

The Brain & brain data

Mads Jensen, PhD

✉ mads@cas.au.dk



AARHUS UNIVERSITY



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 - fMRI
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 - Transcranial magnetic stimulation (TMS)

Practical information

Portfolio papers

- A selection of three paper with an introduction and discussion/conclusion is to be handed in as one joint submission.

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- Citation style is APA7

The exam questions

- Open questions
- Philosophical questions?

Topic	Question
The brain	<ul style="list-style-type: none">• Describe a cognitive function?• Discuss the use of fMRI and EEG/MEG for action selection?
Electrophysiology	<ul style="list-style-type: none">• What are the pros and cons of EEG vs MEG?• How are ERPs related to brain structures and functions of the mind?
Oscillations	<ul style="list-style-type: none">• How can oscillations be used to investigate and cognition?• Link oscillations to a cognitive function. This can be in term of frequencies and/or cortical location(s) etc.
MVPA	<ul style="list-style-type: none">• Why use MVPA for statistical assessment of EEG data?• Pros and cons of linear vs non-linear MVPA models for brain imaging data
Neural Networks	<ul style="list-style-type: none">• Are neural networks better than MVPA for analysis of neuroimaging data?• Can Neural networks be used to model cognition?

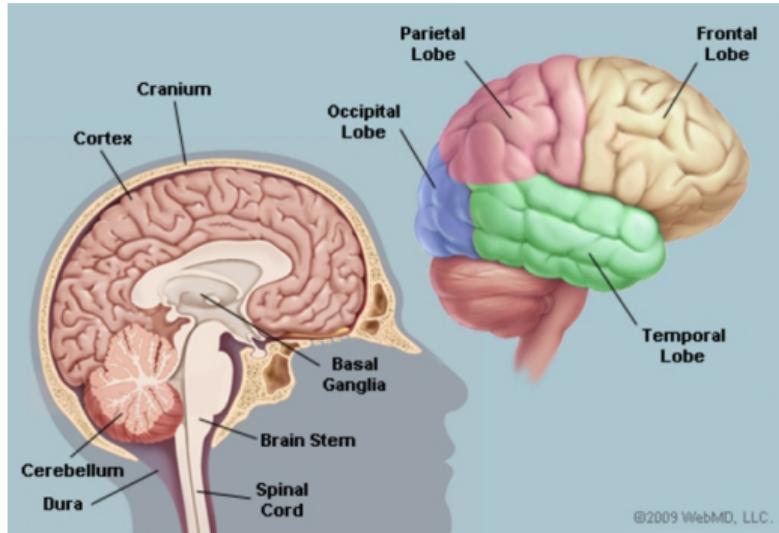
The brain

The brain

Neurons, connections, and organised chaos!

The brain

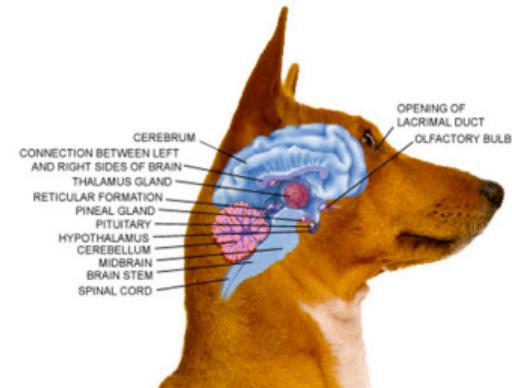
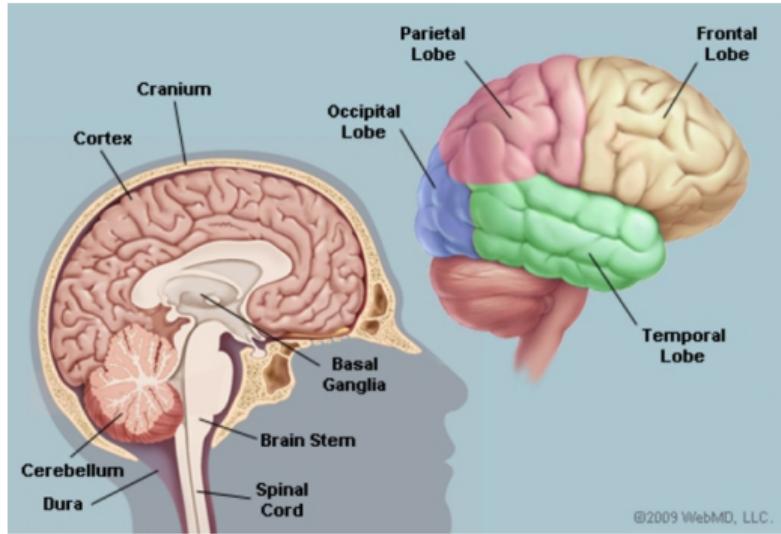
Neurons, connections, and organised chaos!



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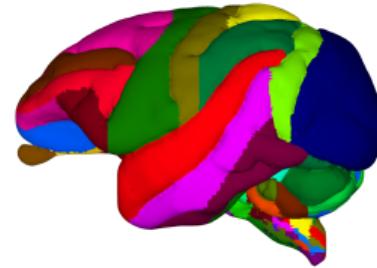
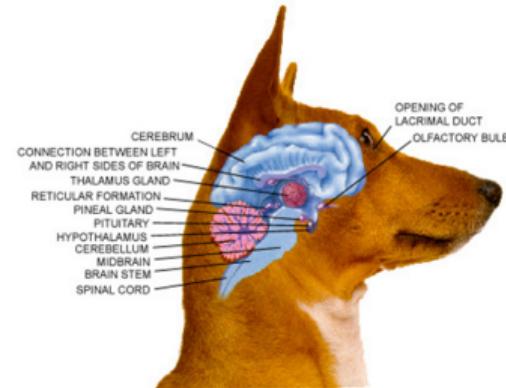
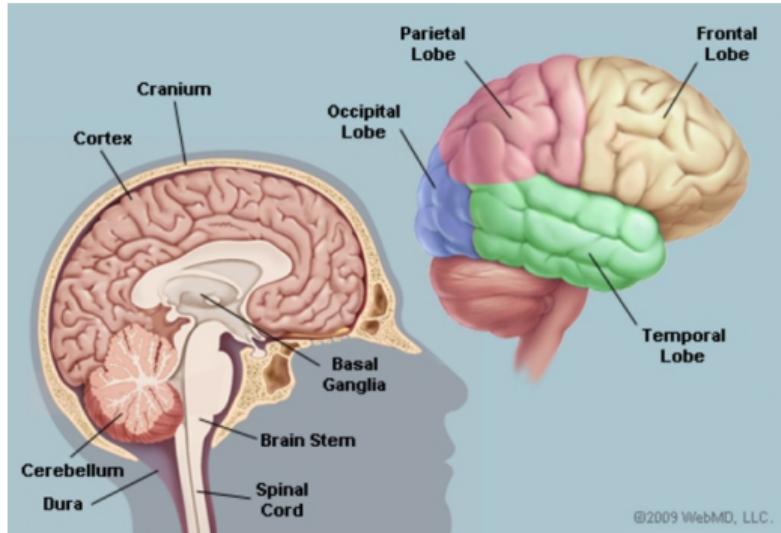
The brain

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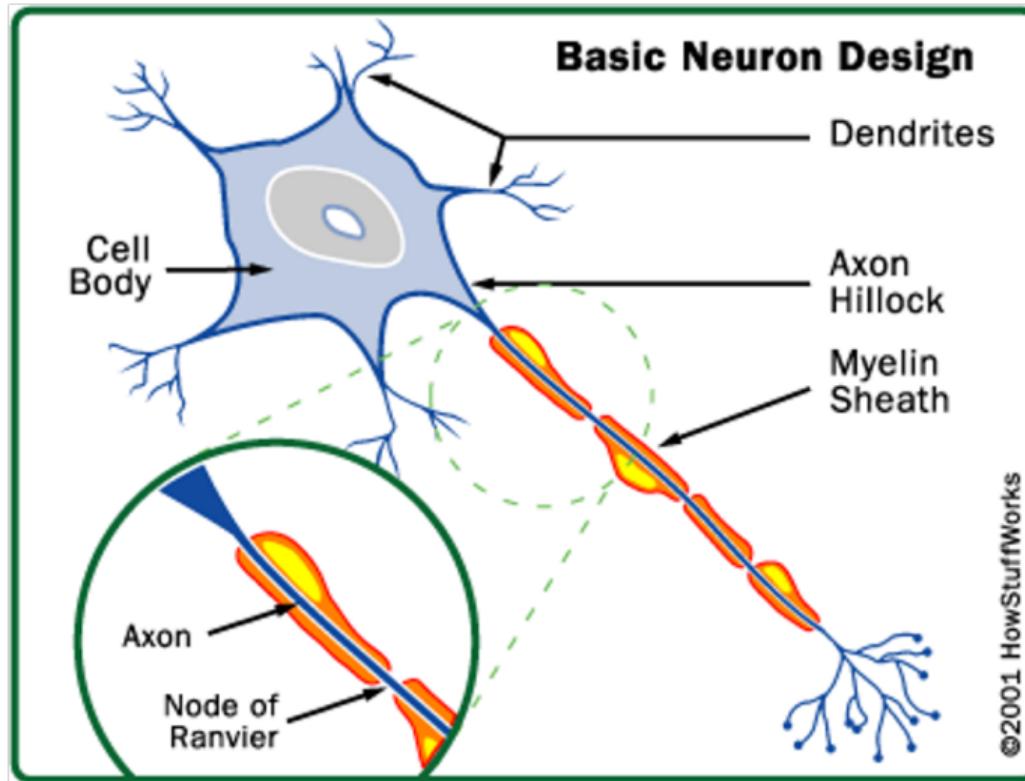


The brain

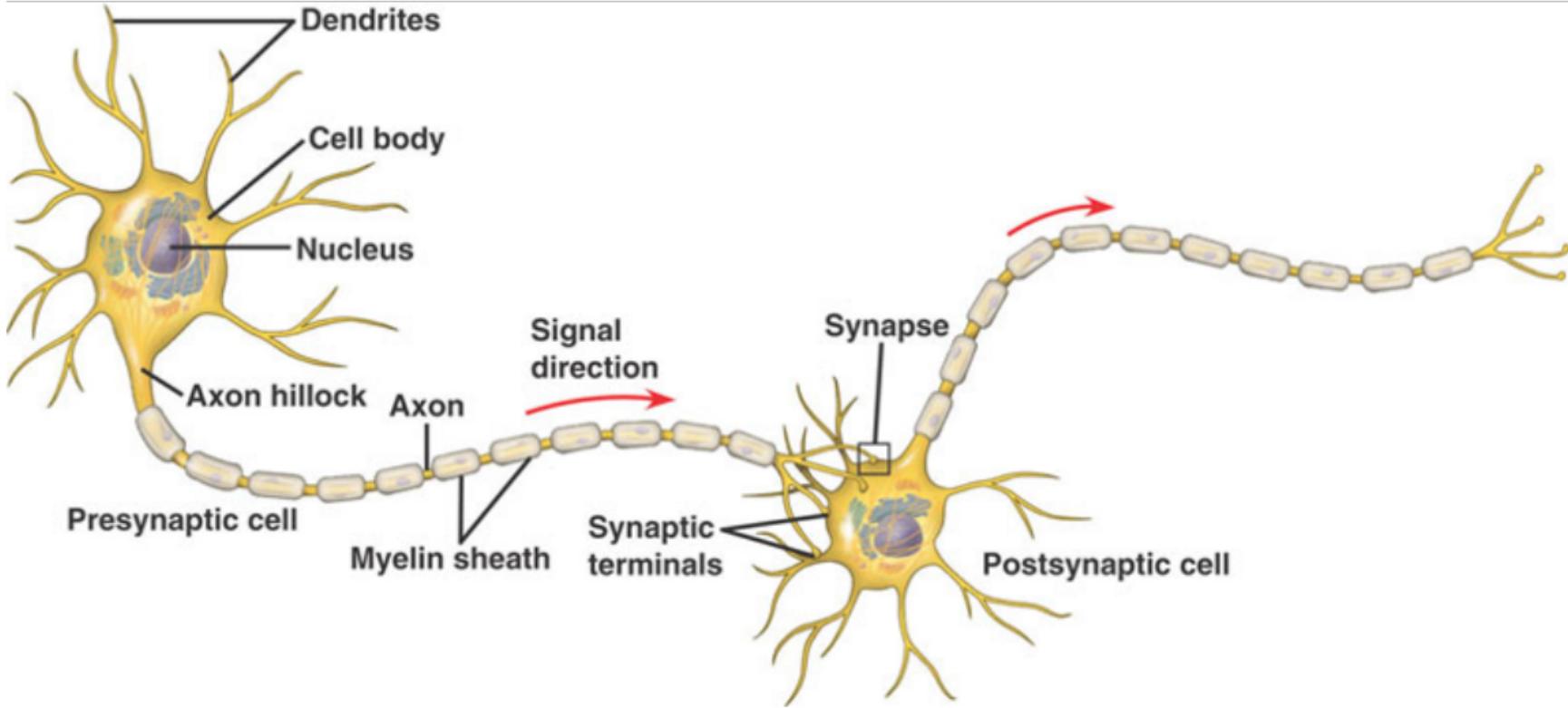
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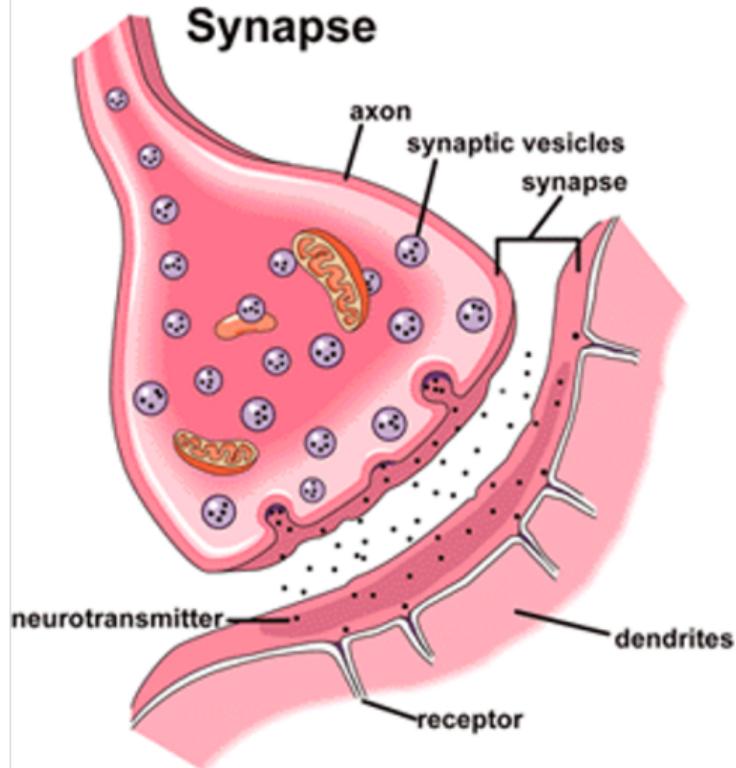
Neurons



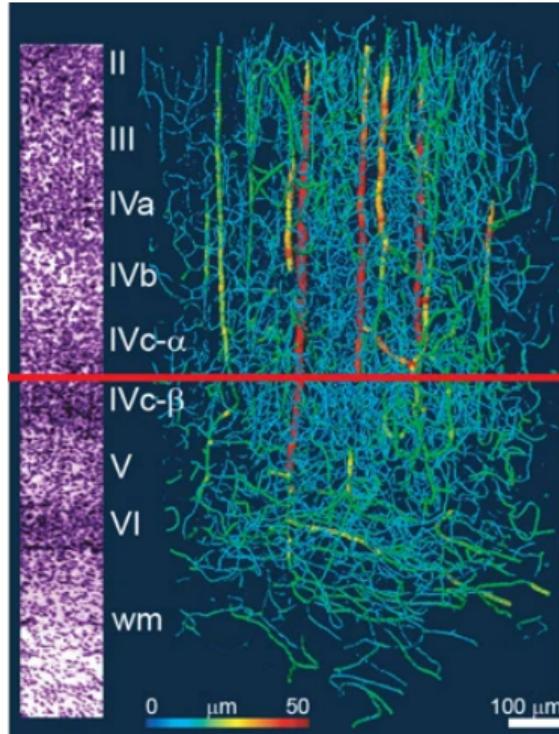
Neurons



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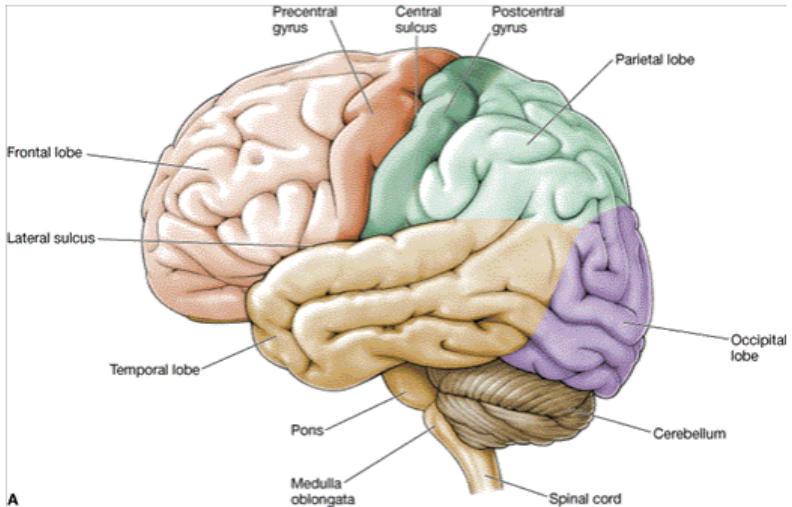


Cortical columns



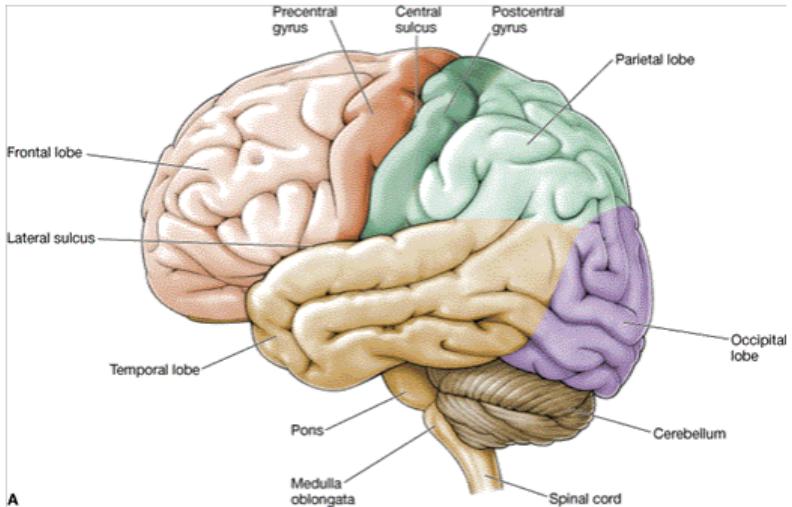
(Figure from Logothetis, 2008)

Gross anatomy

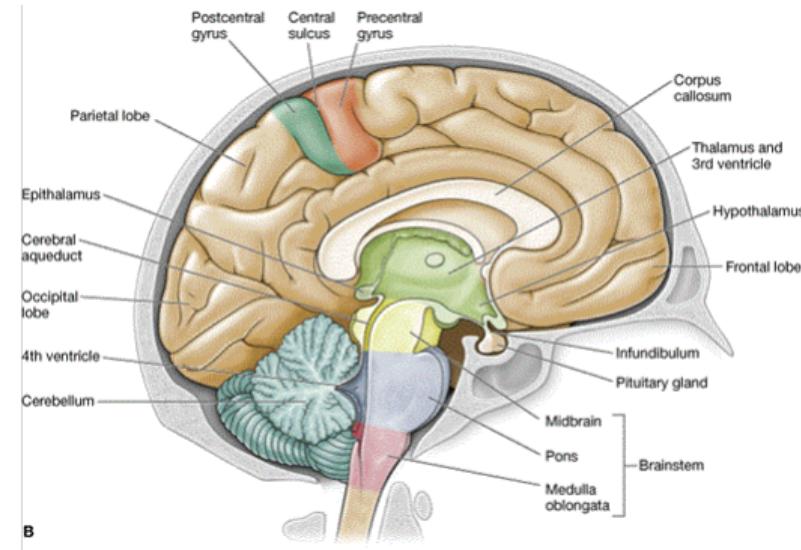


A

Gross anatomy



A

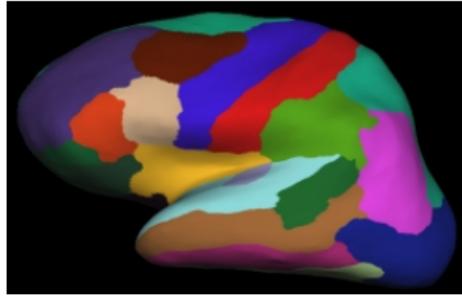


B

Cortical parcellation

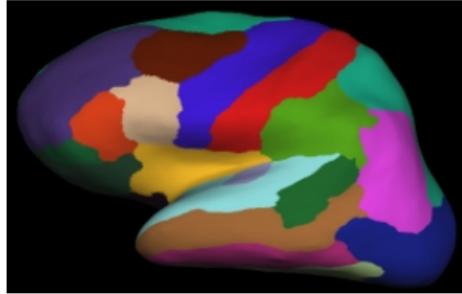
Cortical parcellation

Desikan-Killiany Atlas

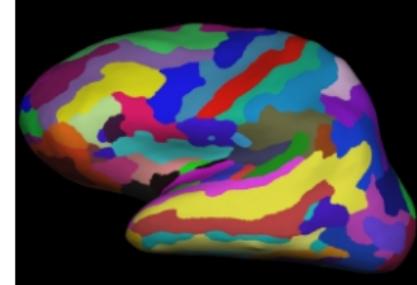


Cortical parcellation

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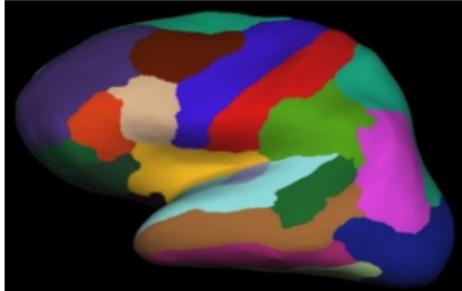


Destrieux Atlas

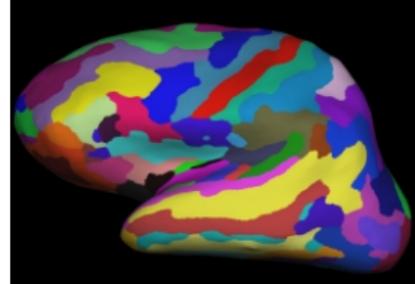


Cortical parcellation

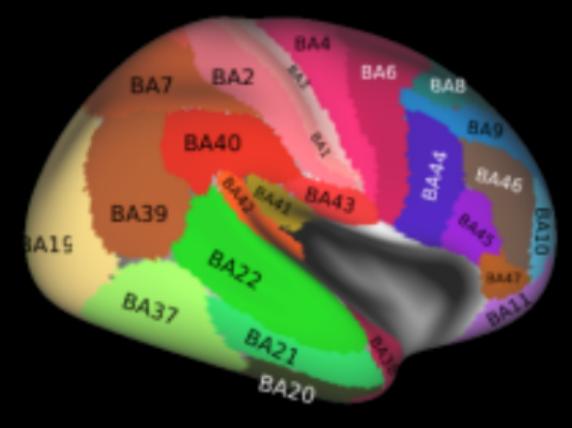
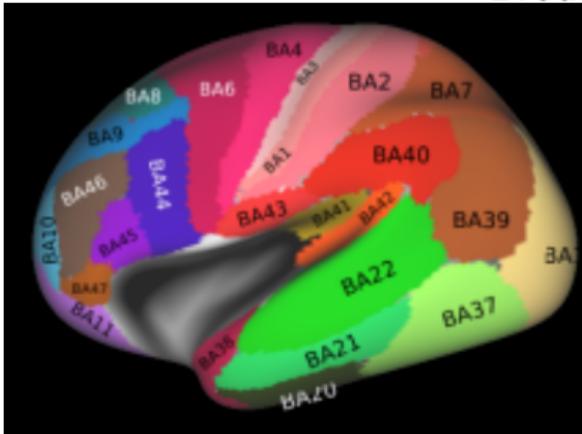
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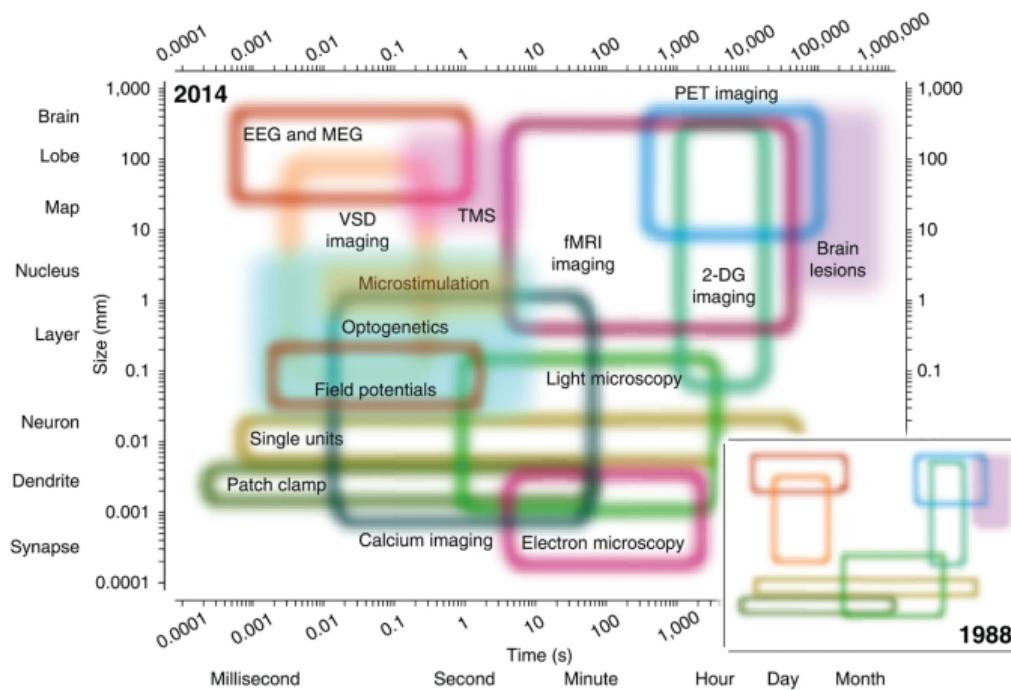


Brodmann areas



Brain data: the big picture

Overview

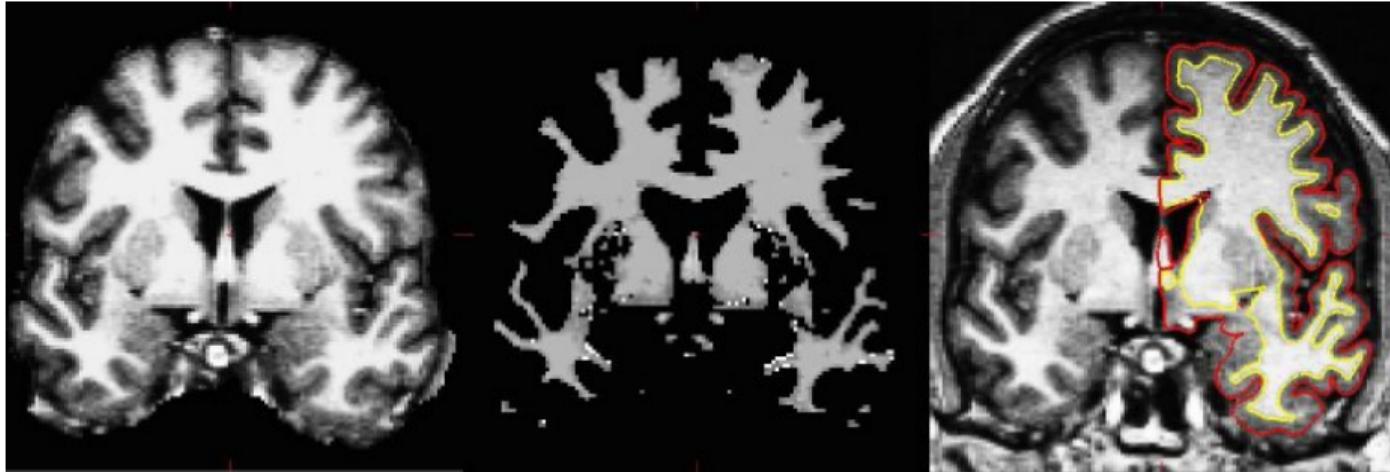


(Figure from Sejnowski et al., 2014)

Types of data

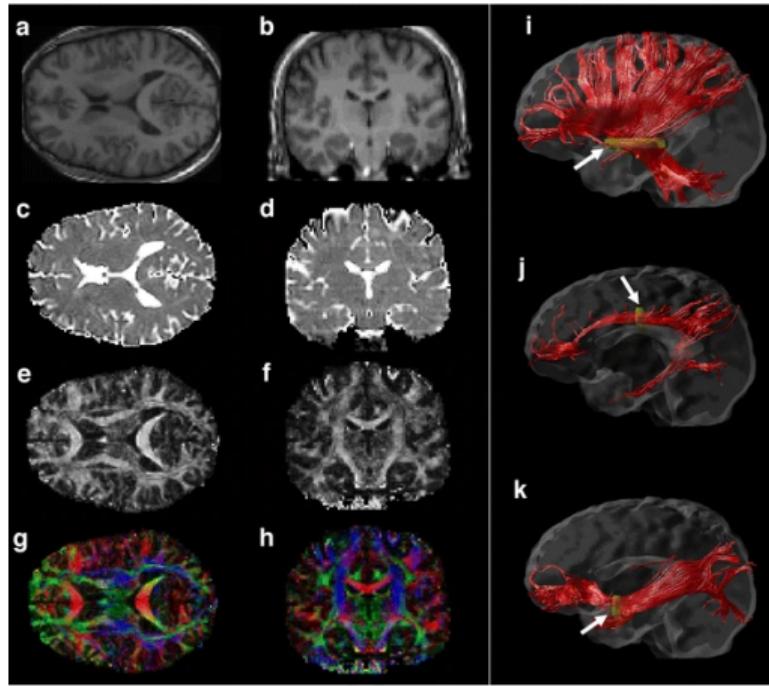
- Anatomical vs functional data
- Spatial or temporal precision

Structural images



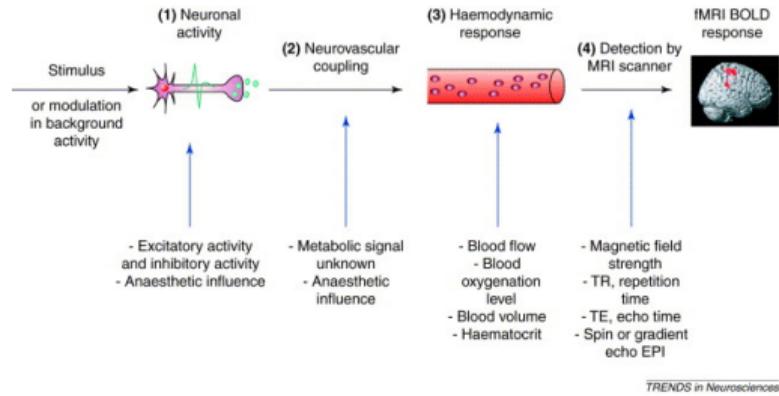
(Figure from <http://surfer.nmr.mgh.harvard.edu/fswiki/FreeSurferAnalysisPipelineOverview>)

Diffusion Tensor Imaging (DTI)



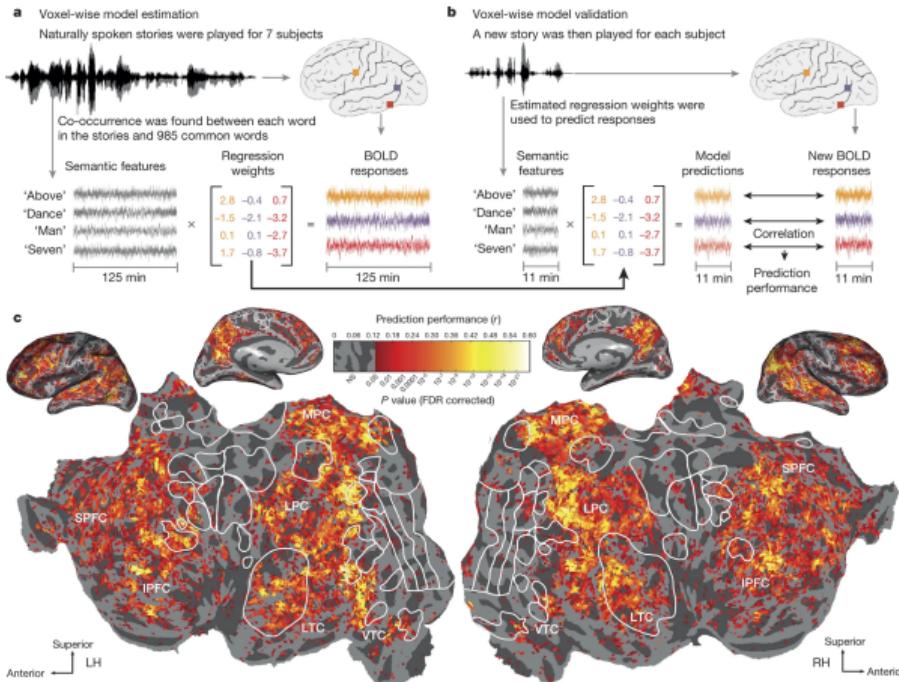
(Figure from Assaf & Pasternak, 2008)

Blood oxygenation level-dependent (BOLD) signal



(Figure from Arthurs & Boniface, 2002)

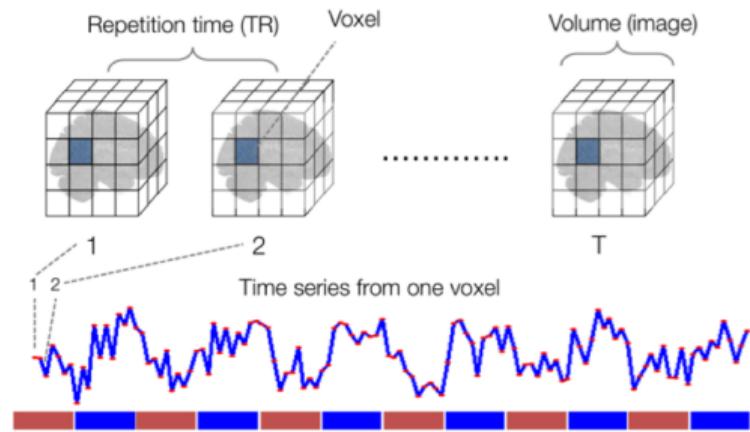
Cortical surface vs voxels



(Figure from Huth et al., 2016)

Cortical surface vs voxels

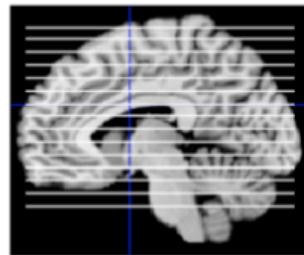
fMRI data time series



(Figure from <https://leanpub.com/principlesoffmri/read>)

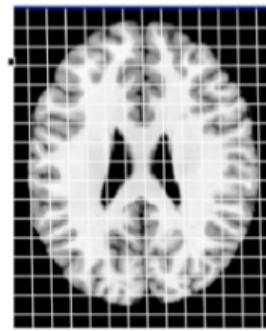
Cortical surface vs voxels

Field of View (FOV)
(e.g. 192 mm)

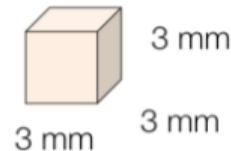


Slice thickness
(e.g., 3 mm)

Matrix Size
(e.g., 64 x 64)



In-plane resolution
 $192 \text{ mm} / 64 = 3 \text{ mm}$



Voxel Size

(Figure from <https://leanpub.com/principlesoffmri/read>)

Brain data

What is that is special about brain data?

Brain data

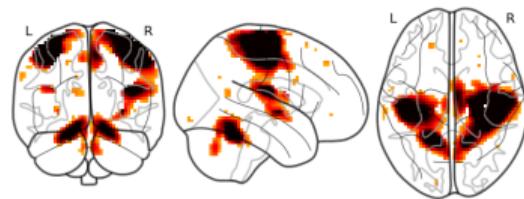
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- Dependence in one or more dimensions

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 - ▶ Structural MRI dependence in space

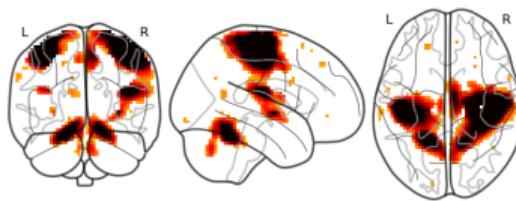


Nilearn, (see Abraham et al., 2014)

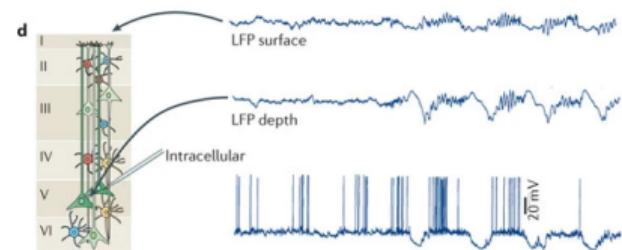
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 - ▶ Structural MRI dependence in space
 - ▶ Local field potential dependence in time



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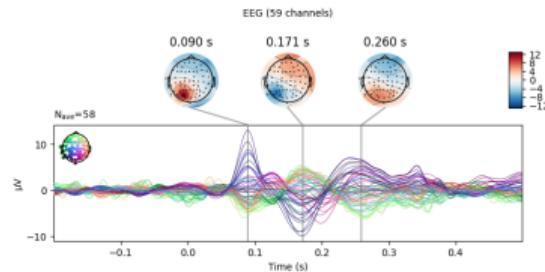
Nature Reviews | Neuroscience

From Buzsaki et al (2012)

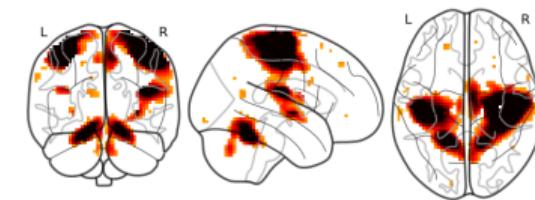
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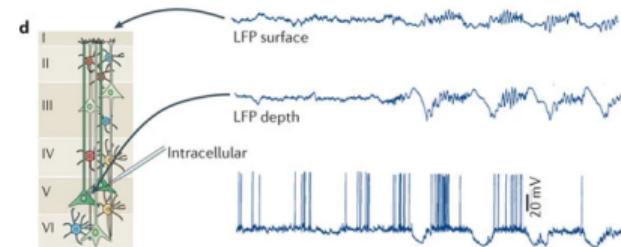
- Dependence in one or more dimensions
 - ▶ Structural MRI dependence in space
 - ▶ Local field potential dependence in time
 - ▶ MEG/EEG dependence in space *and* time



MNE-python, (see Gramfort et al., 2013)



Nilearn, (see Abraham et al., 2014)



Nature Reviews | Neuroscience

From Buzsaki et al (2012)

Brain imaging modalities

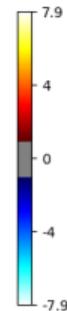
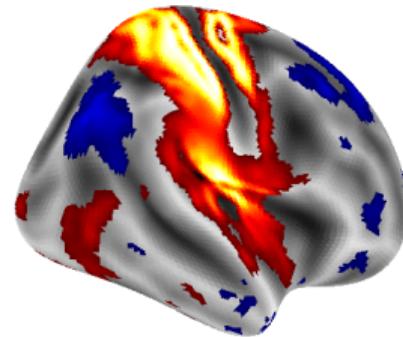
Functional magnetic resonance imaging (fMRI)



Functional magnetic resonance imaging (fMRI)



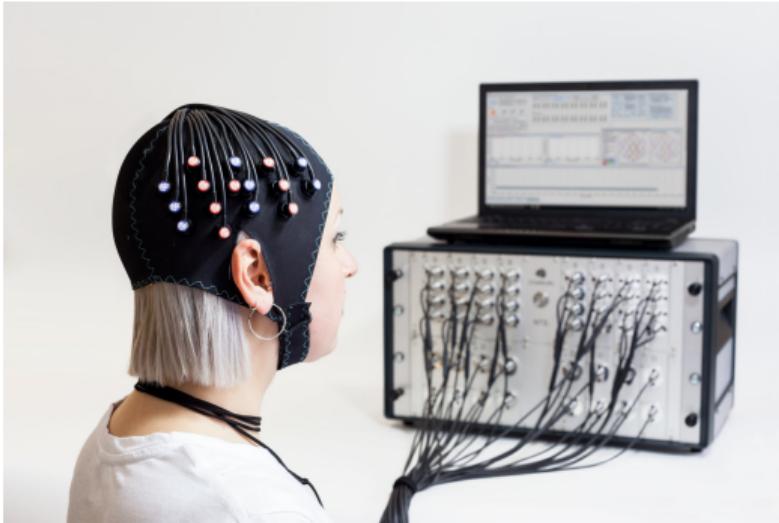
Surface right hemisphere



from Nilearn

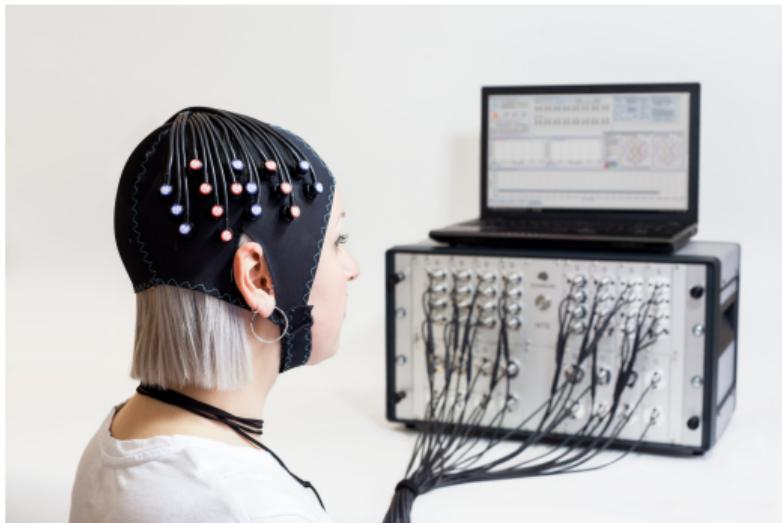
https://nilearn.github.io/auto_examples/01_plotting/plot_3d_map_to_surface_projection.html

Functional near-infrared spectroscopy (fNIRS)

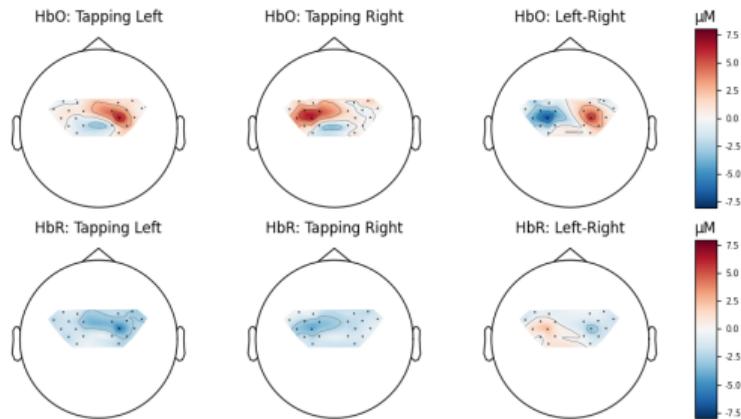


From wikipedia

Functional near-infrared spectroscopy (fNIRS)

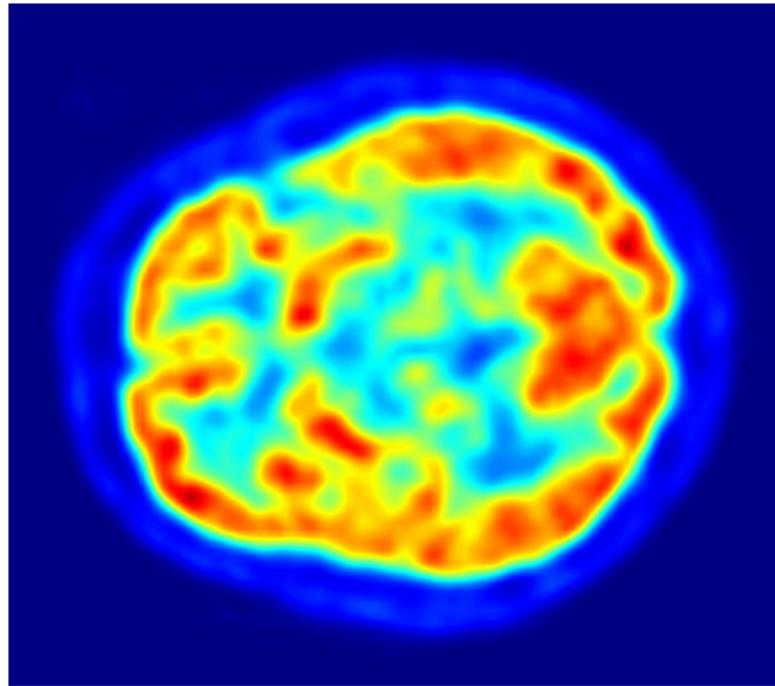


From wikipedia



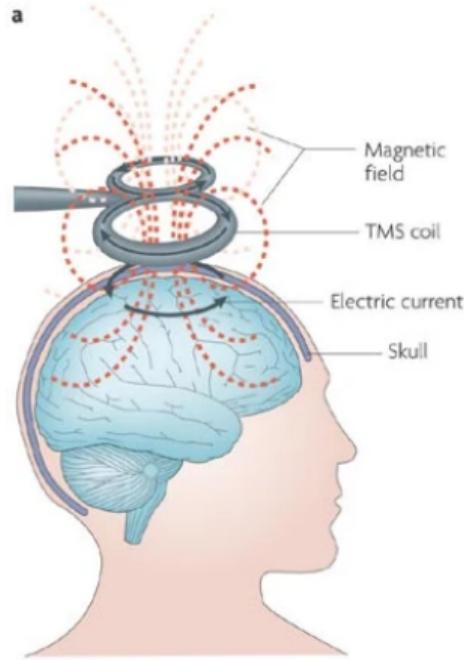
from mne-python
https://mne.tools/stable/auto_tutorials/preprocessing/plot_70_fnirs_processing.html

Positron emission tomography (PET)

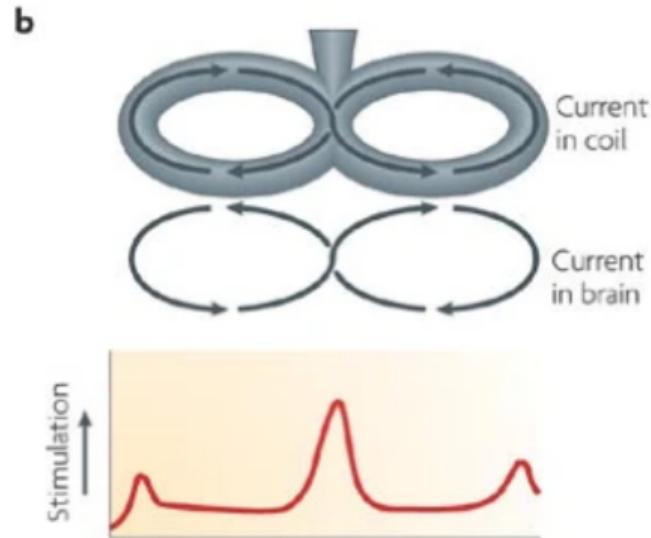
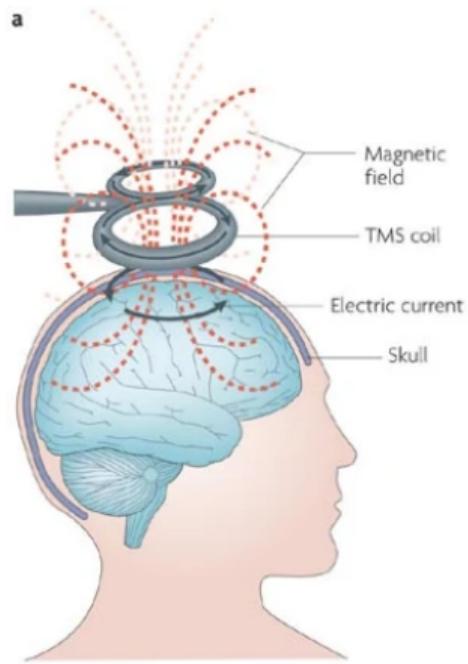


Affecting the cortex

Transcranial magnetic stimulation (TMS)

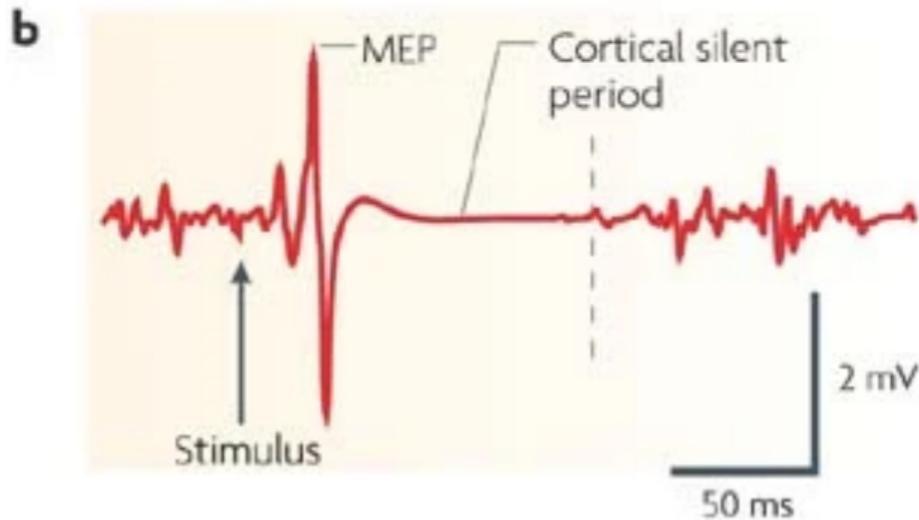


Transcranial magnetic stimulation (TMS)



(From Ridding & Rothwell, 2007)

Transcranial magnetic stimulation (TMS)



Nature Reviews | Neuroscience

(From Ridding & Rothwell, 2007)

Questions?

References I

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<https://doi.org/10.1038/nn.3839>