
I do not mean that if you are good you will be happy;
I mean that if you are happy you will be good.*

Bertrand Russell

Using Memory Mechanisms to Help Heal Painful Experiences

- The machinery of memory:
 - When explicit or implicit memory is re-activated, it is re-built from schematic elements, not retrieved *in toto*.
 - When attention moves on, elements of the memory get re-consolidated.
- The open processes of memory activation and consolidation create a window of opportunity for shaping your internal world.
- Activated memory tends to associate with other things in awareness (e.g., thoughts, sensations), esp. if they are prominent and lasting.
- When memory goes back into storage, it takes associations with it.
- You can imbue implicit and explicit memory with positive associations.

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.

Neuropsychology of TIG4

- Extinction, through pairing a negative experience with a powerful positive one.
- Reinforces maintaining PFC-H activation and control during A-SNS-HPAA arousal, so PFC-H is not swamped or hijacked
- Reinforcement of self-directed regulation of negative experiences; enhances sense of efficacy
- Dampens secondary associations to negative material; that reduces negative experiences and behavior, which also reduces vicious cycles
- Reduces defenses around negative material; thus more amenable to therapeutic help, and to insight

TIG4 Capabilities, Resources, Skills

- Capabilities:
 - Dividing attention
 - Sustaining awareness of the negative material without getting sucked in (and even retraumatized)

- Resources:
 - Self-compassion
 - Internalized sense of affiliation

- Skills:
 - Internalizing “antidotes”
 - Accessing “the tip of the root”

Psychological Antidotes

Approaching Opportunities

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

Avoiding Threats

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

Affiliating with “Us”

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

Potential Synergies of TIG and MBSR

- Improved mindfulness from MBSR enhances TIG.
- Increased positive experiences and resources from TIG support MBSR in general ways (e.g., reducing sympathetic NS arousal).
- Use TIG to heighten internalization of specific experiences during MBSR training (and thereafter), such as:
 - 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

Closing Reflections on the “Well-Being Brain”

What is the nature of the brain when a person is:

- Experiencing inner peace?
- Self-actualizing?
- Enlightened (or close to it)?

“Home Base” of the Human Brain

When not ill, in pain, hungry, upset, or chemically disturbed, most people settle into being:

- Conscious
- Calm
- Contented
- Caring
- Creative

Yet It's So Easy to Be Driven from Home . . .

- When we can't attain our goals
- When we feel threatened or harmed
- When we feel disconnected, unappreciated, unloved

What can we do about our biologically-based capacities for and inclinations toward:

- Frustration and disappointment?
- Fear and anger? Fighting, fleeing, and freezing?
- Heartache and shame?

- And using suffering as an engine of survival?

Three Motivational Systems

- **Approach** “carrots,” opportunities, rewards, pleasure
- **Avoid** “sticks,” threats, penalties, pain
- **Affiliate** with “us,” proximity, bonds, feeling close

- Reptiles and fish approach and avoid. Mammals and birds also *affiliate* - especially primates and humans. Affiliating is a breakthrough, co-evolving with emotion.

- Although the three branches of the evolving vagus nerve loosely map to the three systems, the essence of each is its aim, not its neuropsychology. Each system can draw on another system for its ends.

Evolution of Bonding, Cooperation, and Love

- Unlike reptiles and fish, mammals and birds raise their young and often pair-bond. The increased “computational requirements” necessitate more cortex, relative to body-weight.
 - Monogamous species have the biggest brains.
- The more social the primate group, the bigger the brain
 - Groomers get more of a stress relief benefit than groomees.
- Human hunter-gatherer bands competed intensely with other bands; the ones with the best teamwork usually won.
 - Genetically, it makes sense to altruistically sacrifice your own life if that promotes the survival of others with whom you share genes.

Neural Substrates of Empathy

- Three *simulating* systems:
 - Thoughts: “theory of mind”; prefrontal cortex
 - Feelings: resonating emotionally; insula
 - Actions: “mirror” systems; temporal-parietal
- These systems can re-create traces of the experience of others.
- There is a range of empathic capacities and inclinations.
- Empathy manifests routinely, including with strangers. It is also widely ignored or suppressed (e.g., estrangement in couples, everyday disdain or discrimination, persecution, war).
- Empathy can be trained and valued.

Activating Substrates of Empathy

- Foundation:
 - Intention
 - Boundaries
 - Feeling cared about and appreciated
 - Self-compassion
- Thoughts - active imagining and hypothesis-testing
- Feelings - attention to micro-expressions; interoception
- Actions - rapport with the other's posture, movements (embodied cognition)

Two Modes of Activating the Three Systems

- **Reactive:** Ignorance, disturbance, suffering, harm, high “selfing”
- **Responsive:** Wisdom, equanimity, happiness, benefit, low “selfing”
- It’s typical to shift between modes - though:
 - Sometimes both modes intertwine within a single action, interaction, or experience.
 - Some people stabilize in one mode.
- Internal and external factors determine which mode is active and how it’s expressed.

Reactive Mode

	<u>View</u>	<u>Action</u>	<u>Experience</u>
Approach	Scarcity, loss, unreliability, not expected rewards	Grasp, acquire	Greed, longing, frustration, disappointment
Avoid	Harms present or lurking	Fight, flight, freeze	Fear, anger, weakness
Affiliate	Separated, being “beta,” devalued	Cling, seek approval, reproach	Loneliness, heart-break, envy, jealousy, shame

Reactive Dysfunctions in Each System

- **Approach** - Addiction; over-drinking, -eating, -gambling; compulsion; hoarding; driving for goals at great cost; spiritual materialism
- **Avoid** - Anxiety disorders; PTSD; panic, terror; rage; violence
- **Affiliate** - Borderline, narcissistic, antisocial PD; symbiosis; *folie a deux*; “looking for love in all the wrong places”

The Reactive Triangle



Responsive Mode

	<u>View</u>	<u>Action</u>	<u>Experience</u>
Approach	Sufficiency, abundance, disenchantment	Aspire, give, let go	Glad, grateful, fulfilled, satisfied
Avoid	Resources, challenges-in- context	Govern/restrain, truth-to-power, forgive	Strength, safety, peace
Affiliate	Connection, belonging, social supplies	Open to others; join; be empathic, compassionate, kind, caring; love	Membership, closeness, friend- ship, bonding loved and loving

The Responsive Triangle



Coming Home . . .

Gratitude

Love

Peace

Some Ways to Take the Fruit as the Path

General factors: See clearly. Have compassion for yourself. Take life less personally. Take in the good. Deepen equanimity.

Approach system

- Be glad.
- Appreciate your resources.
- Give over to your best purposes.

Avoid system

- Cool the fires.
- Recognize paper tigers.
- Tolerate risking the dreaded experience.

Affiliate system

- Sense the suffering in others.
- Be kind.
- Act with unilateral virtue.

Choices . . .



Reactive Mode

Or?



Responsive Mode

Penetrative insight

joined with calm abiding

utterly eradicates

afflicted states.

Shantideva

Great Books

See www.RickHanson.net for other great books.

- Austin, J. 2009. *Selfless Insight: Zen and the Meditative Transformations of Consciousness*. MIT Press.
- Begley, S. 2007. *Train Your Mind, Change Your Brain: How a New Science Reveals Our Extraordinary Potential to Transform Ourselves*. Ballantine.
- Hanson, R. 2009. *Buddha's Brain: The Practical Neuroscience of Happiness, Love, and Wisdom*. New Harbinger.
- Johnson, S. 2005. *Mind Wide Open: Your Brain and the Neuroscience of Everyday Life*. Scribner.
- Kornfield, J. 2009. *The Wise Heart: A Guide to the Universal Teachings of Buddhist Psychology*. Bantam.
- LeDoux, J. 2003. *Synaptic Self: How Our Brains Become Who We Are*. Penguin
- Sapolsky, R. 2004. *Why Zebras Don't Get Ulcers*. Holt.
- Siegel, D. 2007. *The Mindful Brain: Reflection and Attunement in the Cultivation of Well-Being*. W. W. Norton & Co.
- Thompson, E. 2007. *Mind in Life: Biology, Phenomenology, and the Sciences of Mind*. Belknap Press.

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. 67

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

- 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.