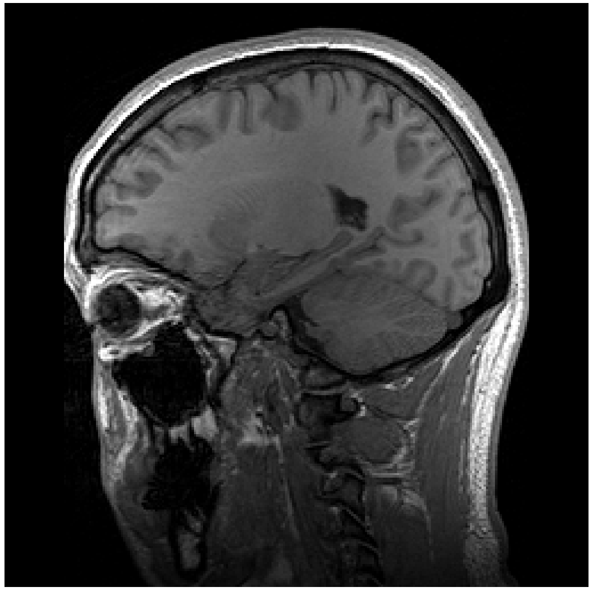
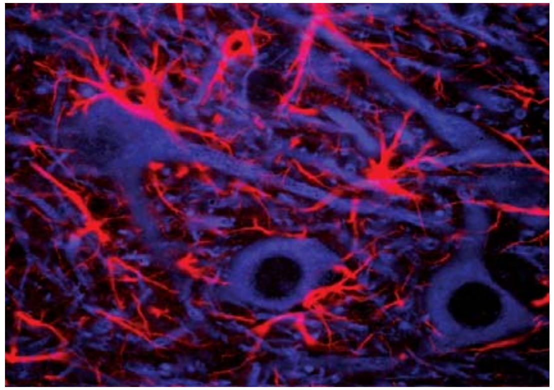
NEUROSCIENCE



Barbora Cimrová

Neuroscience



- is the scientific **study of the nervous system (NS)**

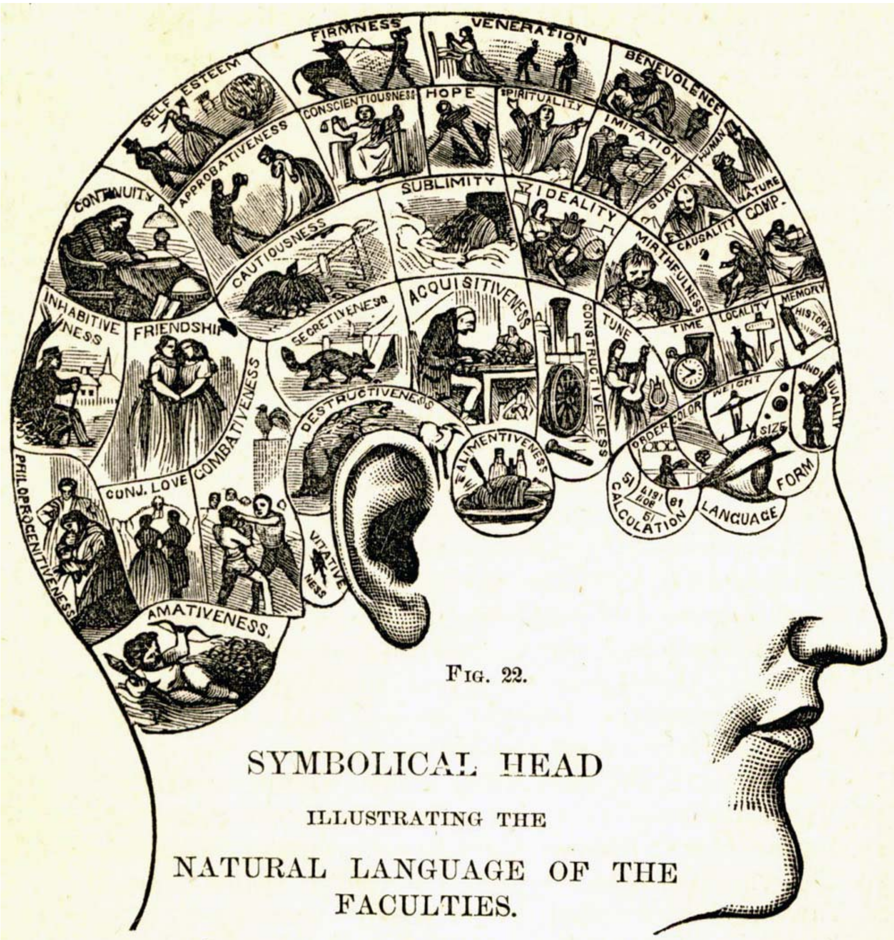
- structure, organization, function of its parts and its functioning as a whole unit
- traditionally: branch of biology
- an interdisciplinary science
- collaborates with other fields such as chemistry, medicine and allied disciplines, linguistics, mathematics, philosophy, physics, psychology, computer science, engineering.

“Whether judged in molecular, cellular, systemic, behavioral, or cognitive terms, the ***human nervous system*** *is a* ***stupendous piece of biological machinery****.*

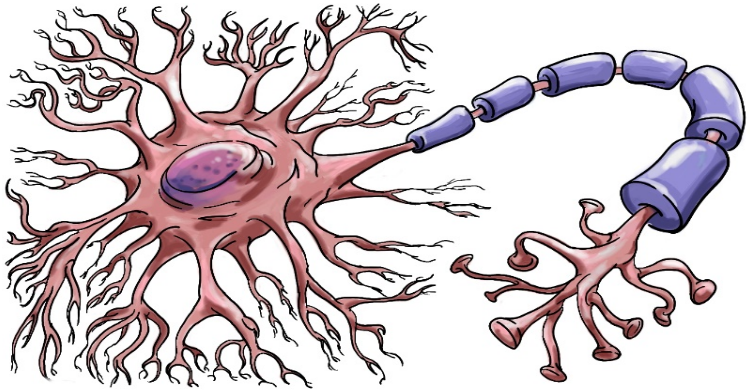
Given its accomplishments — all the artifacts of human culture, for instance — there is good reason for wanting to understand how the brain and the rest of the nervous system works.”

Purves et al. (2004) Preface in NEUROSCIENCE: 3rd Edition, Sinauer Associates, Inc., Sunderland, MA U.S.A.

Mind-body problem



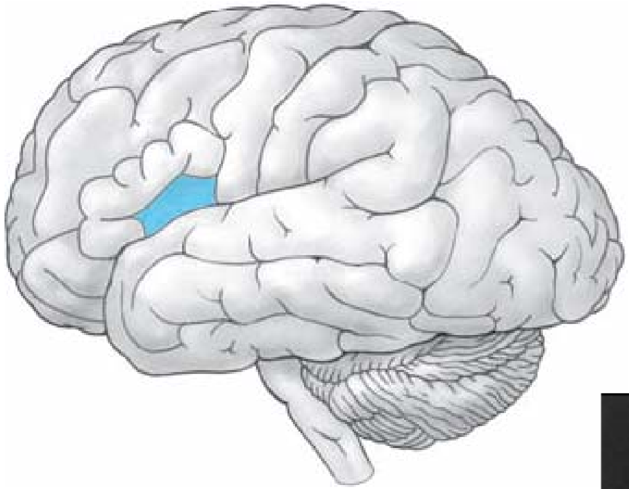
Phrenology (Gall, 19th century)



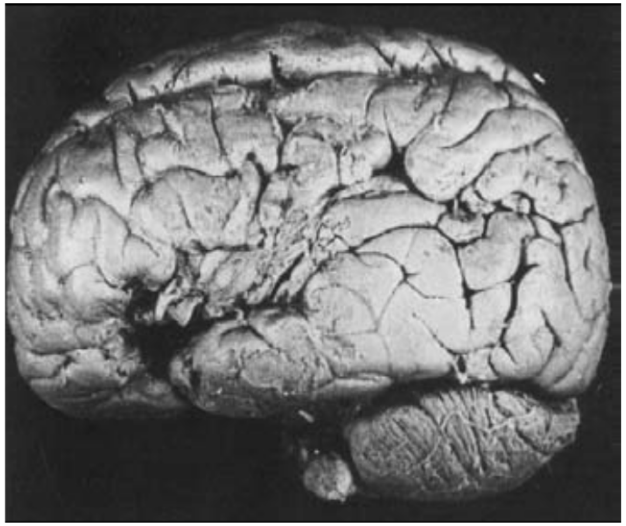
Experimental Approaches to Brain Function

- brain damage and its consequence
- experiments on animals
- functional brain imaging techniques
- methods that can reversibly disable particular brain area

Localization and Lateralization of Language



Paul Broca (1824–1880):



1) a behavior, such as language, is controlled by a specific brain area
2) destroying the area selectively destroys the behavior

Broca's aphasia – inability to produce speach

https://www.youtube.com/watch?v=6CJWo5TDHLE

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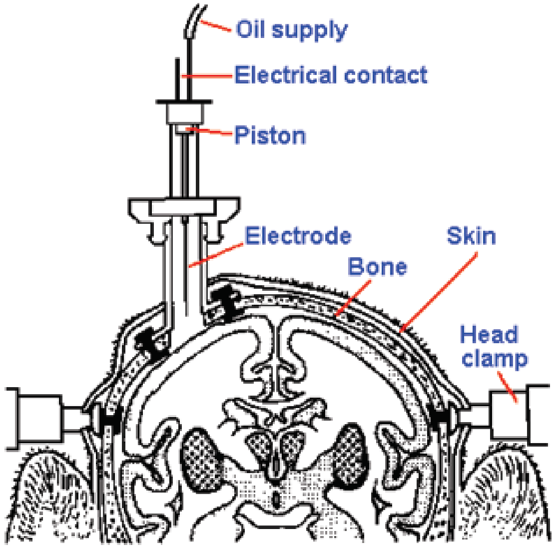
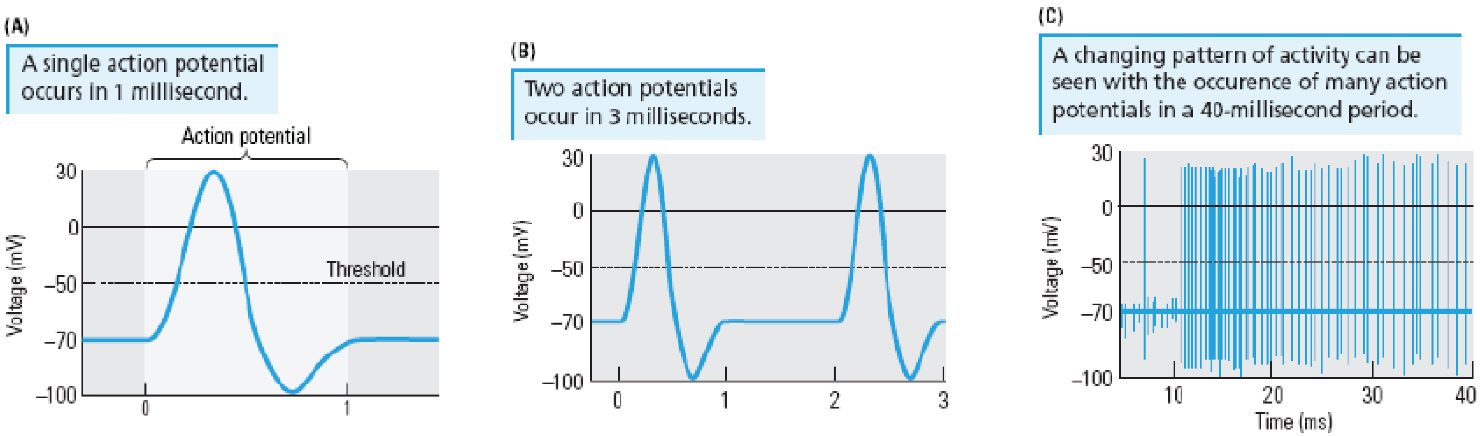
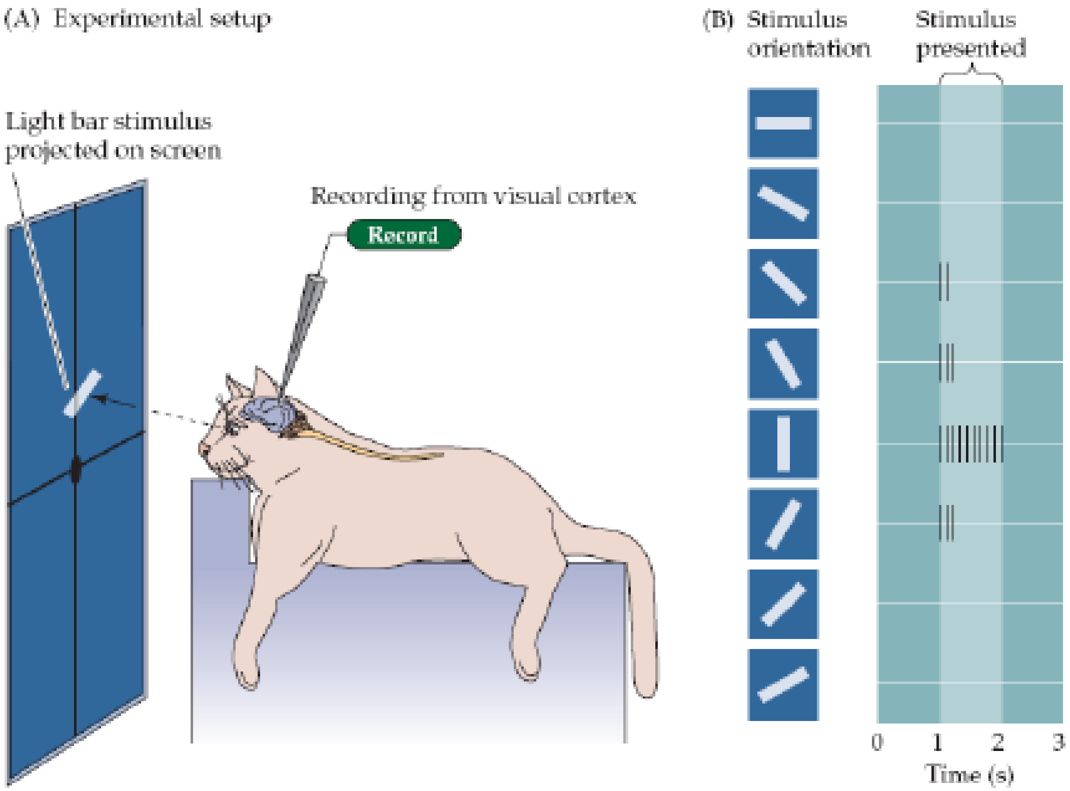


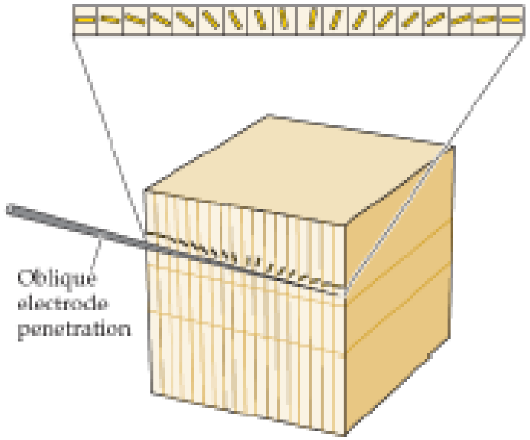
single-cell recording



Simple cells in primary visual cortex



- Hubel a Wiesel, 1968
- 1981 Nobel prize



https://www.youtube.com/watch?v=8VdFf3egwfg

Experimental Approaches to Brain Function

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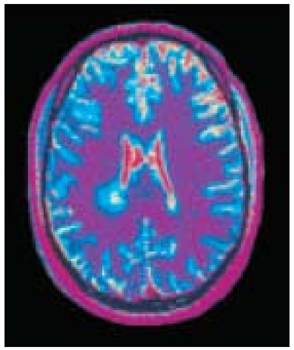
Brain Imaging Techniques

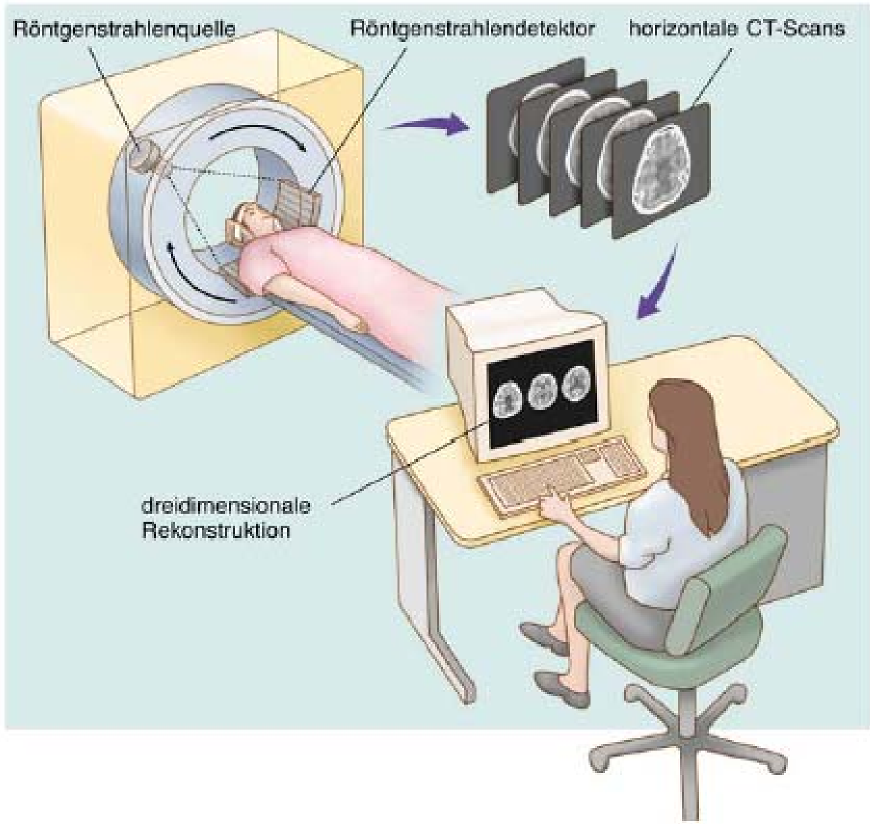
- structural
  - CT
  - MRI

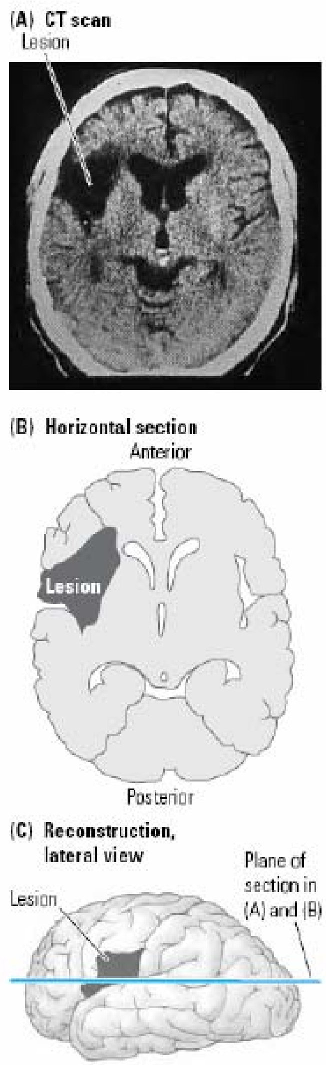
- functional
  - fMRI
  - PET
  - EEG



CT – computed tomography

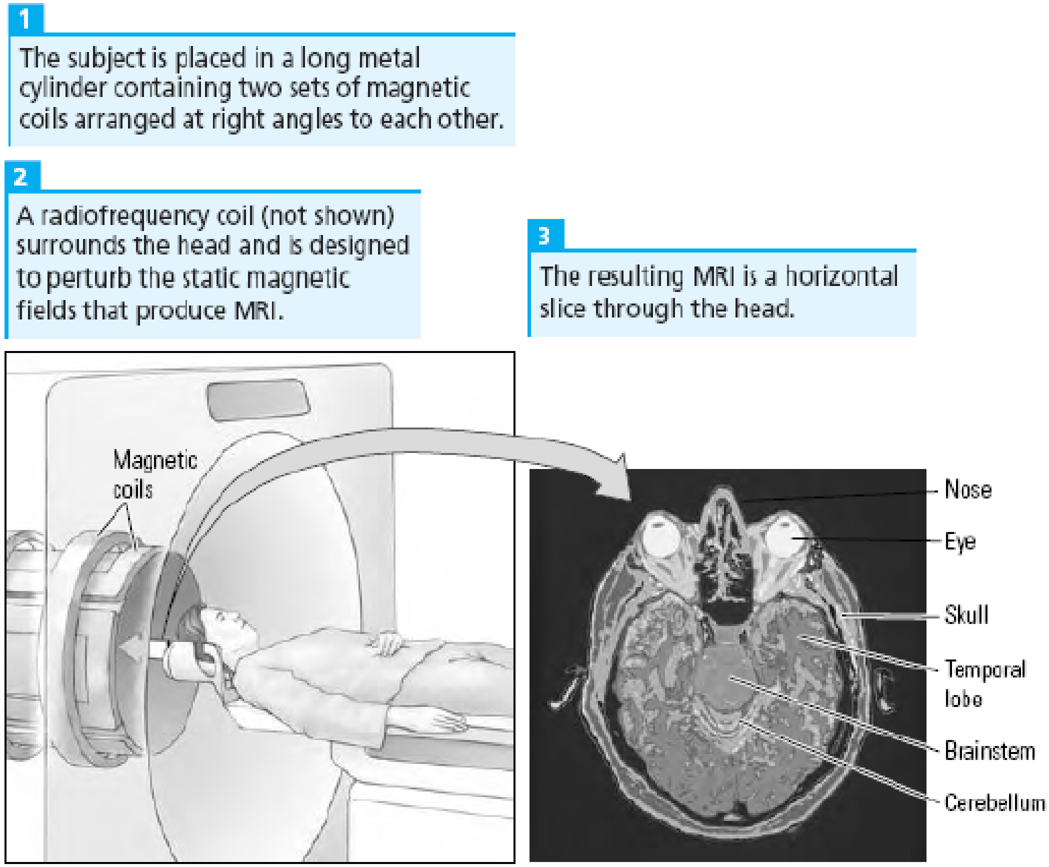
- **fast** (< 5 minutes)
- not very expensive => **available**
- **invasive**





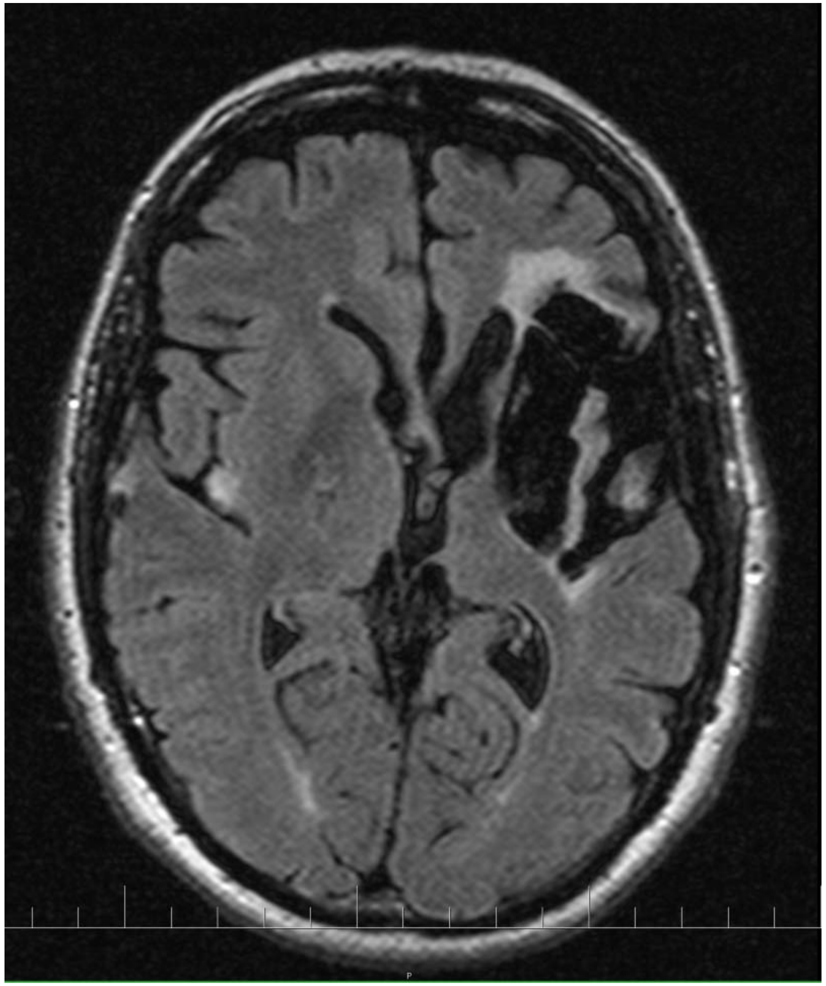
- narrow X-ray beam is detected by sensitive
- CT scanner rotates (from 0° to 180°)
- Computer then calculate the radiodensity of each point within the slice plane, producing a tomographic image

MRI – magnetic resonance imaging

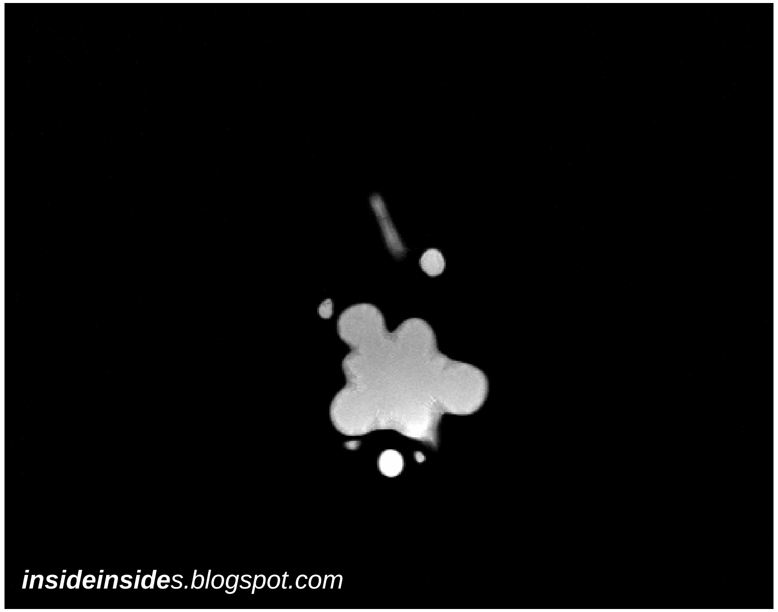


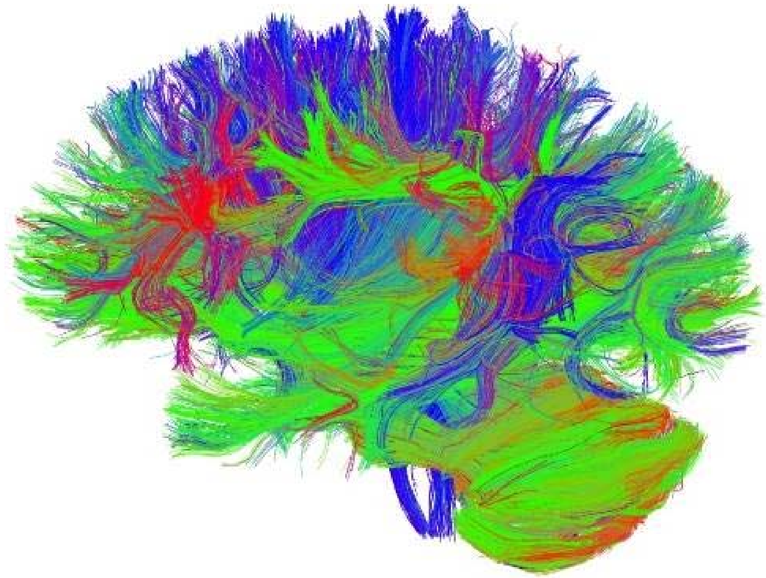
- high spatial resolution (mm)
- noninvasive
- expensive
- slow
- noisy

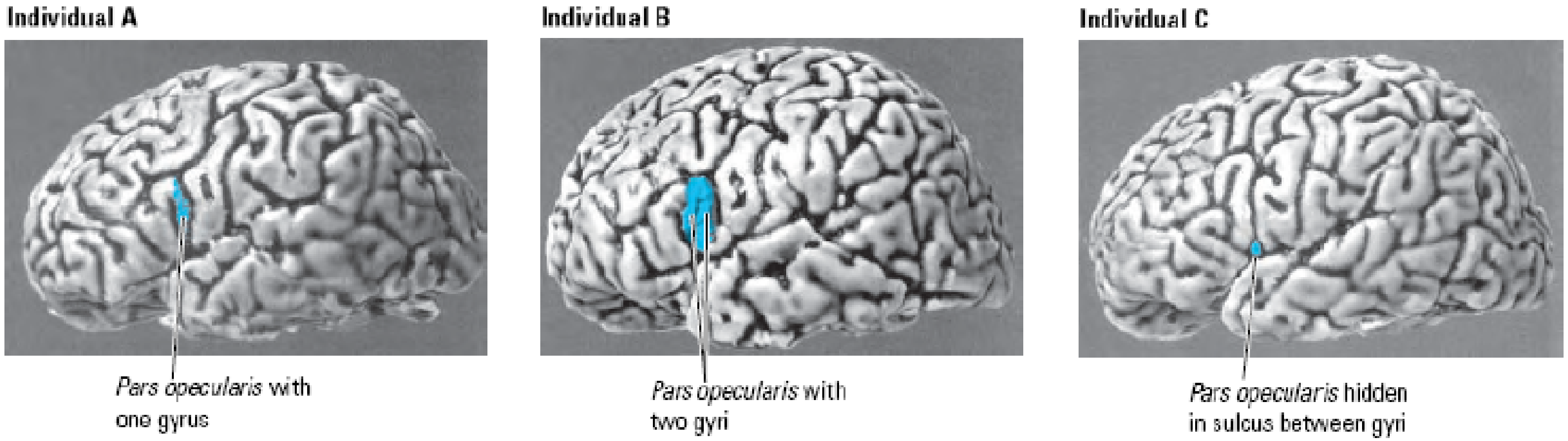
Front



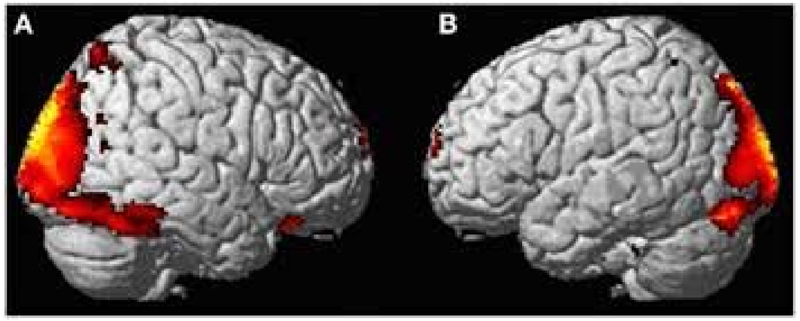
Right Left

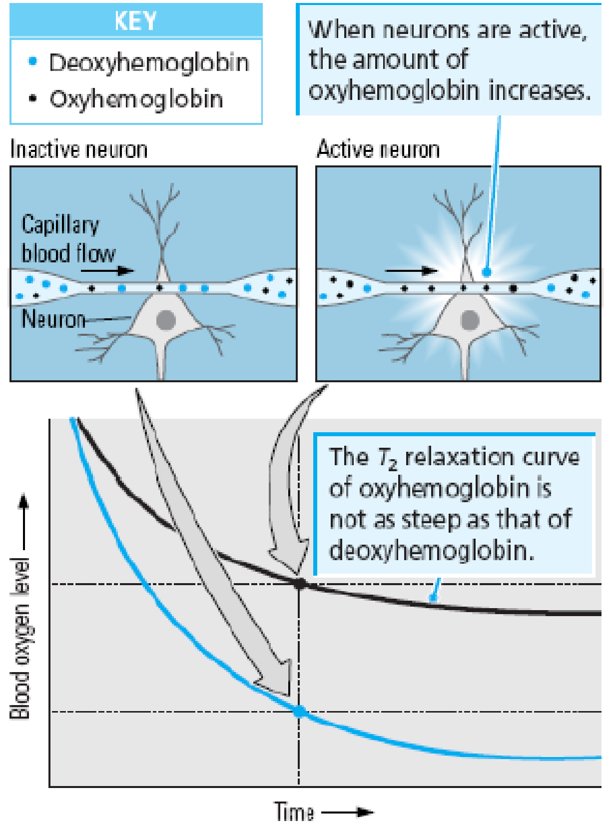

insideinsides.blogspot.com




Individual A
Pars opecularis with one gyrus
Individual B
Pars opecularis with two gyri
Individual C
Pars opecularis hidden in sulcus between gyri

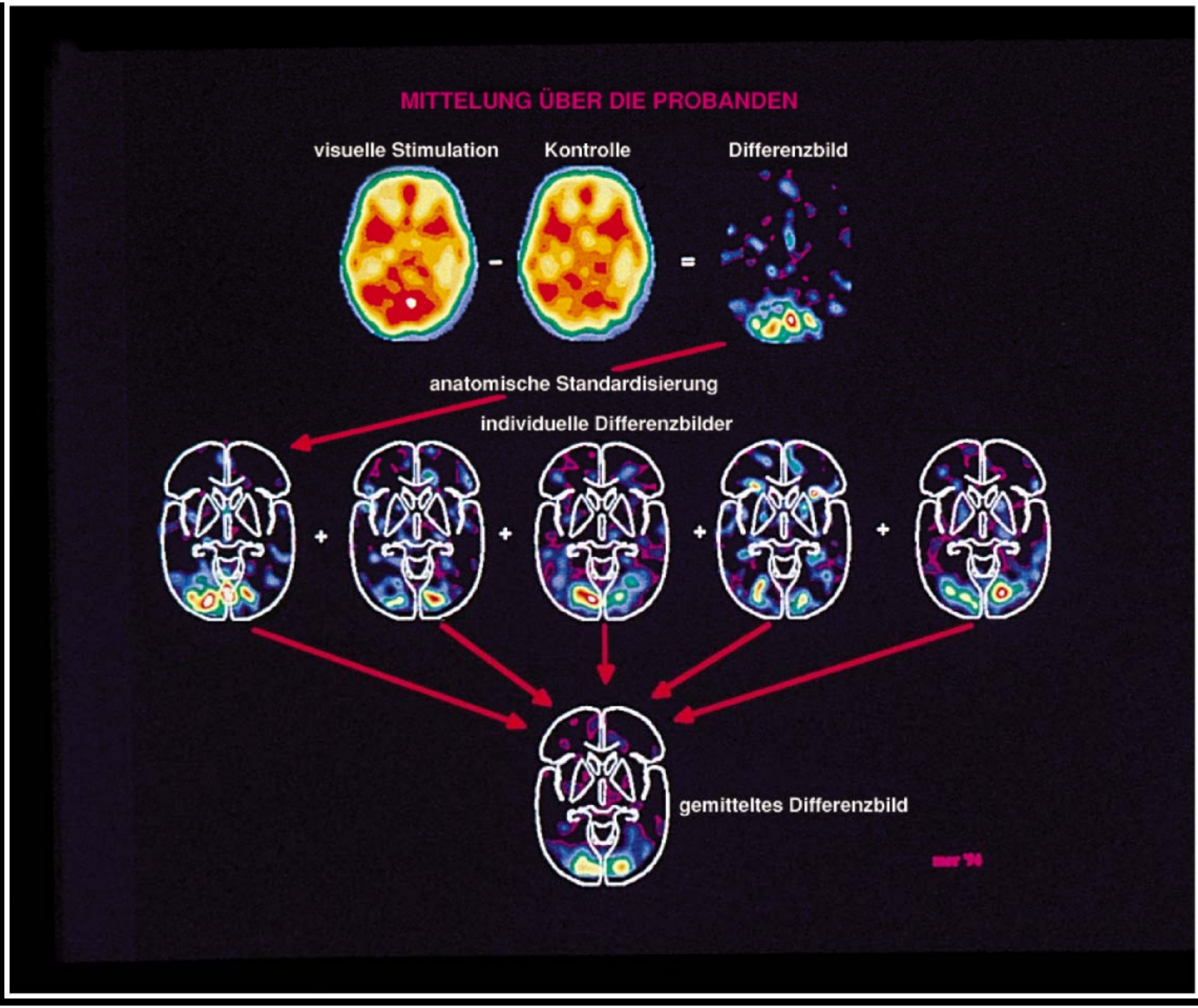
fMRI – functional magnetic resonance imaging





Blood oxygen-level-dependent signal (BOLD) haemodynamic response function

- variant of MRI allowing to see changes of activity in time
- detects differences in the level of oxyhaemoglogin vs. deoxyhaemoglogin, (resulting from neuronal activity)

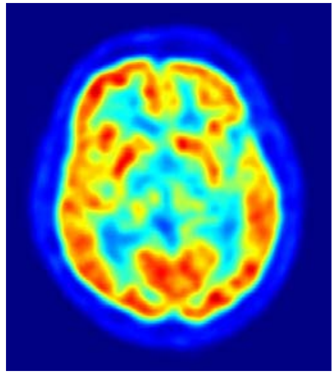


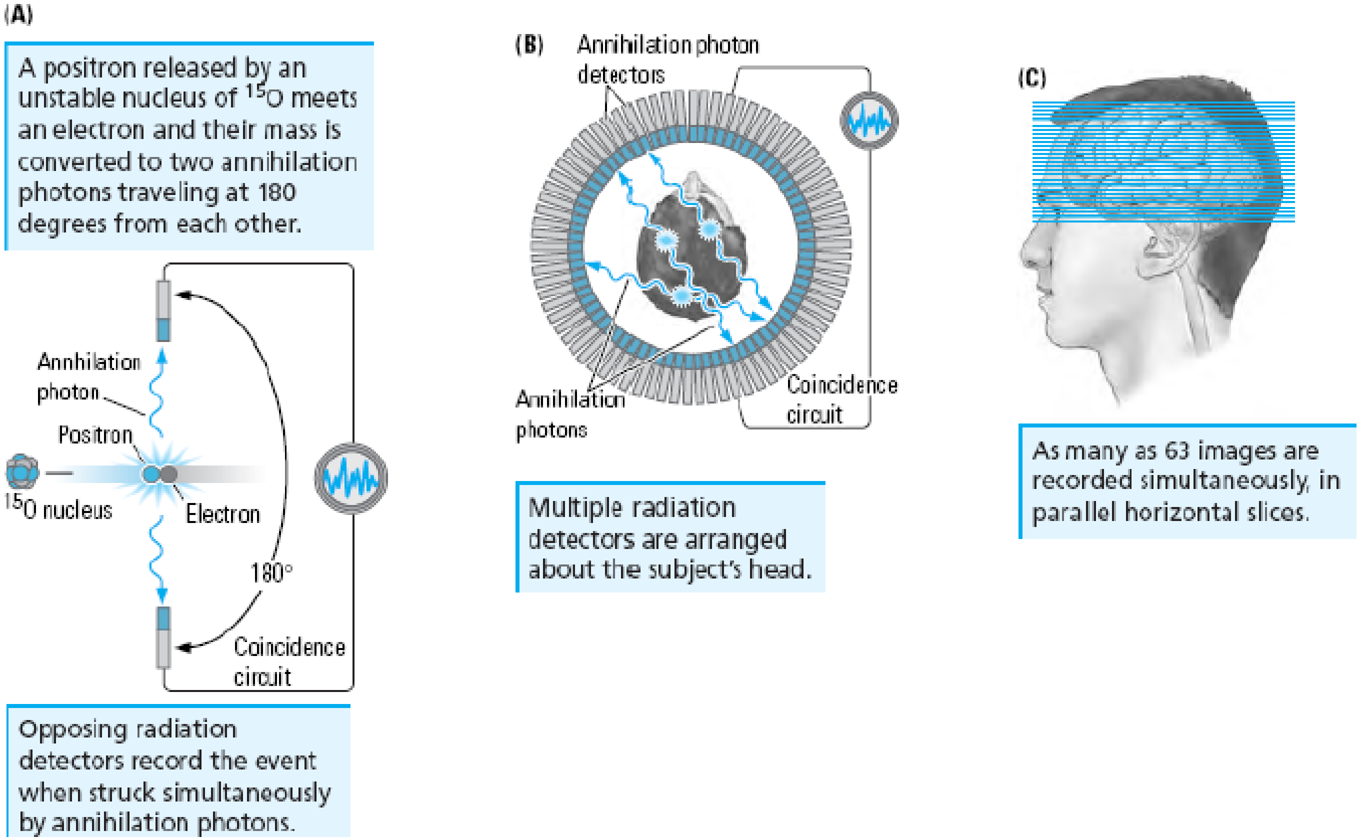
MITTELUNG ÜBER DIE PROBANDEN
visuelle Stimulation
Kontrolle
Differenzbild
anatomische Standardisierung
individuelle Differenzbilder
gemitteltes Differenzbild

Mind reading (image reconstruction from fmri)

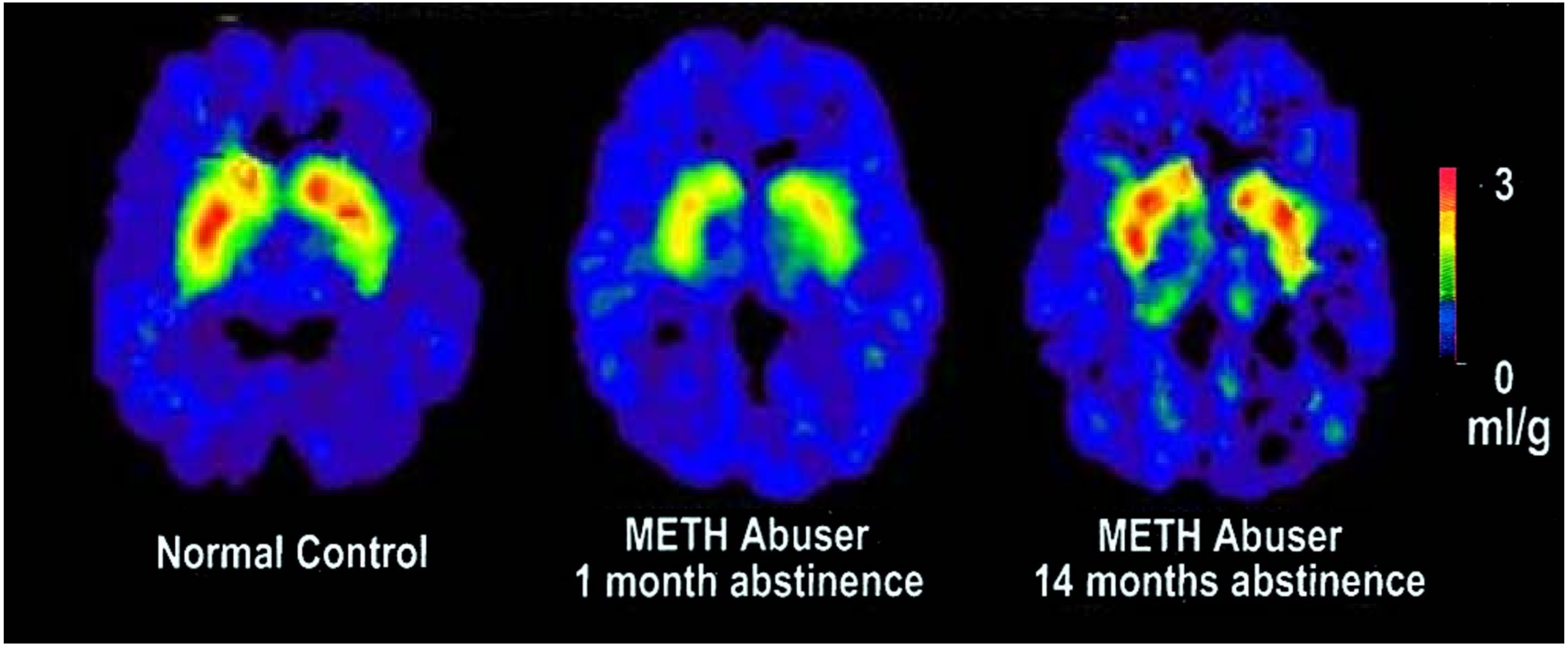
https://www.youtube.com/watch?v=1_yaQTR3KHI

PET – positron-emission tomography





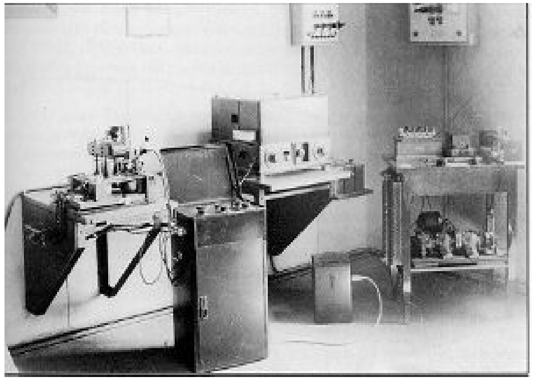
Brain images of the distribution volume of [11C]d-threo-methylphenidate (binding to the dopamine transporter) in a control and a METH abuser.

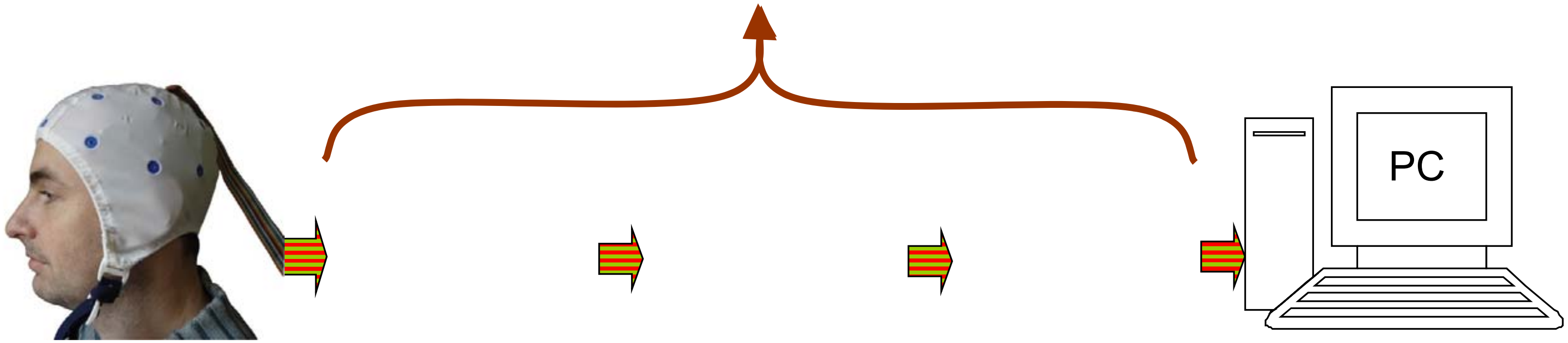


The Journal of Neuroscience

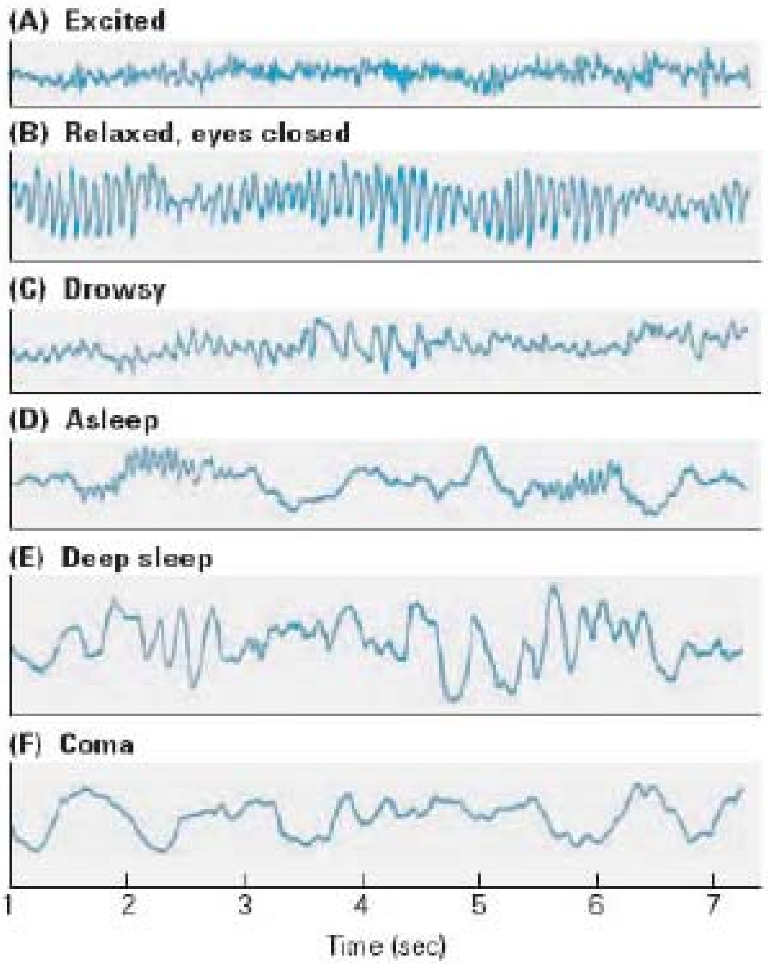
Nora D. Volkow et al. J. Neurosci. 2001;21:9414-9418

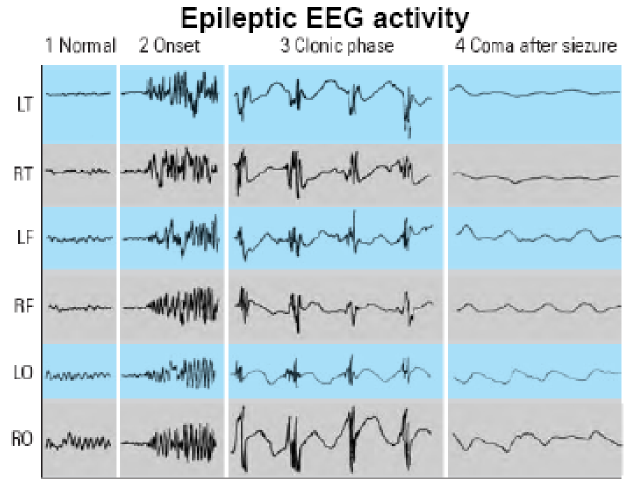
Electroencephalography

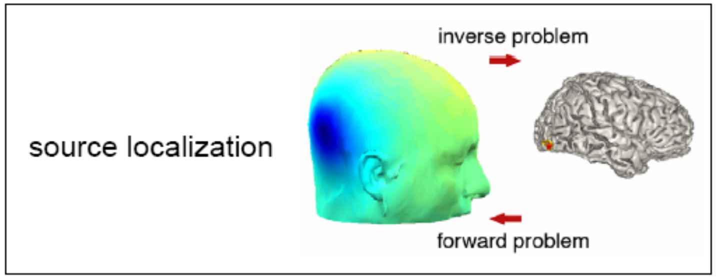




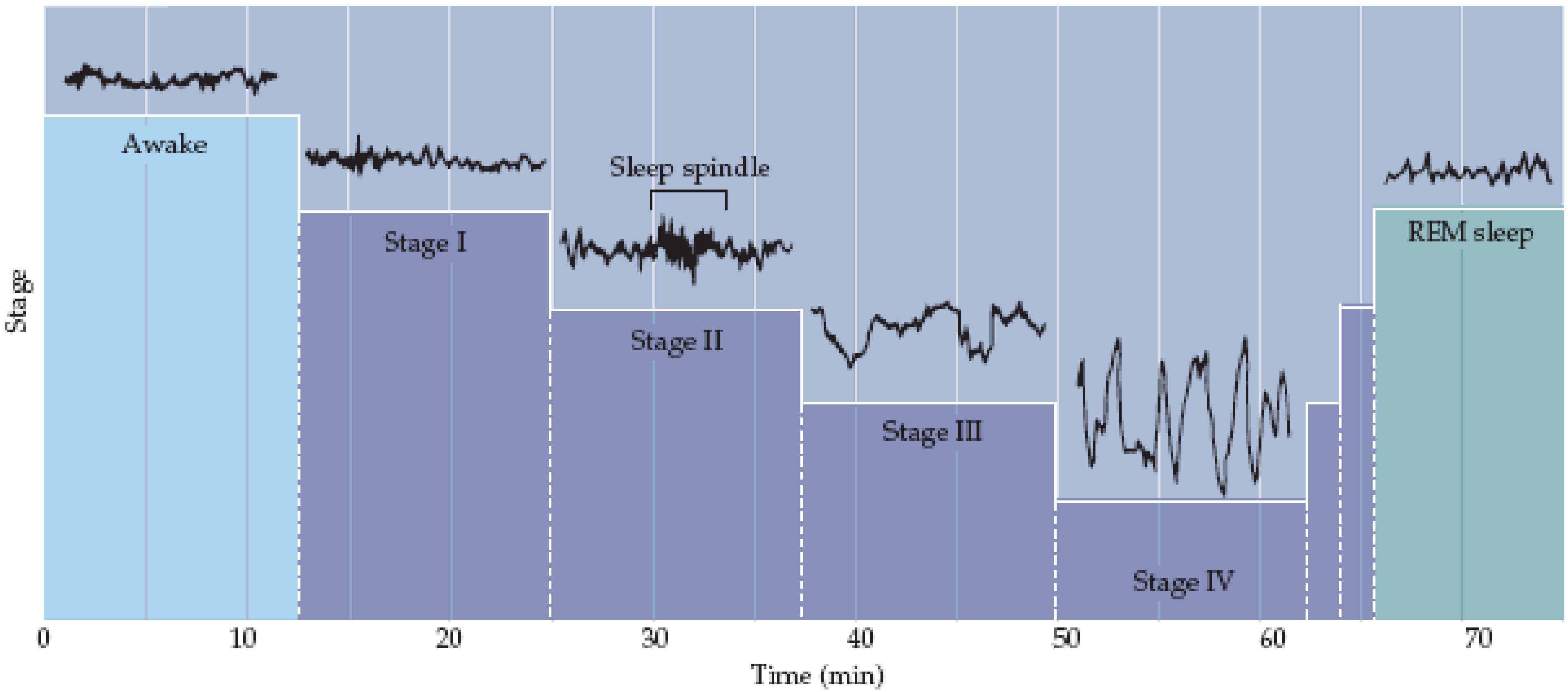
EEG activity in different states of vigilance





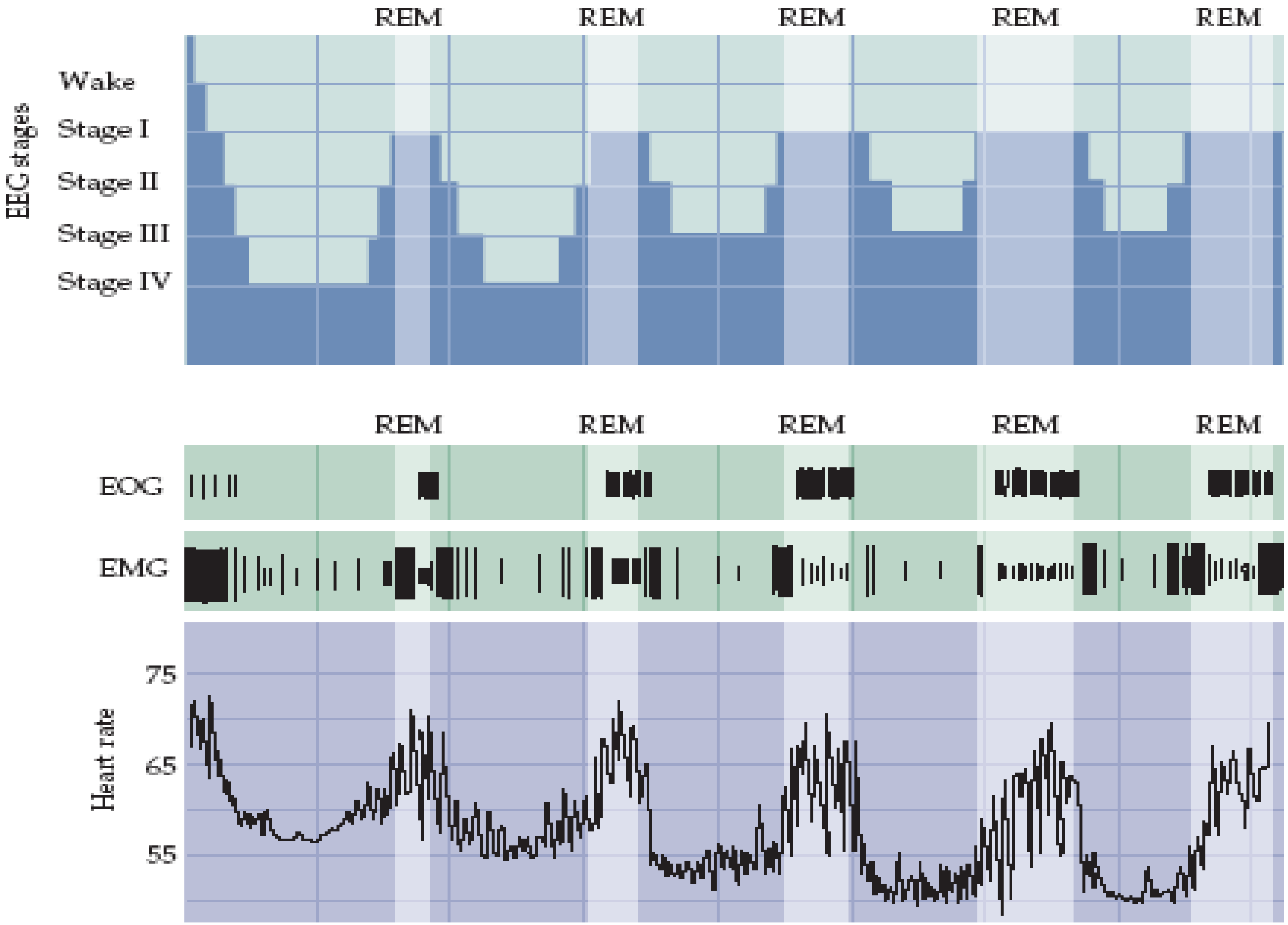


EEG recording during the first hour of sleep



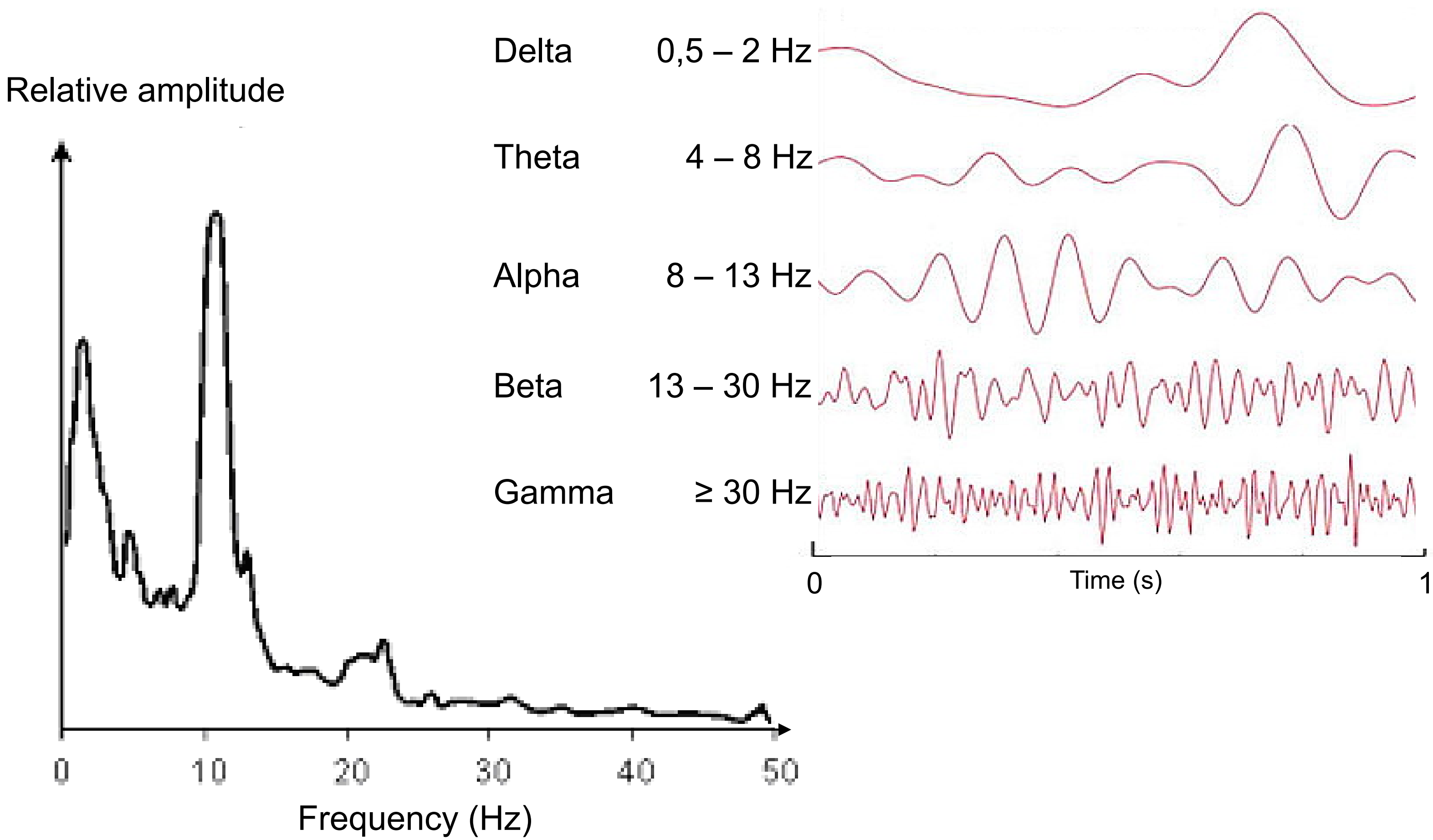
Adjusted according to Hobson, 1989

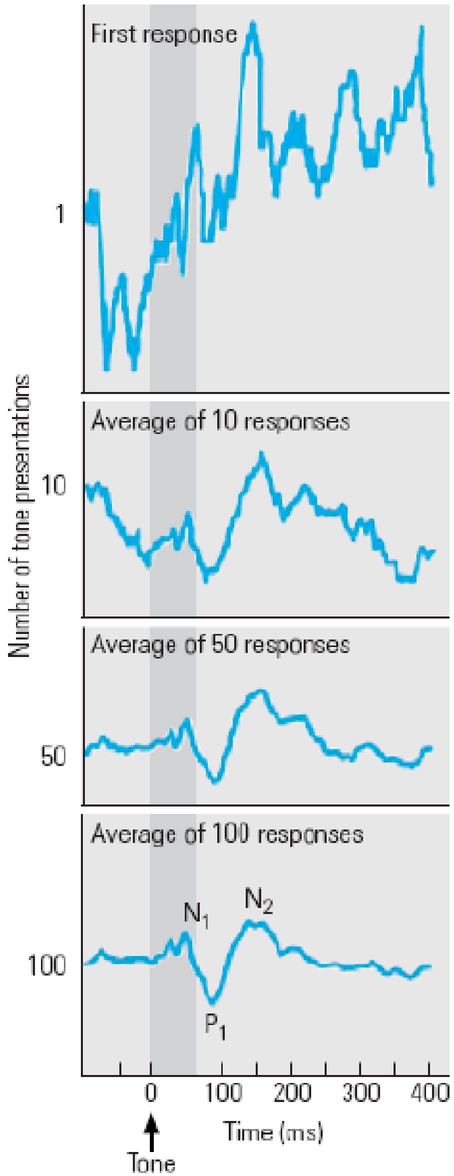
Sleep cycle



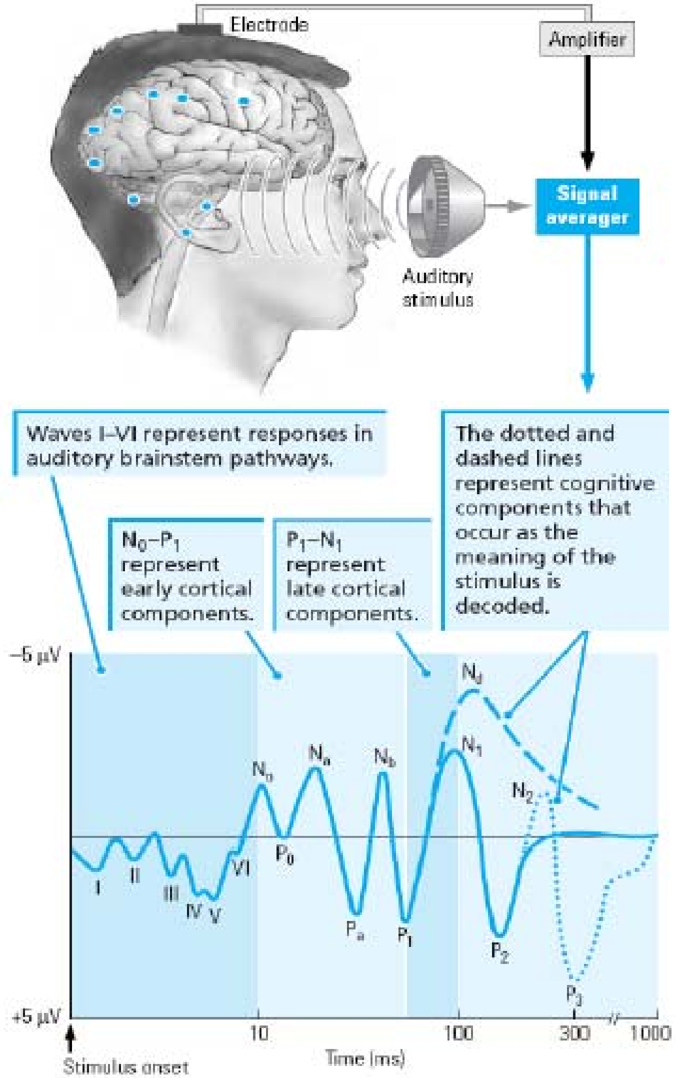
REM
REM
REM
REM
REM
Wake
Stage I
Stage II
Stage III
Stage IV
EEG stages
REM
REM
REM
REM
REM
EOG
EMG
75
65
55
Heart rate

Spectral analysis

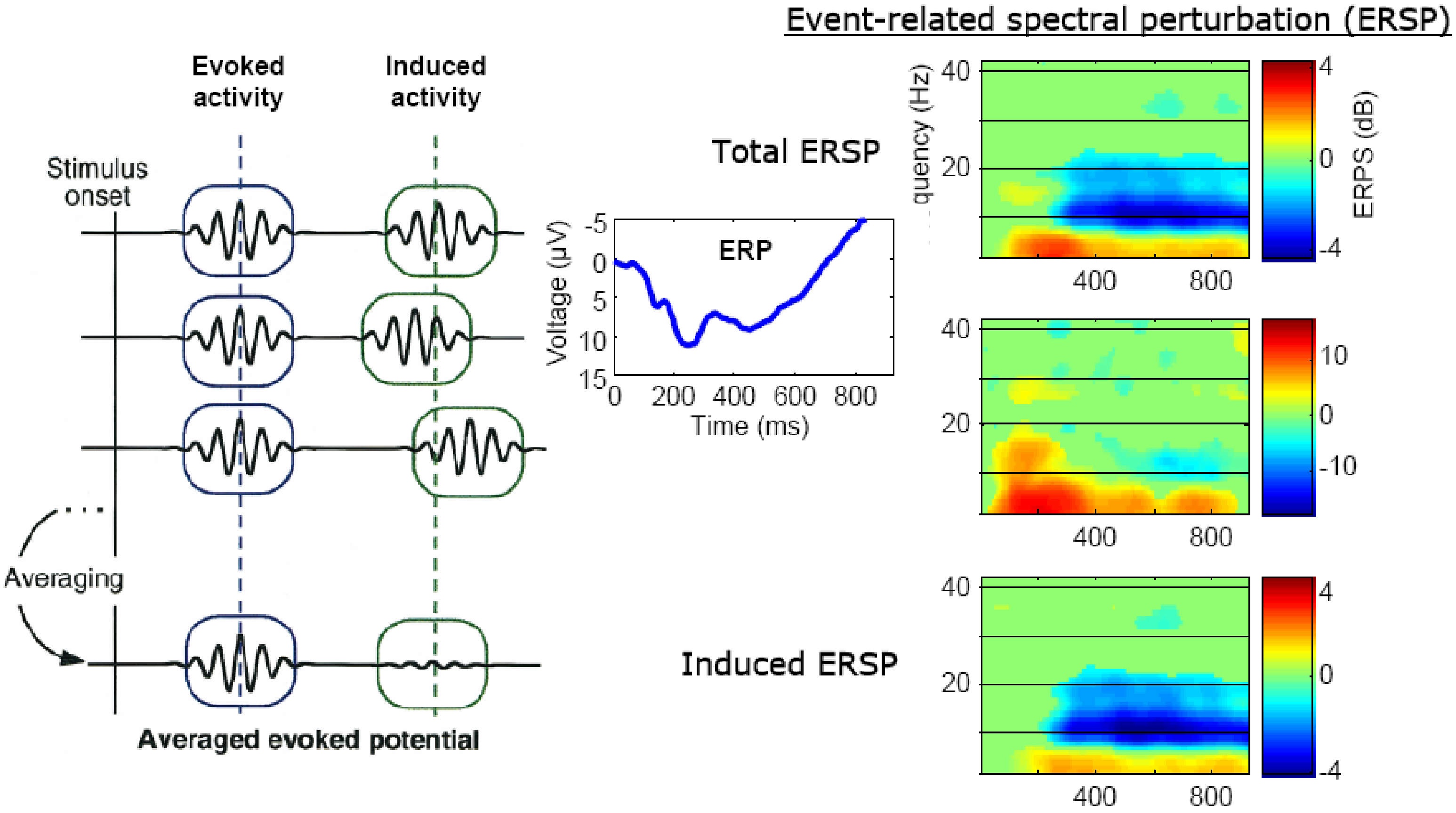




EEG evoked potentials



Evoked and event-related potentials



Tallon-Baudry 1999

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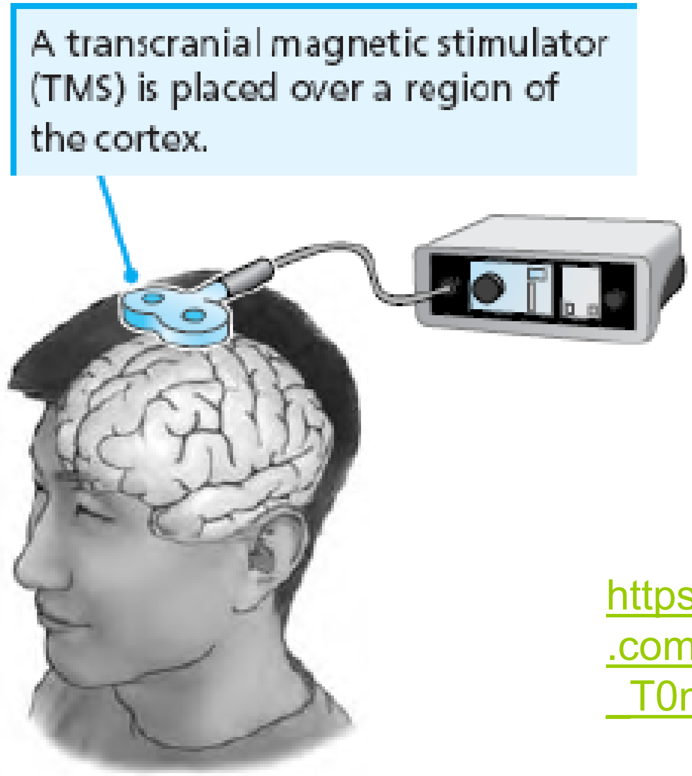
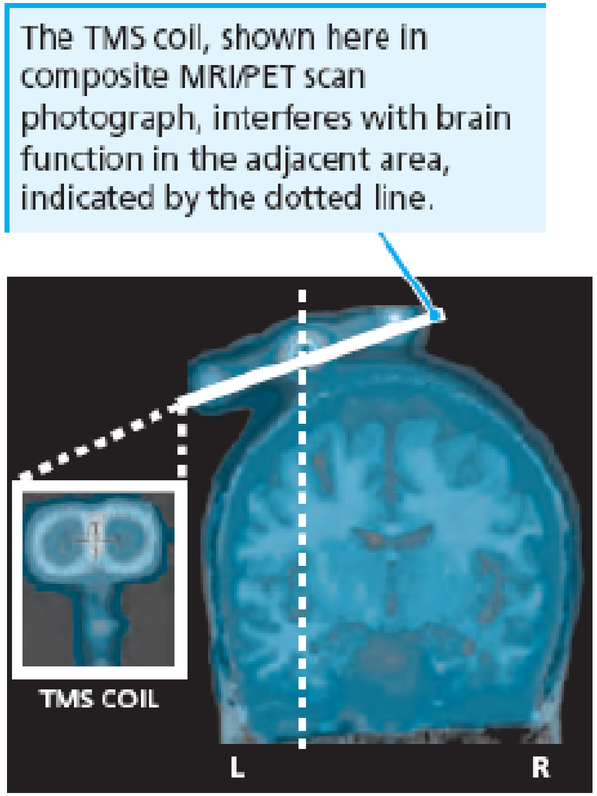
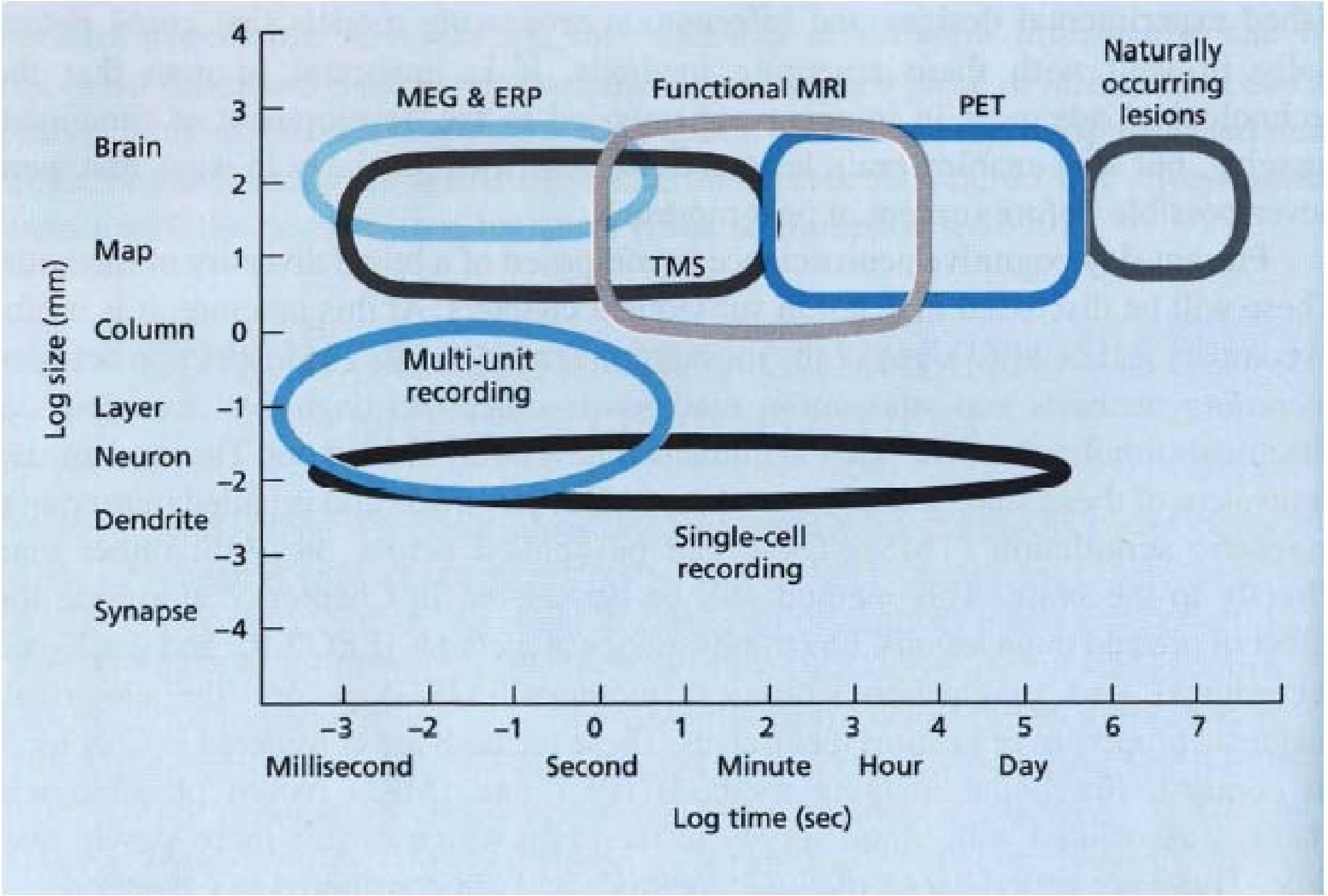
TMS – transcranial magnetic stimulation

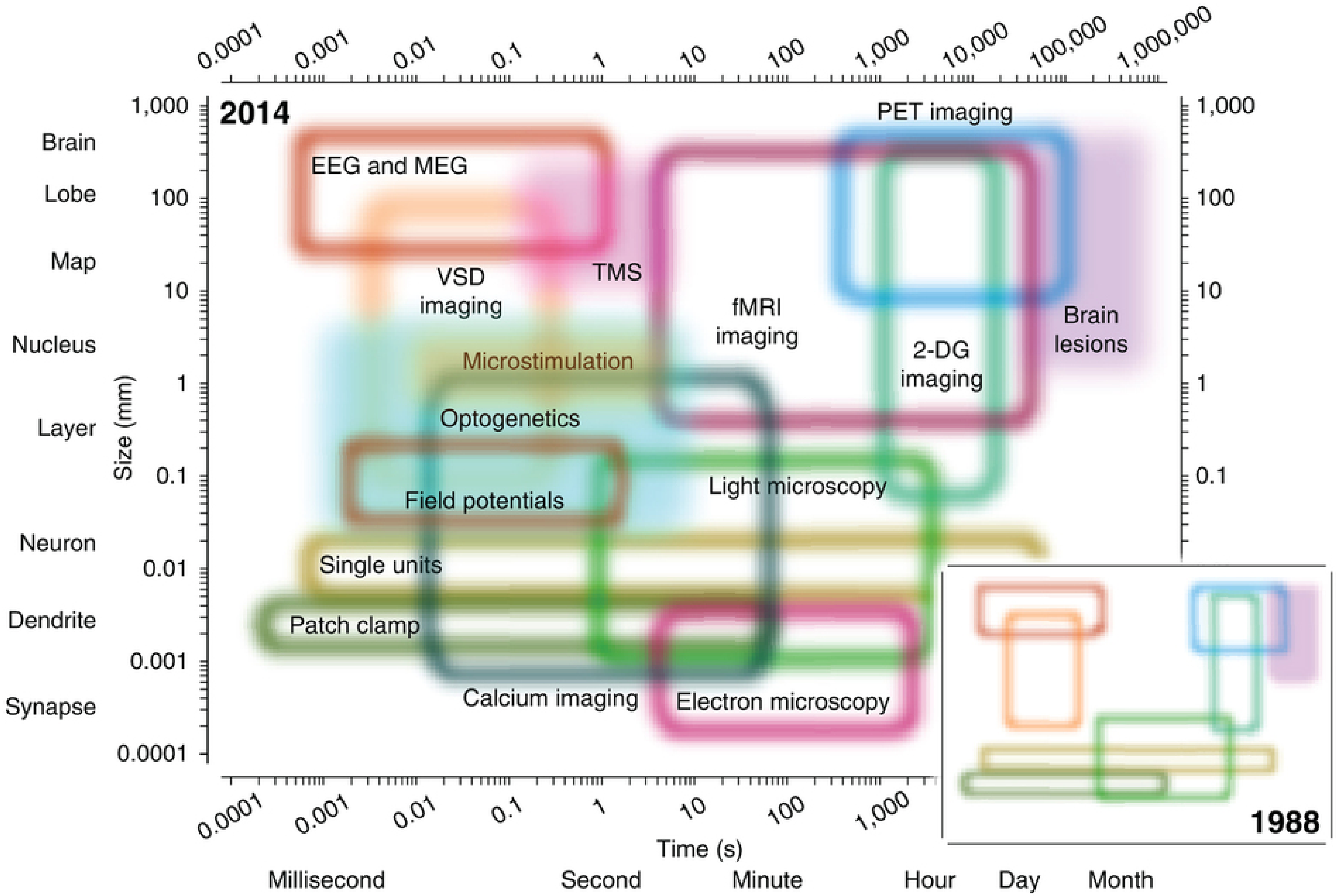


https://www.youtube.com/watch?v=FMR_T0mM7Pc



Time and space resolution





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Thank you for your attention