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Module:	Techniques & Physics
Lecture:	Functional Imaging Basics 1 Neurophysiological techniques
Description:	A review of neurophysiological techniques, in particular Electro- and Magneto- Encephalography
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Objectives:

- Being able to discuss the relative strengths and weaknesses of neurophysiological techniques, in particular Electro- and Magneto- Encephalography.

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Prerequisites:

- basics in neurophysiology

Module Outline: Functional Imaging Basics

This module will …

- Review major functional neurophysiological techniques
- Details Electro- and Magneto- Encephalographic techniques
- Provide an overview of advantages and weakness of each techniques

What is functional neuroimaging?

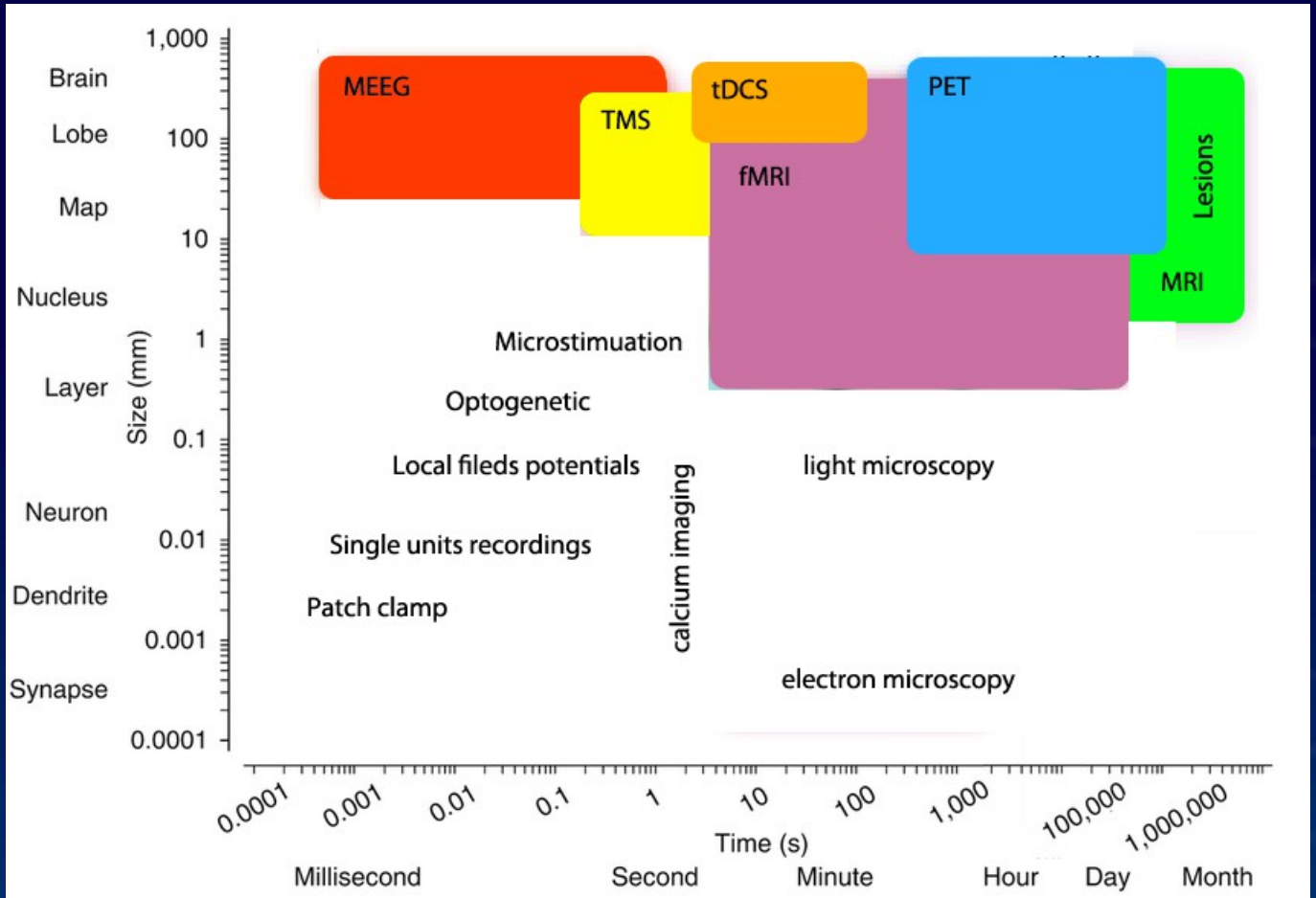
Functional neuroimaging is the use of neuroimaging technology to measure an aspect of brain function, often with a view to understanding the relationship between activity in certain brain areas or within a network and specific mental functions.

It is primarily used as a research tool in cognitive neuroscience, cognitive psychology, neuropsychology, and social neuroscience.

Clinical applications do exists but are still limited, in part because functional neuroimaging results are primarily statistical and dependent on the experimental design and/or protocol set-up.

http://en.wikipedia.org/wiki/Functional_neuroimaging

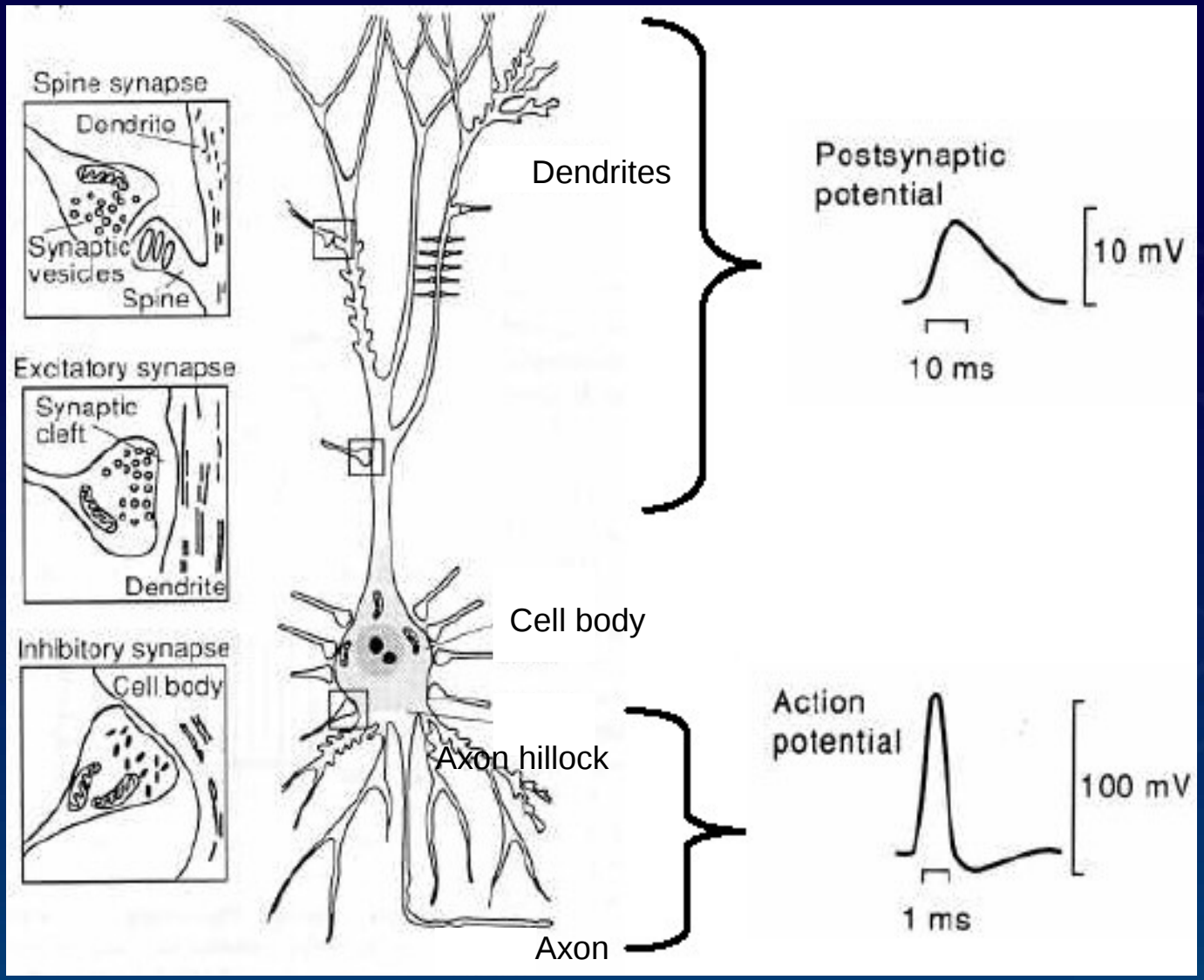
What techniques are used?

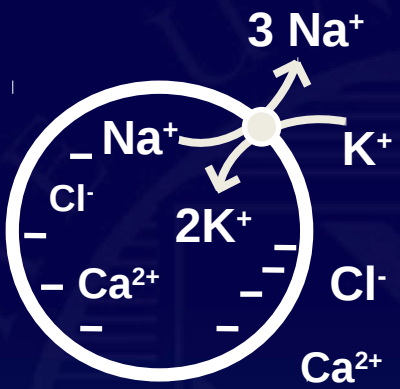


Spatio-temporal resolution of brain imaghing techniques. Boxes represent the array of human brain imaging techniques available: magneto and electroencephalography (MEEG), Transcranial magnetic stimulation (TMS), transcranial Direct-Current Stimulation (fDCS), functional Magnetic Rresonance Imaging (fMRI), Positron Emission Tomography (PET), and structual MRI in participants without or with lesions. Adapted from Sejnowski et al. (2014). Nat Neurosc 17, 1440-1441

There are many techniques that can be considered. For human brain imaging, the spatial resolution is limited to the millimetre scale.

Neurophysiology reminder





Resting potential
(at equilibrium)

Line Garnero, LENA, Paris

Intra vs. Extracellualr recordings

Intracellular recording

Single cell recording

Compares intracellular & extracellular environments

Amplitude measured in millivolts

Recording signal is always positive

Extracellular recording

Multi-unit recording and local filed potentials

Variation in potential depends on importance of Excitatory Post Synaptic Potentials (EPSP) & resistance of extracellular environment (extracell recording) or EPSP vs IPSP (Inhibitory PSP) relative to the electrode position (LFP)

Amplitude measured in microvolts

Magneto- / Electro- EncephaloGraphy (MEG / EEG)

Electrical activity generates magnetic fields – and both can be recorded using scalp macro-detectors

EEG

MEG

Electric and magnetic fields provide large-scale, short-time measures of the modulations of synaptic potential fields around their background levels. They correspond directly to the sum of synchronous firing of neurons.

ElectroEncephaloGraphy (EEG)

No issues with motion - EEG cap is put on the subjects head
Relatively long set-up time (~30min to put and test electrodes)

Excellent temporal resolution – record event at ms scale
Relatively low spatial resolution (cm) – finding the origin of the signal is very difficult and in EEG the problem is worsened by blurring due to the skull/scalp which diffuse the electrical signal

Easy experimental set-up (almost any task can be used)
Cheap equipment (£500 to £1500) with little running cost (need to buy gel to allow conductance between the scalp and the electrodes, caps need to be renewed every couple of years)

MagnetoEncephaloGraphy (MEG)

Vey quick set-up time (just seat)
Small issues due to motion - Sensors are ‘above’ the head

Excellent temporal resolution – record event at ms scale
Variable spatial resolution (mm to cm) – finding the origin of the signal is the same as with EEG but the data are cleaner because magnetic fields are not affected by tissues)

Easy experimental set-up (almost any task can be used)
Expensive equipment (>£1 million) with relatively high running cost (need to fill-up the machine regularly the machine with helium to cool down the sensors).

Summary

You should now be able to:

- List the main human – whole brain imaging techniques
- Distinguish intra- extra- cell recordings
- Identify and compare EEG from MEG

End of presentation

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Module Resources: Imaging Basics

Articles

- Sejnowski et al. (2014). **Putting big data to good use in neuroscience.** Nat Neurosc. 17, 1440-1441

- Teplan M (2002). Fundamentals of EEG Measurements. Measurement Science Review, 2. http://www.measurement.sk/2002/S2/Teplan.pdf

Web-resource

- http://imaging.mrc-cbu.cam.ac.uk/meg/IntroEEGMEG