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?

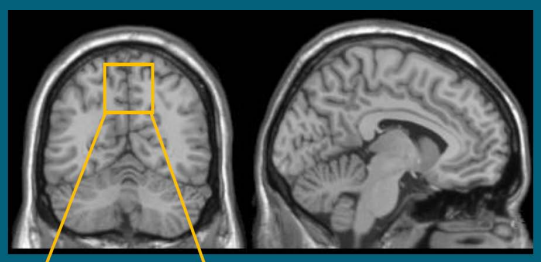
Magnetic resonance imaging (MRI)

Imaging of function and structure of the brain

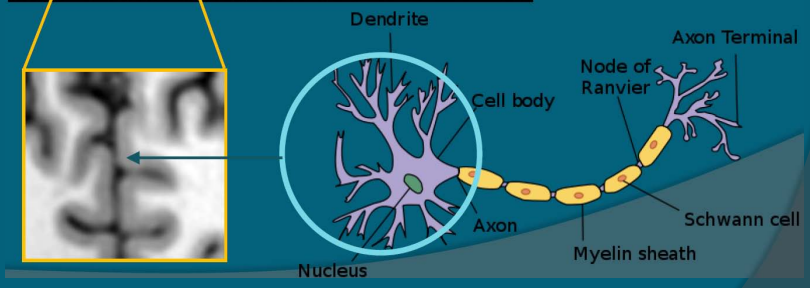
Function: oxygenation of blood
→ activation of brain regions

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

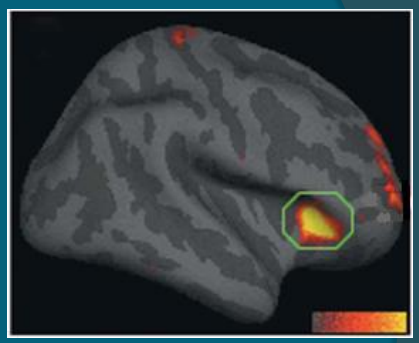
… between experienced meditators and non-meditators

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)

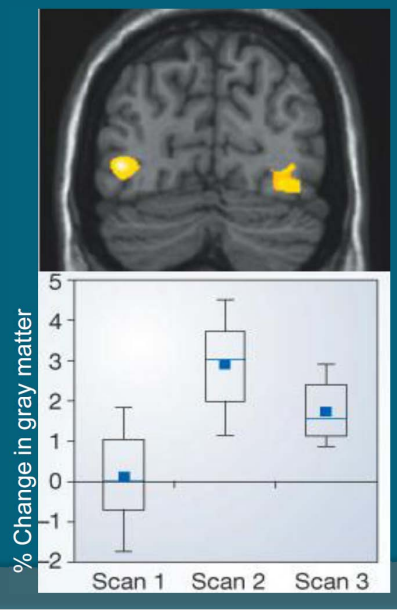


Right insula

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

Cross-sectional studies!

Neuroplasticity through training



Draganski et al., 2004, Nature
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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

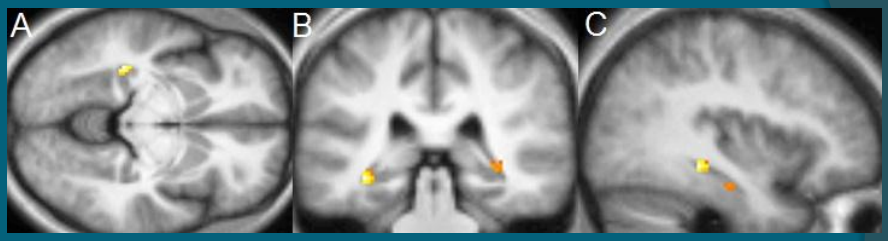
- 16 MBSR
- 17 waitlist control group

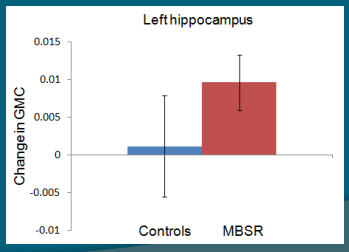
Structural MRIs

- Before and after the course

Increase in gray matter concentration

Left Hippocampus





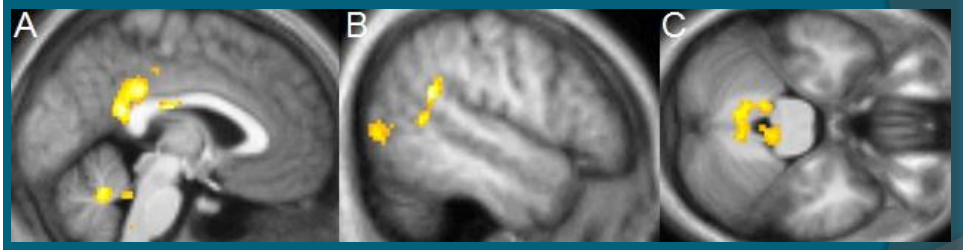
Hölzel et al. (2011). *Psychiatry Research: Neuroimaging.*

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**



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Increase in gray matter concentration

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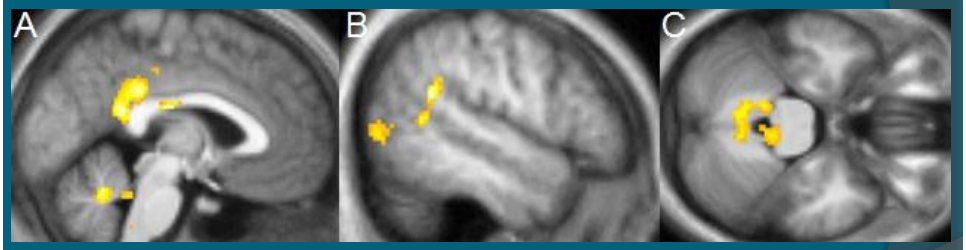


Self

Change in perspective

Coordination of movement & emotion

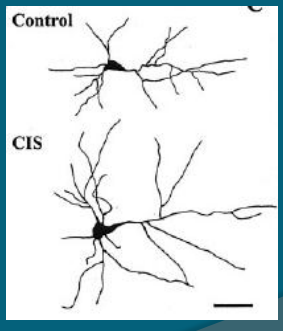
Hölzel et al. (2011). *Psychiatry Research: Neuroimaging.*

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

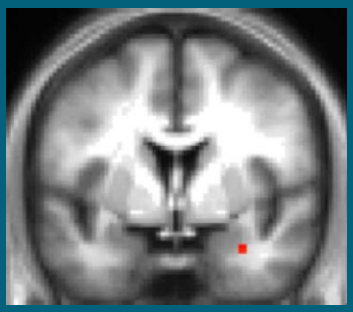
Are changes in perceived stress related to gray matter changes in the amygdala?

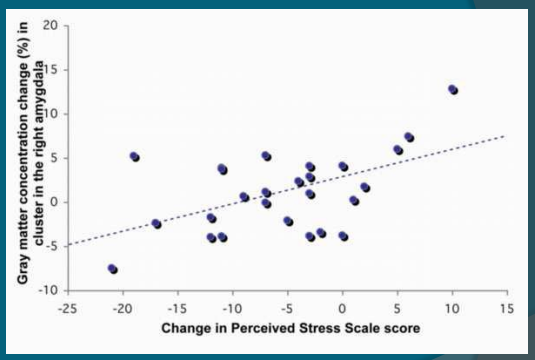
Perceived stress

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

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

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!