What Neuroimaging tells us about Brain Plasticity

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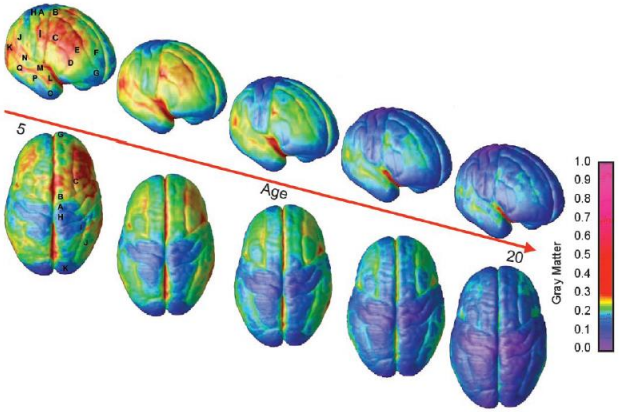
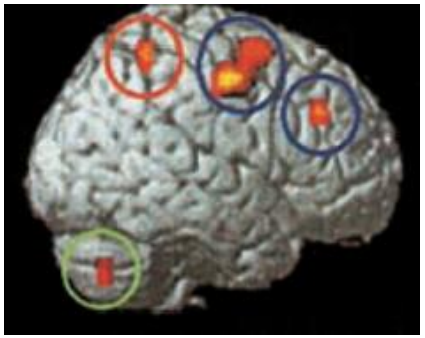
Overview

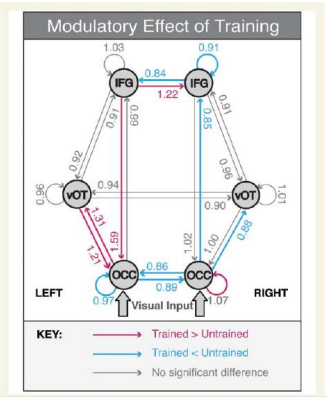
- Structural MRI can track changes in grey and white matter as we develop and learn new skills



- Functional MRI can track brain activity as we learn new tasks and perform practiced tasks



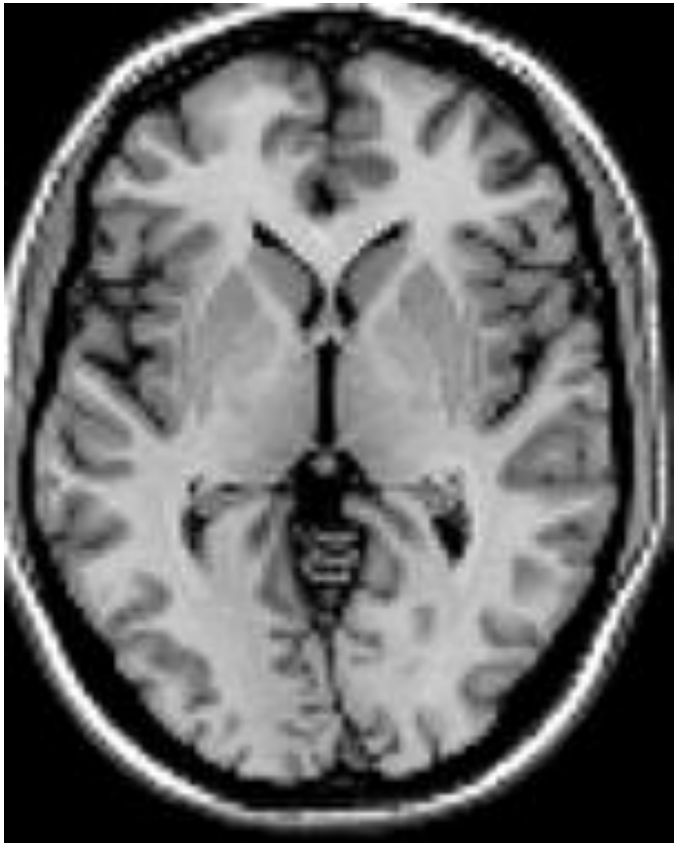
- Use MEG (and fMRI) combined with connectivity models for studying signalling among brain regions



MRI Scanner

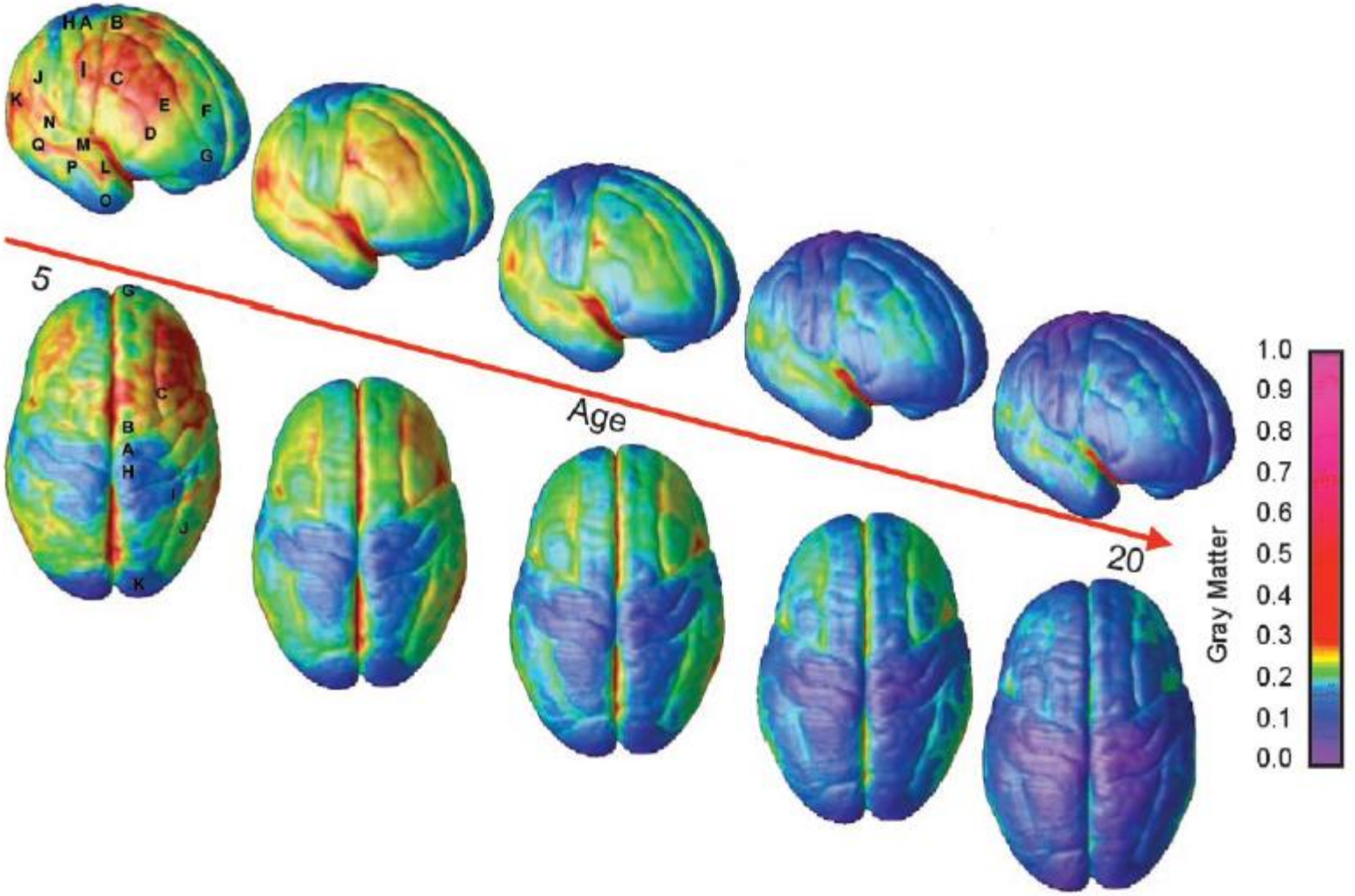
Grey and white matter

White matter:
Glial cells and myelinated axons



Grey matter:
glia, vasculature, and neurons with dendritic and synaptic processes

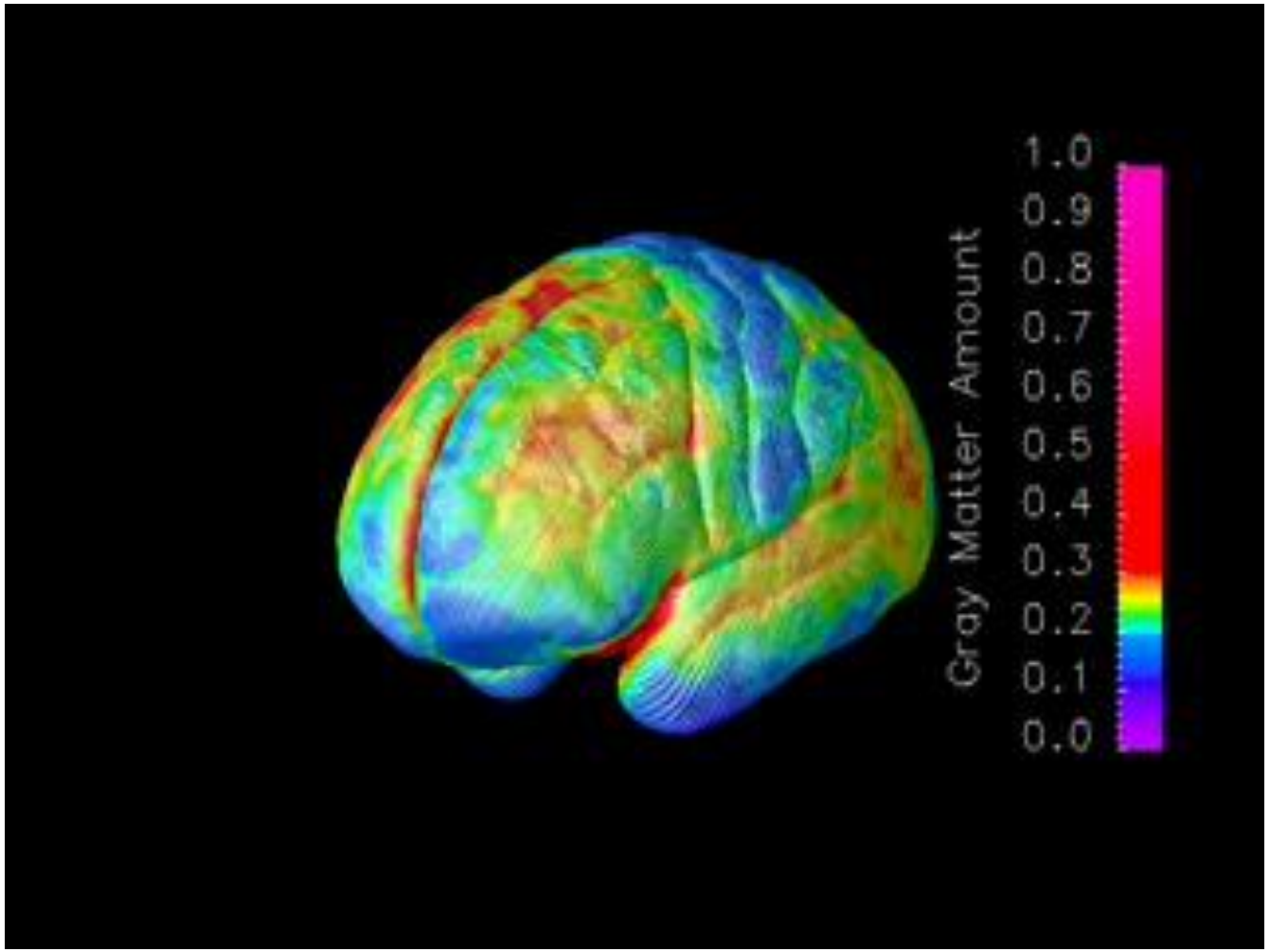
Development



13 children scanned every 2 years

Gogtay et al. PNAS, 2004

Development

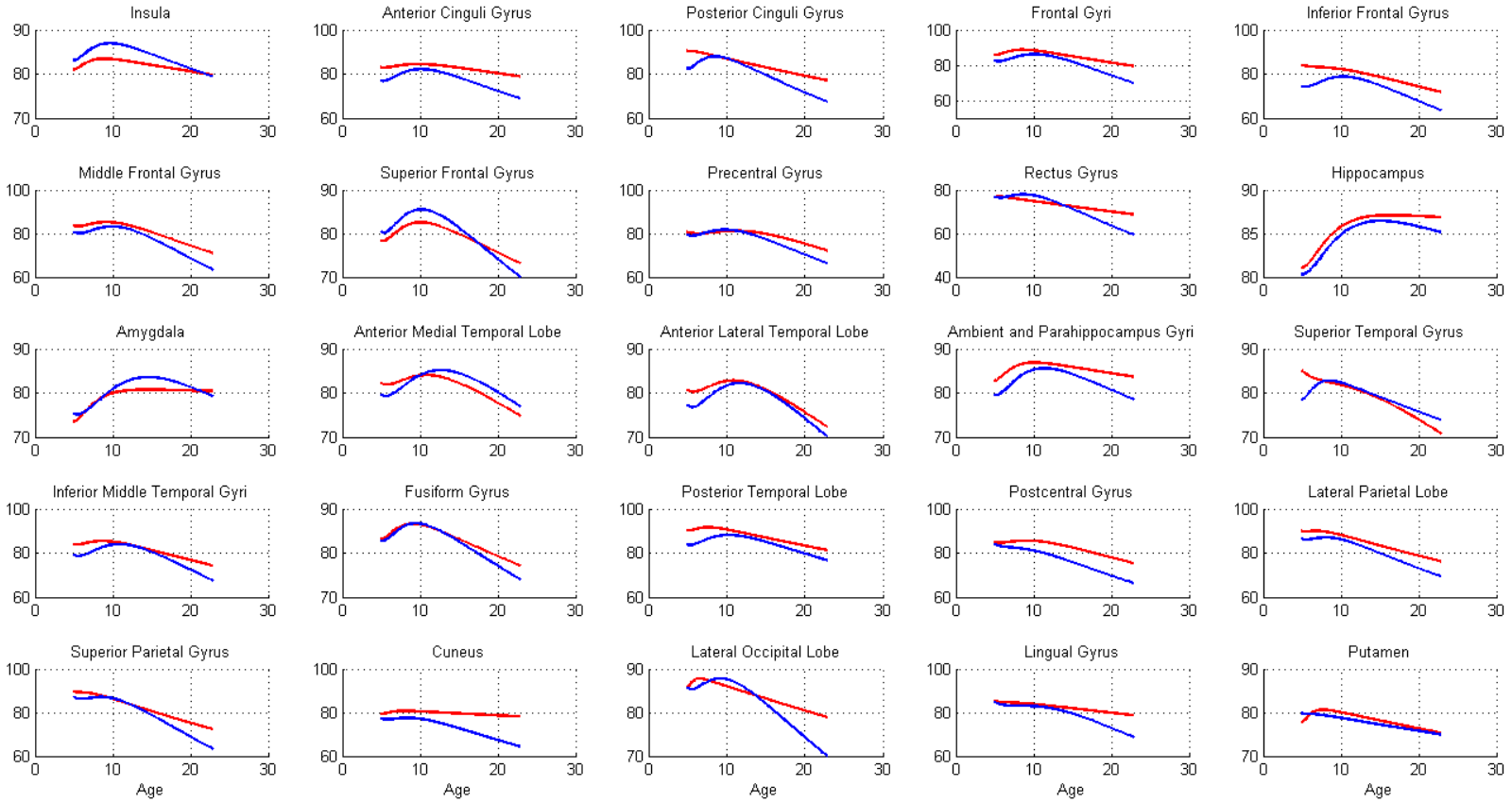


13 children scanned every 2 years

Gogtay et al. PNAS, 2004

Development

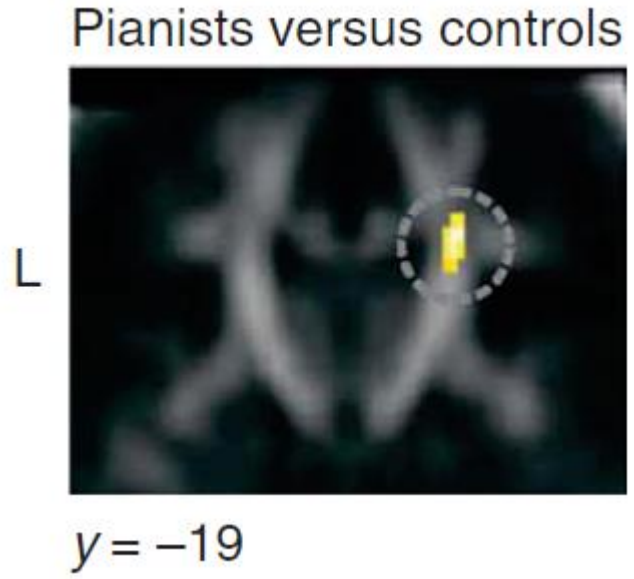
289 children, each scanned twice. Ziegler et al. in prep, 2015



Gray Matter Density for Boys (blue) and Girls (red). Most areas "inverted –U" except e.g. hippocampus.

Learning – Anatomical Changes

"Fractional Anisotropy (FA)" from MRI measures how directed are white matter tracts.



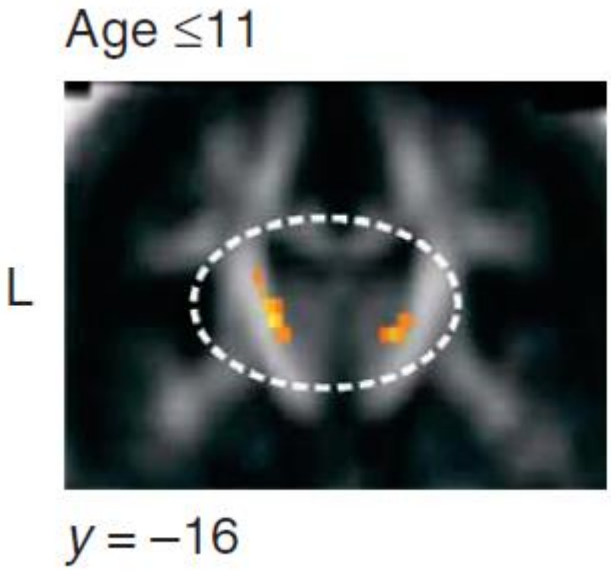
Eight concert pianists versus age-matched non-musicians (controls)

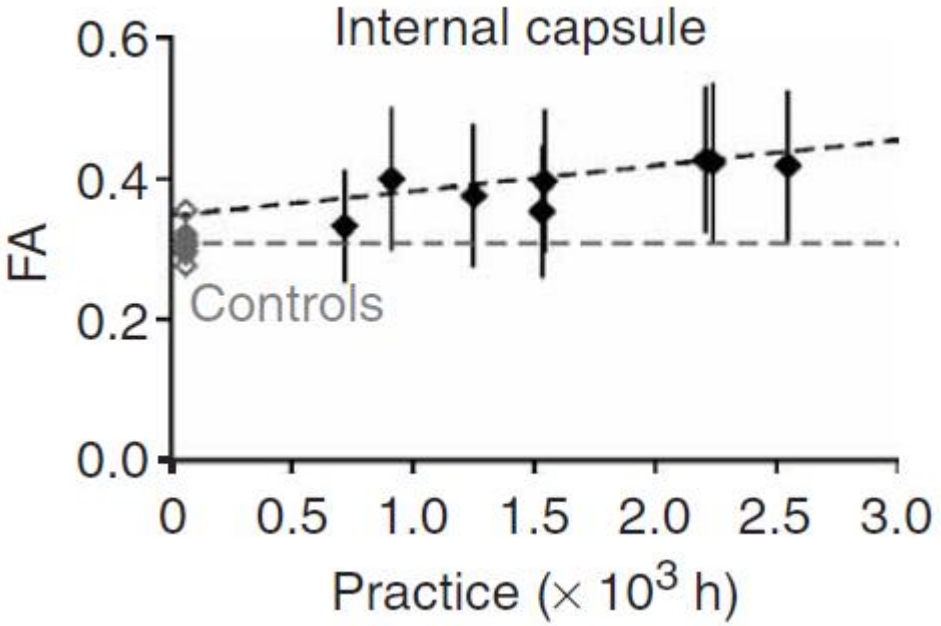
White Matter tracts in Internal capsule

Bengtsson et al., Nature Neuroscience, 2005

Learning – Anatomical Changes

Pianists who practiced for longer during childhood have more directed white matter tracts

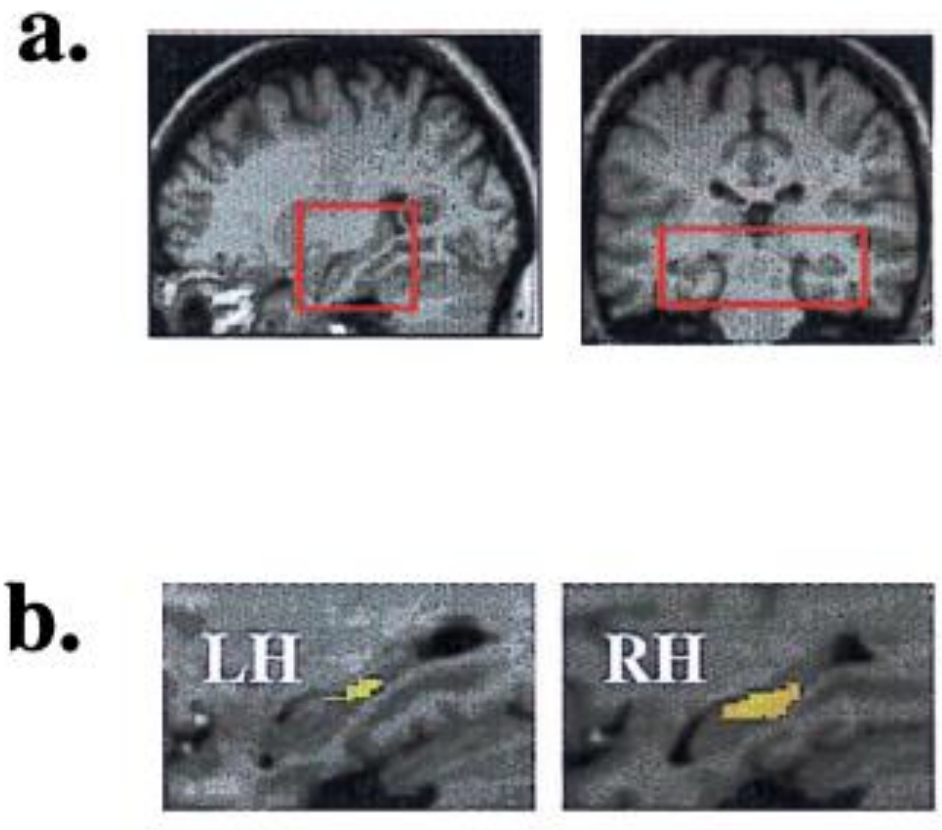




Bengtsson et al., Nature Neuroscience, 2005

Navigation

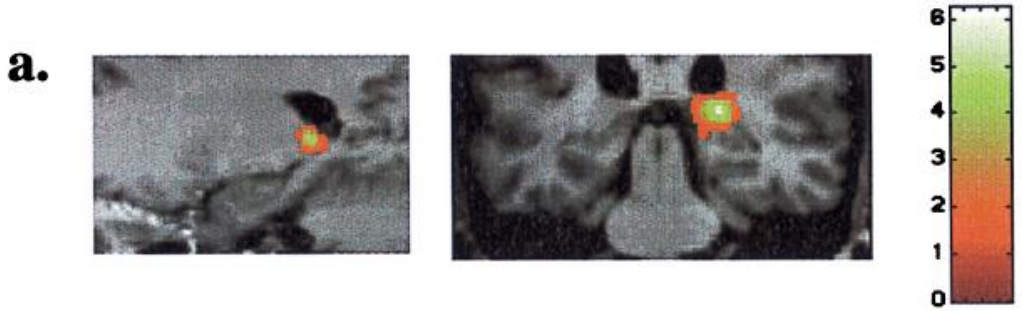
The posterior hippocampus is larger in taxi drivers than control subjects (matched for age, IQ)

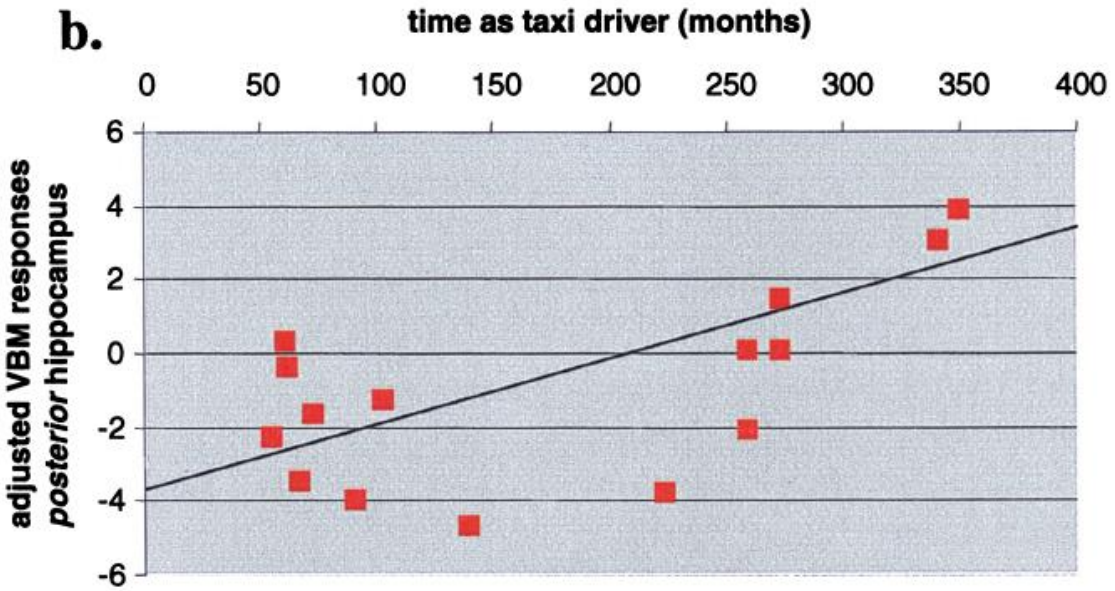


Maguire et al. PNAS, 2000

Navigation

The longer they've been driving taxis the bigger this increase





Maguire et al. PNAS, 2000

Cognitive neuroscience

Behavioural experiments

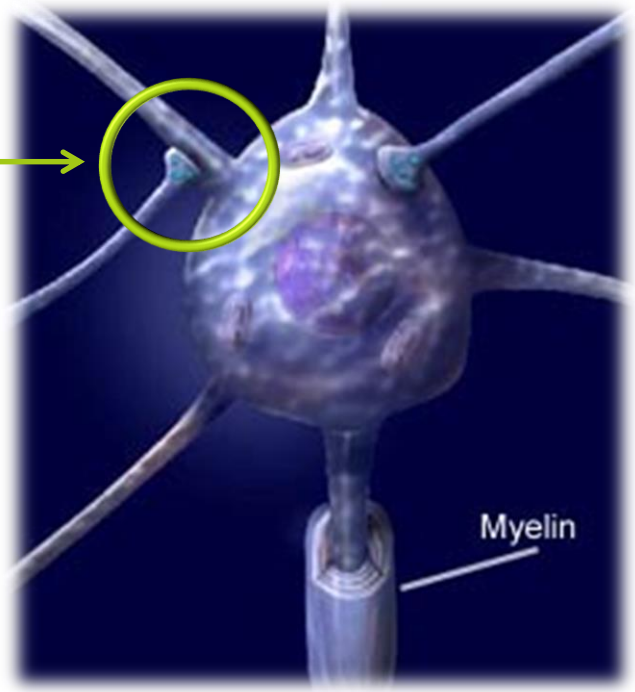
+

Neuroscience

fMRI-signal

BOLD

Blood Oxygen Level Dependent signal



Logothetis, 1993

Learning – Redistributed Activity

Motor Sequence Activity:

A: 13224134 versus

B: 12121212

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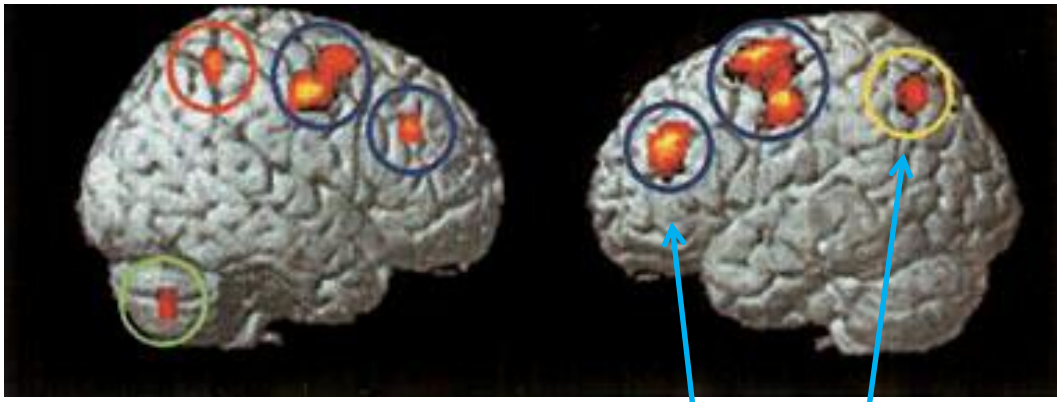
After a Little Practice



Ramnani et al., 2002

"Fronto-Parietal Attention Network"

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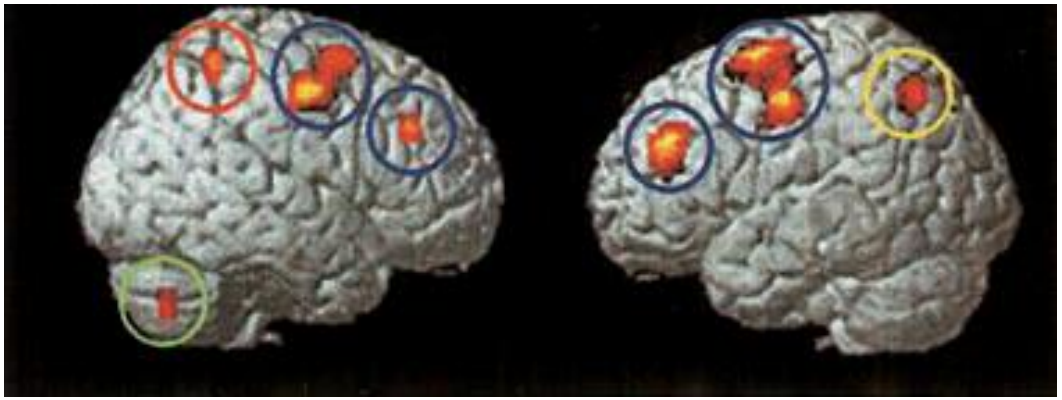
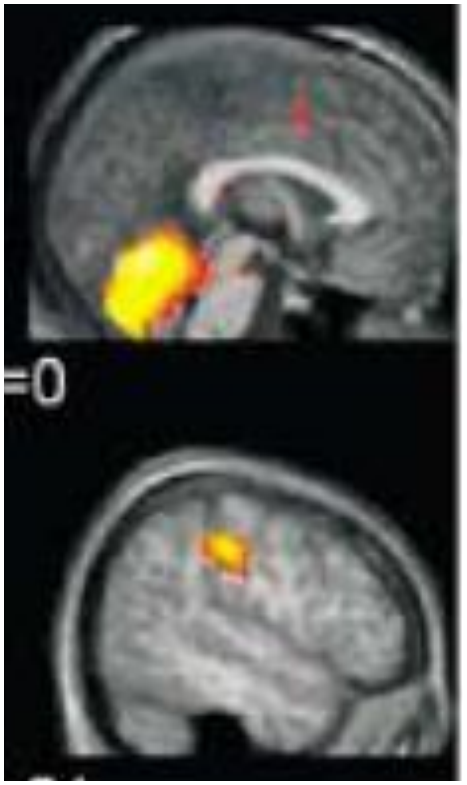


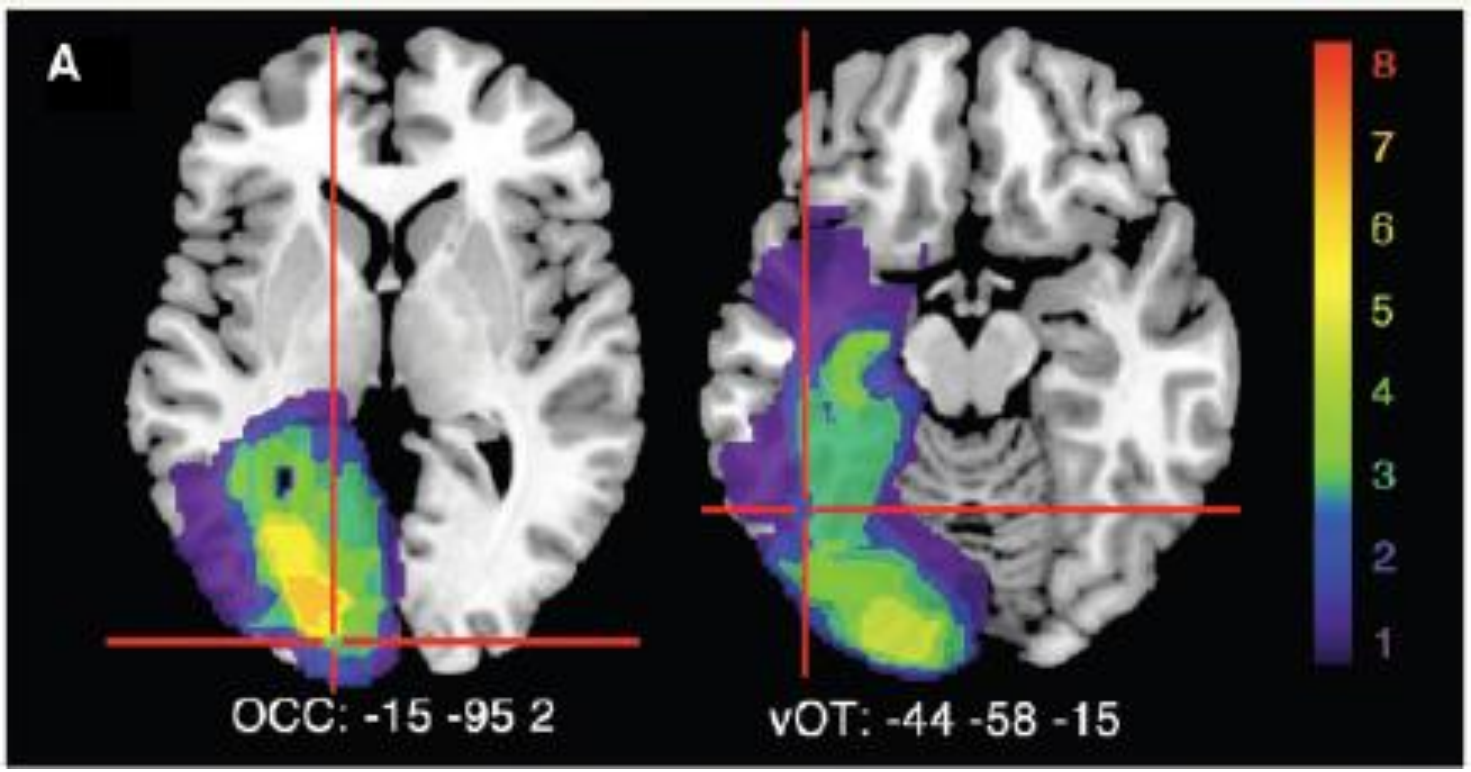
Ramnani et al., 2002

After a lot of practice



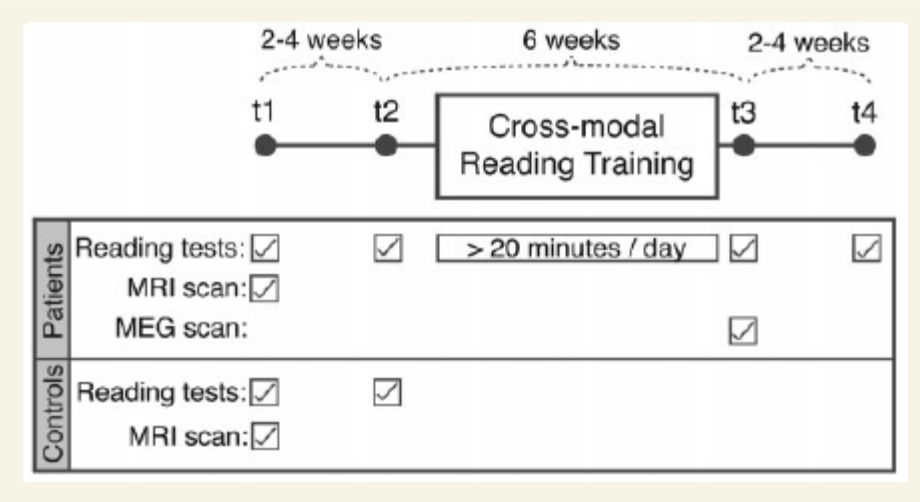
Bengtsson et al., (2004)

Plasticity after Brain Injury



Woodhead et al. Brain, 2013 studied 8 people with a focal brain Injury in left occipito-temporal cortex. They have problems reading, especially longer words.

Plasticity after Brain Injury

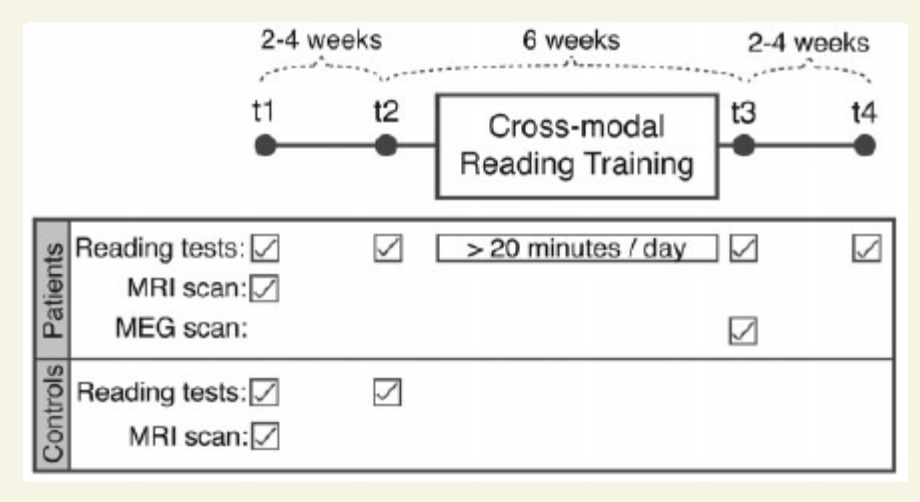


Plasticity after Brain Injury

Present both text and speech.

(i) Listening component: Press button.

(ii) Testing Component: Do text and speech match ?



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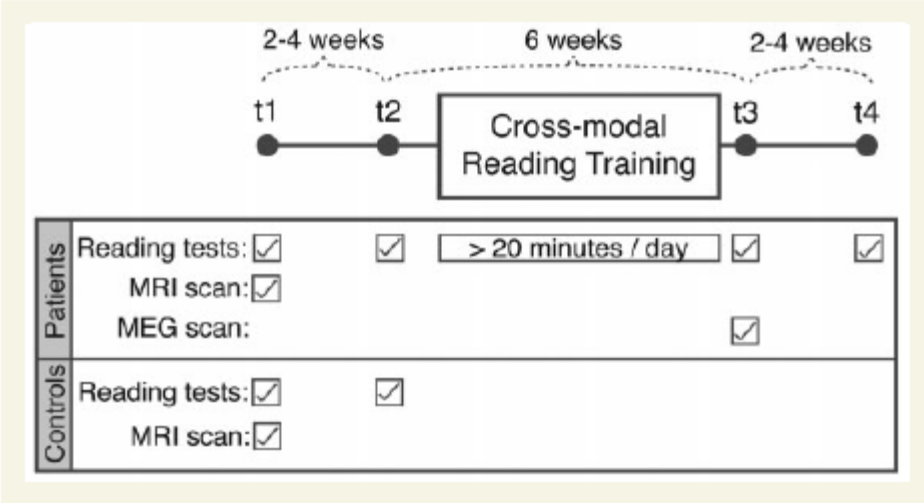
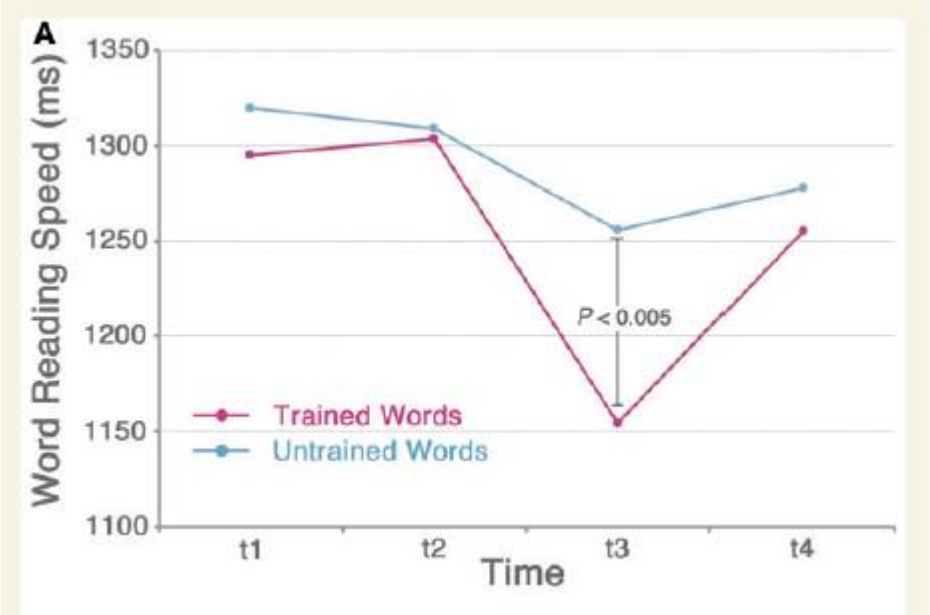




Plasticity after Brain Injury

Measure electrical activity of the brain as they read words after cross-modal training

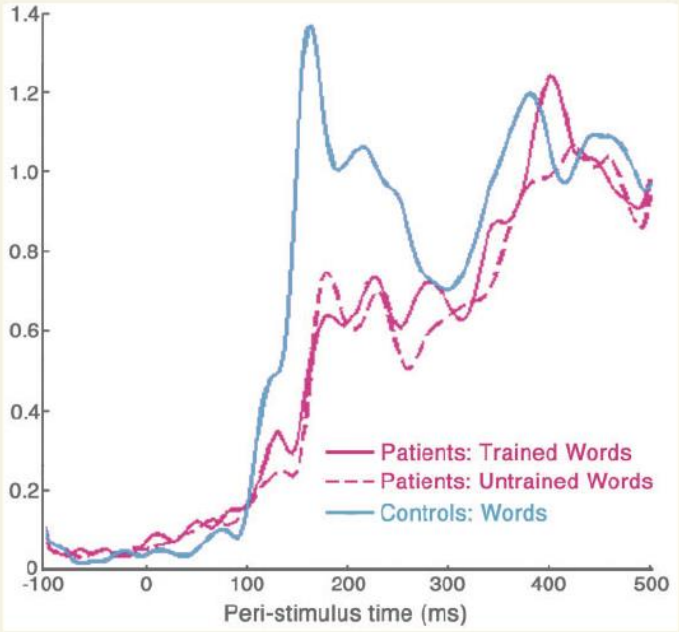
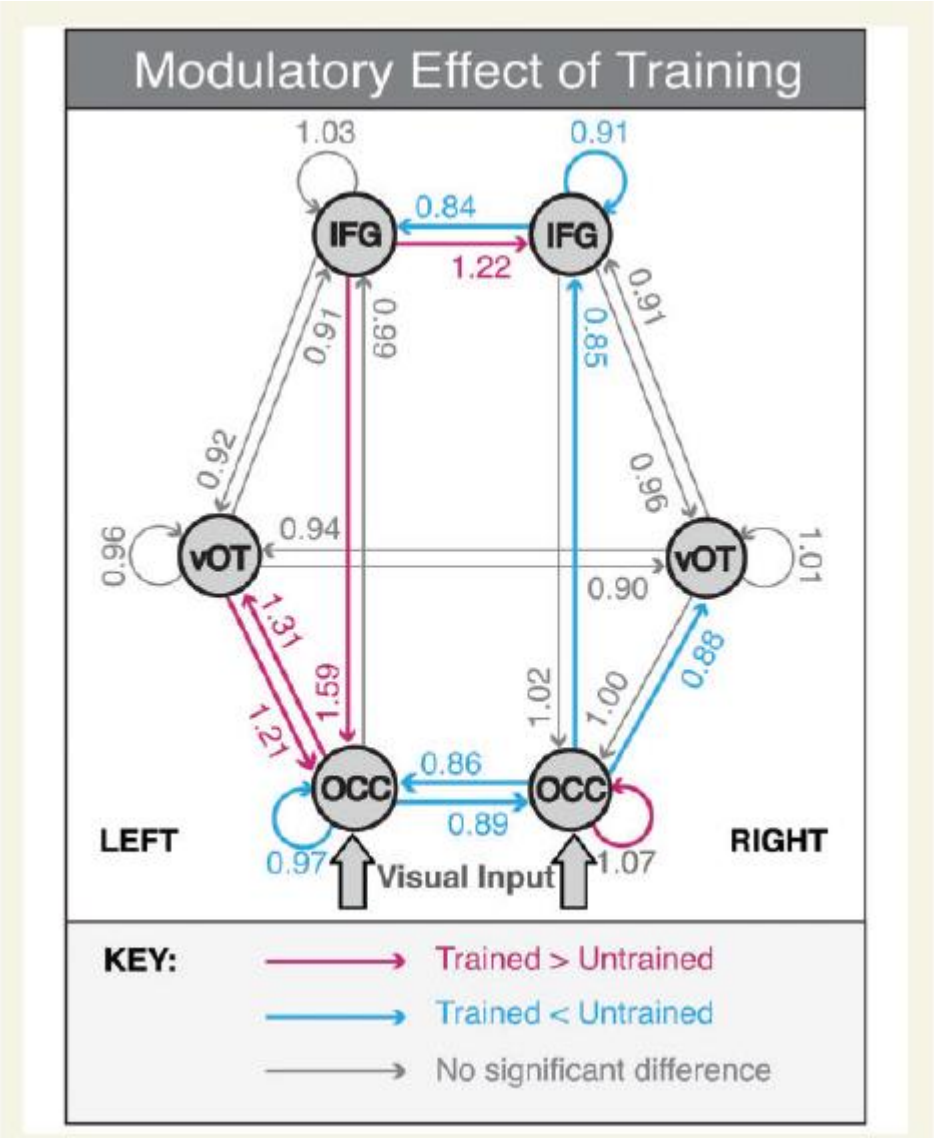


Figure 6 Global field power during word reading in the patient group (trained words, pink solid line; untrained words, pink dotted line) and a group of age-matched healthy controls (blue) using data from Woodhead *et al*. (2012).

MEG Scanner

Plasticity after Brain Injury

Estimate Signalling between Brain regions Using a Brain Connectivity Model.



Stronger Effective Connections On the left side Of the brain For trained words

Summary

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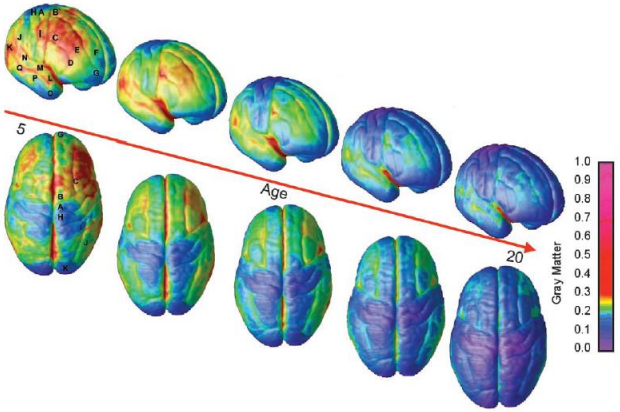

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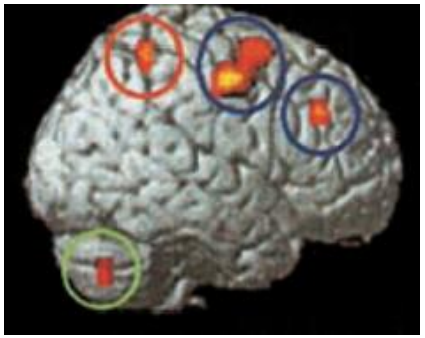

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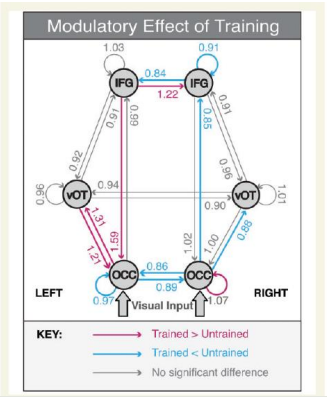
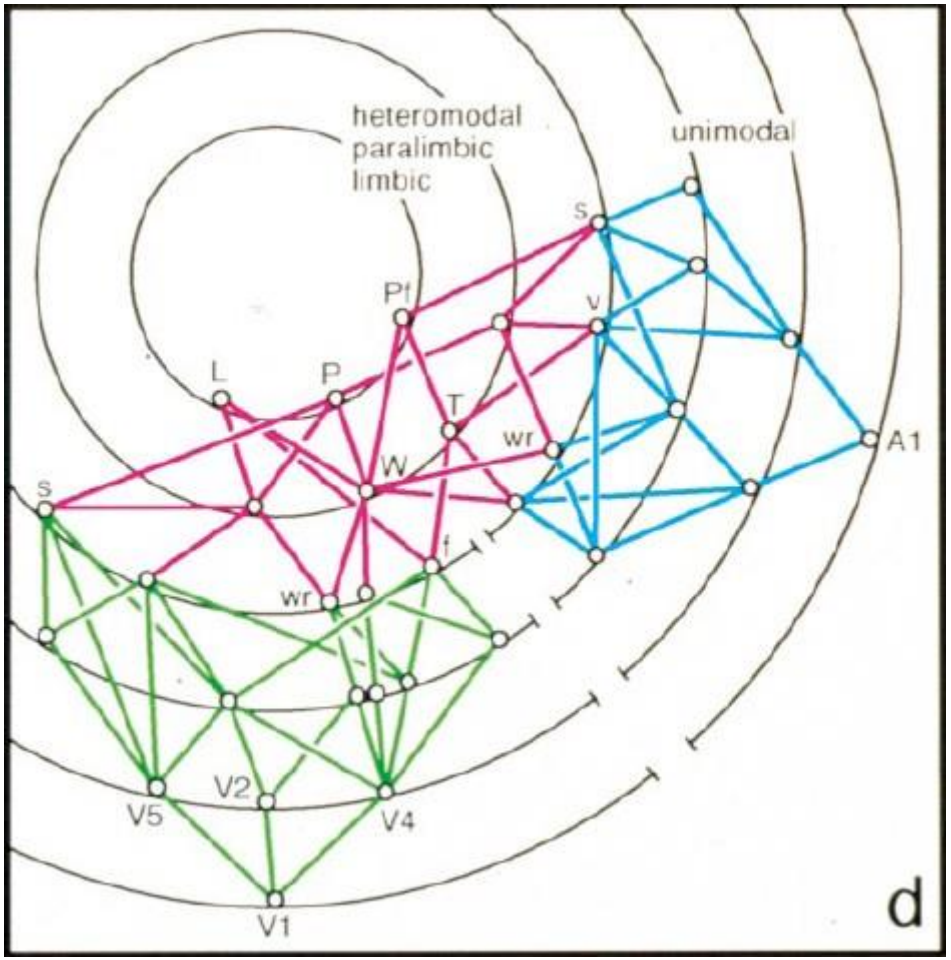


The Hierarchical Brain



M. M. Mesulam, "From sensation to cognition," Brain,121, no. 6, pp. 1013–1052, 1998

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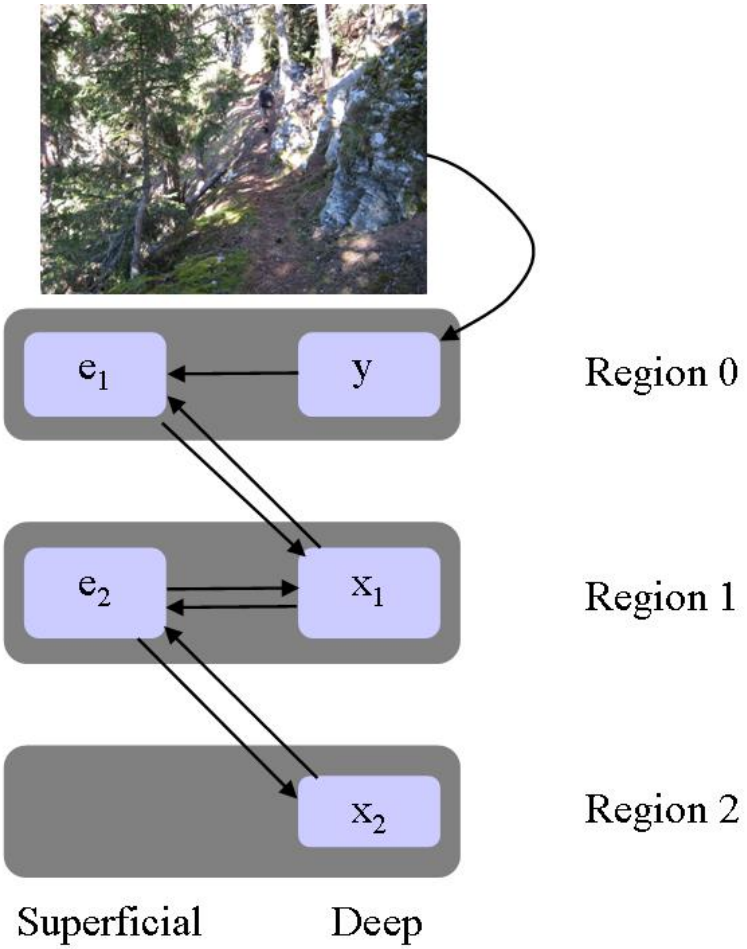

W. Penny (2012). **Bayesian models of Brain and Behaviour.**
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