Hölzel et al. (2011): Mindfulness and brain scans

Lesson 1.1.3 | Concepts and methods

1. Psychology and aim

Mindfulness: awareness of the present moment with a compassionate, non-judgemental stance. **Localisation:** different brain regions contribute to different functions. **Neuroplasticity:** the nervous system can change with experience.

Earlier cross-sectional comparisons of meditators could reflect pre-existing differences. This study followed beginners to investigate gray-matter concentration changes after eight weeks of Mindfulness-Based Stress Reduction (MBSR). Hippocampus and insula were planned regions of interest; whole-brain analysis was exploratory.

2. Sample and design

Final scan sample	MBSR	Waiting-list control
Participants	16: 6 men, 10 women	17: 11 men, 6 women
Mean age	38 years	39 years

Healthy, medication-free volunteers aged 25-55 with little meditation experience. MBSR participants were recruited from existing courses, were right-handed and MRI-eligible. Groups were not randomly allocated.

A controlled longitudinal design: group was between participants; pre/post time was within participants. Outcome: regional gray-matter concentration measured using structural MRI and voxel-based morphometry (VBM). FFMQ self-report and home-practice records supplied additional data.

3. Procedure

MBSR involved eight weekly sessions of about 2.5 hours, a 6.5-hour day in week six, and body scan, mindful yoga and sitting meditation. Guided home practice was prescribed for 45 minutes daily, with informal mindful activities.

MRI scans occurred within two weeks before/after the course; controls were scanned at a comparable interval of about two months. VBM compared small units of brain images. Gray-matter concentration is an MRI-based tissue estimate. Structural MRI measures anatomy, not direct task performance.

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Lesson 1.1.3 | Evidence and interpretation

1. Brain results

Analysis	Finding
Planned: left hippocampus	Gray-matter concentration increased after MBSR; controls showed no significant change in this cluster.
Planned: insula	No significant predicted increase.
Exploratory whole brain	Increases in posterior cingulate cortex, left temporo-parietal junction and cerebellar clusters, including a vermis/brainstem cluster.

The hippocampus is discussed in relation to learning/memory; posterior cingulate to self-referential processing; temporo-parietal junction to perspective-taking; cerebellar areas to cognitive/emotional processes. These functional explanations are interpretations, not functions directly tested here.

2. Mindfulness and practice

The Five Facet Mindfulness Questionnaire (FFMQ) has 39 items rated 1-5: observing, describing, acting with awareness, non-judging and non-reactivity. Usable pre/post questionnaire data came from **14 people per group**, not the full scan sample.

Observing, acting with awareness and non-judging improved significantly in the MBSR group. Describing and non-reactivity did not show significant group-by-time effects.

Practice measure	Reported amount
Prescribed formal practice	45 minutes per day
Actual mean formal practice	27 minutes per day
Mean total over eight weeks	22.6 hours

Reported practice time and changes in FFMQ scores were not significantly correlated with the identified brain changes. The study did not establish a simple more-practice/more-change dose relationship.

Conclusion: MBSR participation was associated with regional structural changes consistent with experience-dependent plasticity. Increased concentration in a memory-related region does not prove improved memory.

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Lesson 1.1.3 | Evaluation and connections

1. Strengths

Longitudinal comparison: the same people were scanned before and after, reducing the problem of relying only on pre-existing group differences.
Objective measure: standardised MRI/VBM reduces reliance on self-report for brain structure.
Control interval: a waiting-list comparison helps assess changes beyond time alone.

2. Limitations

Selection: motivated course volunteers were not randomly allocated; the small, healthy and educated sample limits generalisation.
Inactive control: group contact, expectations, exercise and other components were not matched by an alternative course.
Interpretation: MRI concentration is not a direct measure of memory, empathy or emotional regulation. No long-term scan follow-up established permanence.

3. Ethics

Written informed consent and ethics-board approvals were reported. MRI screening addressed safety. Two MBSR participants withdrew after discomfort during the first scan, demonstrating that discomfort can occur even with non-invasive methods. Brain images and questionnaires require confidentiality and privacy.

4. Debates and applications

Nature/nurture: experience-associated structural change shows that biological characteristics need not be fixed. It does not quantify genetic influence or prove genes irrelevant.
Individual/situational: motivation and self-selection may combine with the course environment and practice.
Application: findings motivate further study of training and plasticity; clinical effectiveness needs separate evidence.

> Remember the non-findings: no significant insula increase; no significant practice-time/brain-change correlation; no direct test of improved memory.

Hint: Separate the brain measurement, the psychological function associated with that region, and any actual behavioural test. Only the first was directly measured here.