

Neural correlates of mindfulness practice

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Commonly reported benefits ...

- Relaxation and well-being that last beyond the time spent meditating
- Improved mood and ability to deal with difficult / challenging situations
- Improved concentration and memory

Effects of mindfulness practice

- Improved immune function (e.g., Davidson et al., 2003)
- Reduced blood pressure (e.g., Carlson et al., 2007)
- Reduced cortisol levels (e.g., Carlson et al., 2007)

Mindfulness effective in the treatment of ...

- Anxiety (Hofmann et al., 2010)
- Depression (Teasdale et al., 2000)
- Substance abuse (Bowen et al., 2010)
- Chronic pain (Grossman et al., 2007)

Mindfulness in the treatment of PTSD

- ◉ Preliminary study on mindfulness-based exposure therapy (King et al., 2012)
 - Intervention appeared acceptable and veterans showed compliance
 - PTSD symptoms improved significantly in completers (N=16, p=.03)

Definition

- ◉ Non-judgmental awareness of experiences in the present moment
- ◉ Attitude of acceptance, curiosity and openness

What are the neural mechanisms that might underlie its beneficial effects?

Magnetic resonance imaging (MRI)

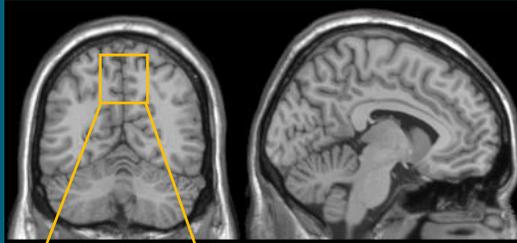


Imaging of function and structure of the brain

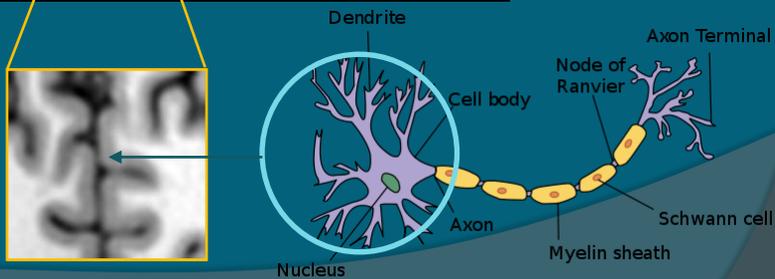
Function: oxygenation of blood
→ activation of brain regions

Structure: morphometry of the brain

Brain gray matter



Surface of both hemispheres
Deeper nuclei
Tissue: **Neuronal cell bodies**



Brain gray matter

Greater gray matter correlates with better performance of tasks associated with that brain region

(Critchley et al., 2004; Milad et al., 2005; Mechelli et al., 2004)

Difference in brain structure

... between experienced meditators and non-meditators

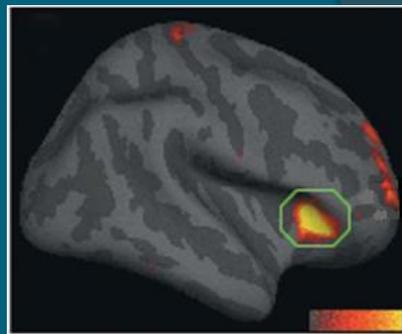
Lazar et al. (2005)
Pagnoni & Cekic (2007)
Hölzel et al. (2008)
Luders et al. (2009)
Vestergaard-Poulsen et al. (2009)
Grant et al. (2010)

Some different and some overlapping findings



Hippocampus

Hölzel et al. (2008);
Luders et al. (2009);
Lazar et al. (unpublished)

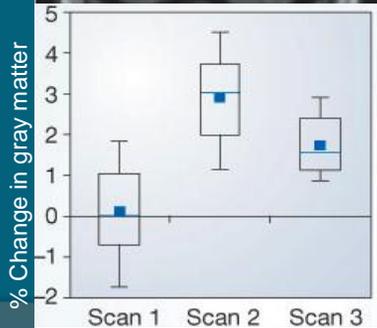
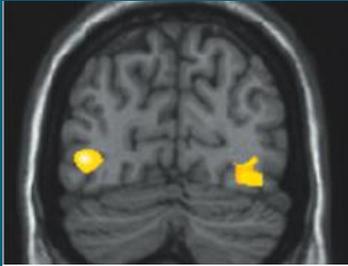


Right insula

Hölzel et al. (2008);
Lazar et al. (2005)

Cross-sectional
studies!

Neuroplasticity through training



Draganski et al., 2004, Nature
Reprinted with permission from Macmillan Publishers Ltd.

Study 1

Does gray matter concentration increase following mindfulness practice?

Mindfulness-Based Stress Reduction (MBSR, Jon Kabat-Zinn)

- Body Scan
- Yoga
- Sitting meditation
- Daily homework practice for 8 weeks

Methods

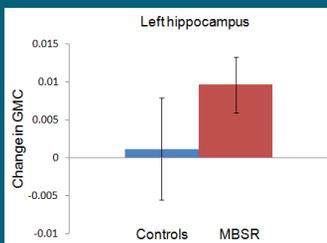
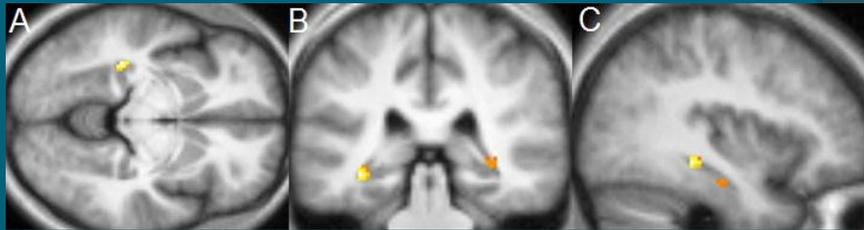
Participants: healthy, meditation-naïve

- 16 MBSR
- 17 waitlist control group

Structural MRIs

- Before and after the course

Increase in gray matter concentration Left Hippocampus



Hölzel et al. (2011). *Psychiatry Research: Neuroimaging*.

Hippocampus

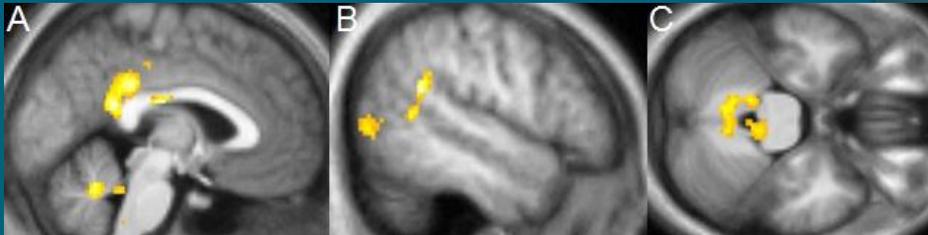
- Susceptible for neurotoxic effect of stress
- Lower gray matter in PTSD, and other disorders (e.g., depression, Alzheimer's)
- Ability to form new synapses and generate new neurons
- Involved in
 - Learning and memory
 - Emotion regulation

Increase in gray matter concentration

Posterior
cingulate cortex

Temporo-parietal
Junction

Cerebellum



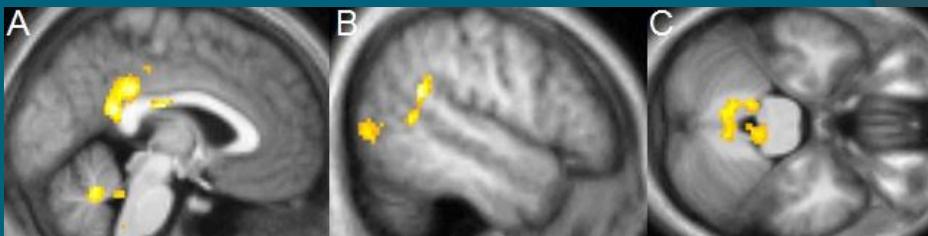
Hölzel et al. (2011). *Psychiatry Research: Neuroimaging*.

Increase in gray matter concentration

Posterior
cingulate cortex

Temporo-parietal
Junction

Cerebellum



Self

Change in
perspective

Coordination
of movement &
emotion

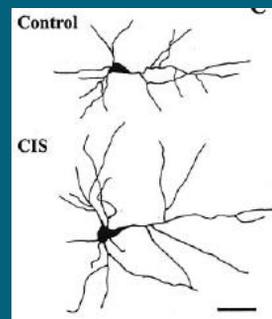
Hölzel et al. (2011). *Psychiatry Research: Neuroimaging*.

Open questions

- Preliminary finding – replication is necessary
- Cellular mechanisms are unknown
- Is meditation the primary cause for the changes?
(social contacts, movement, diet, etc.)
- How are changes in the brain related to well-being?

Stress

- MBSR reduces stress (Chiesa & Serretti, 2009)
- Amygdala activation in response to stress inducing stimuli
- Rodent studies:
Stress leads to growth of dendrites
(Vyas et al., 2002)



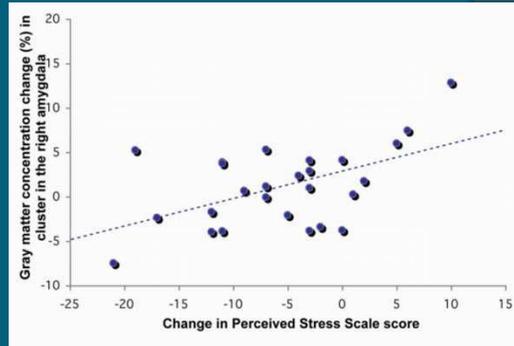
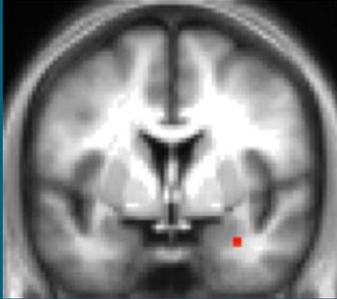
Study 2

Are changes in perceived stress related to gray matter changes in the amygdala?

Perceived stress

- 26 healthy, stressed participants
- Perceived stress scale
(Cohen & Williamson, 1983)
- Before and after MBSR program
- Significant reduction in stress ($p < 0.001$)
- Regression analysis

Decrease in perceived stress correlates with decrease in amygdala gray matter concentration



Hölzel et al. (2010). *Social Cognitive and Affective Neuroscience*.

Summary

- Increase in gray matter concentration, e.g., in hippocampus, following mindfulness training
- Decrease in perceived stress correlates with decrease in amygdala gray matter concentration
- Specific neural mechanisms of mindfulness-induced pain analgesia

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Thank you for your
attention!