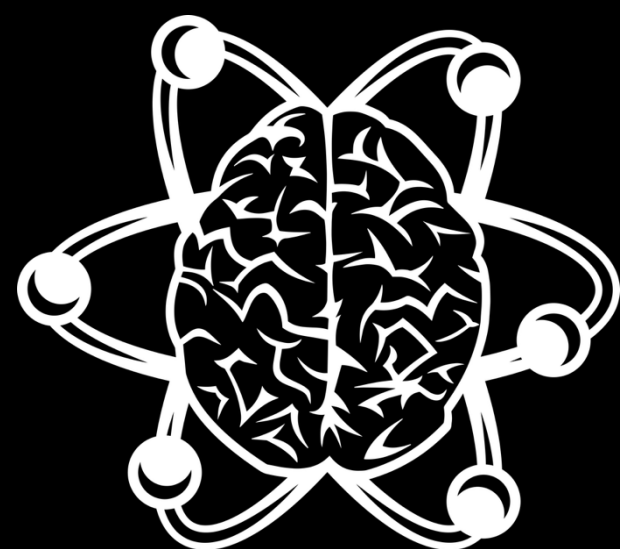
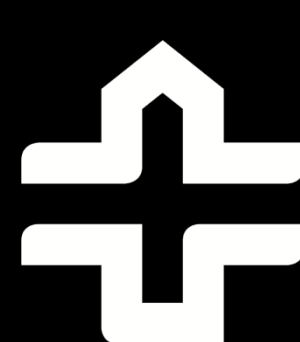




WELCOME TO THE PET NEUROIMAGING COURSE

Turku PET Centre Brain Imaging Course 2026

Lauri Nummenmaa, Turku PET Centre



STAR WARS

EPISODE IV

A NEW HOPE

COMPOSED BY JOHN WILLIAMS



253 students

From 39 different countries

Objectives

- Understand basic principles of human neuroimaging
- Know basics of PET and structural and functional MR imaging
- Grasp the basic pharmacokinetic models behind PET imaging
- Understand the nuts and bolts of (F)MRI and PET data preprocessing and modelling
- Learn the principles of statistical analysis of brain imaging data
- Total 5 ECTS credits

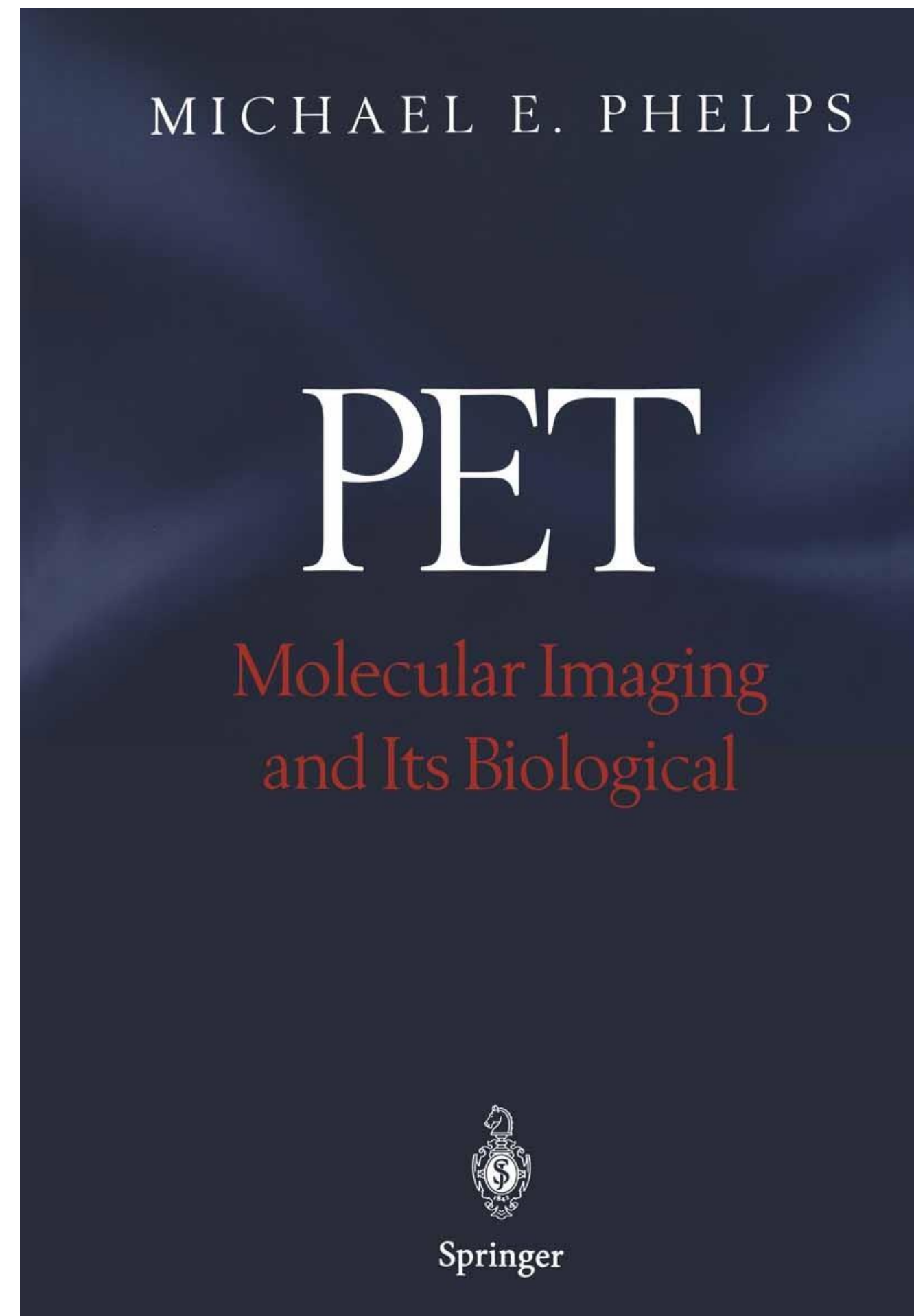
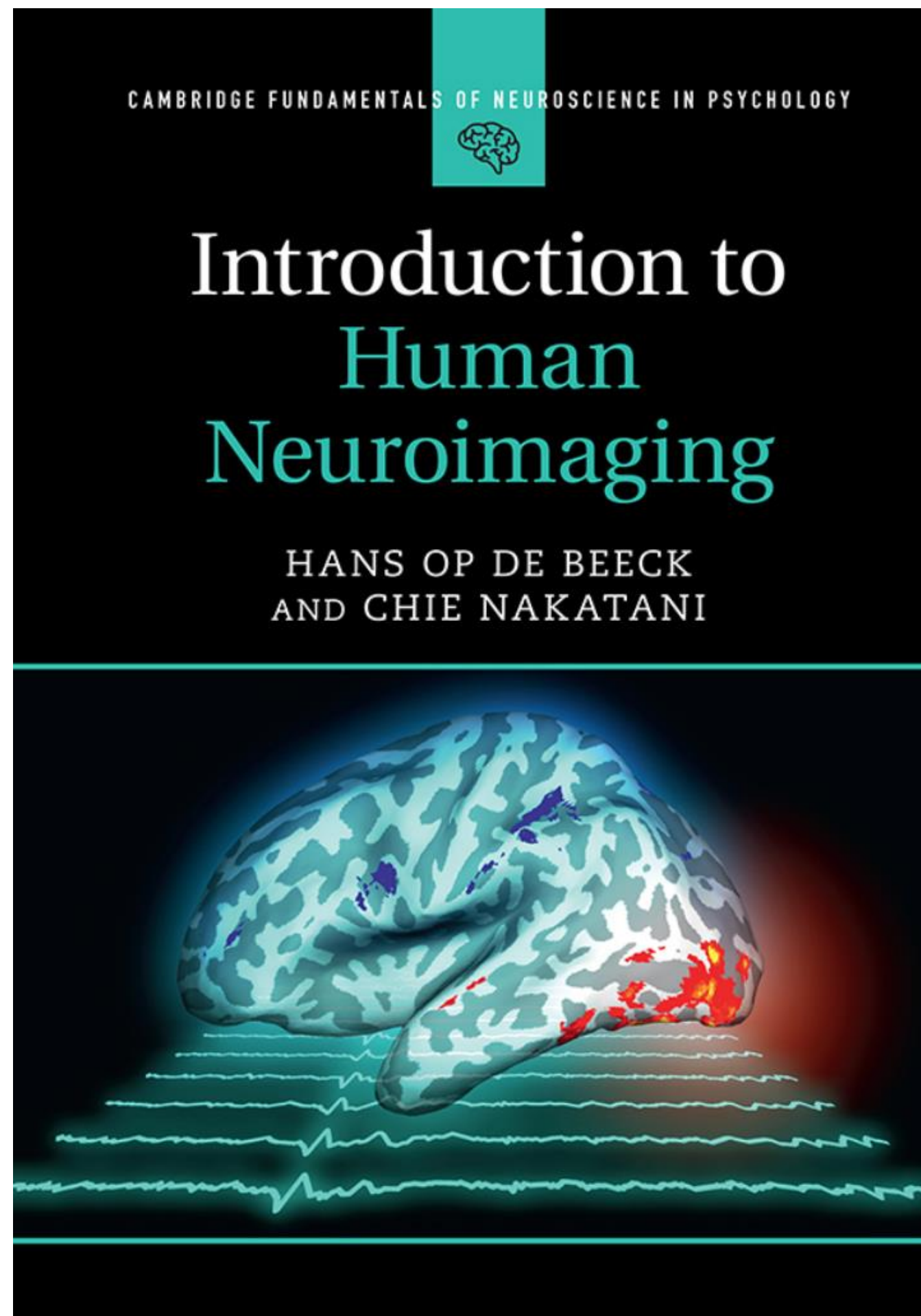
Practical stuff

- Materials available at emotion.utu.fi/neurocourse
- Lectures streamed and stored on **Echo360**, Q/A session on **Discord** throughout the course (see webpage)
- **Day 1:** Principles of neuroimaging
- **Day 2:** Practical issues in brain imaging and data analysis
- **Day 3:** Advanced topics in brain signal analysis

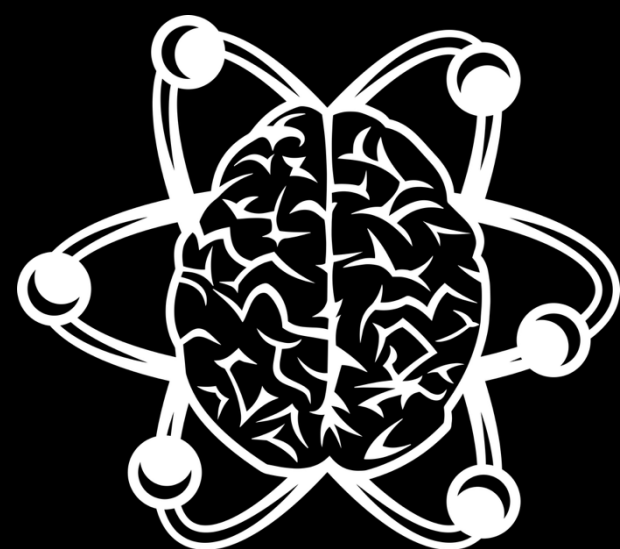
Computer labs

- **Day 4:** Data preprocessing
- **Day 5:** Statistical inference
- Note – we have limited seats at the computer labs, please bring your own laptop if possible so we don't have to share the lab computers!

Examination



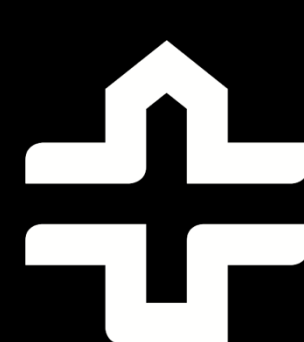
- **Electronic examination** on the Uni Turku **Exam** system
- Multiple choice questions from books and lectures
- Open from Oct 1st to Dec 31st
- **NOTE:** only available Uni Turku students, external attendants can get certificate for participation upon request



BASIC PRINCIPLES OF HUMAN NEUROIMAGING

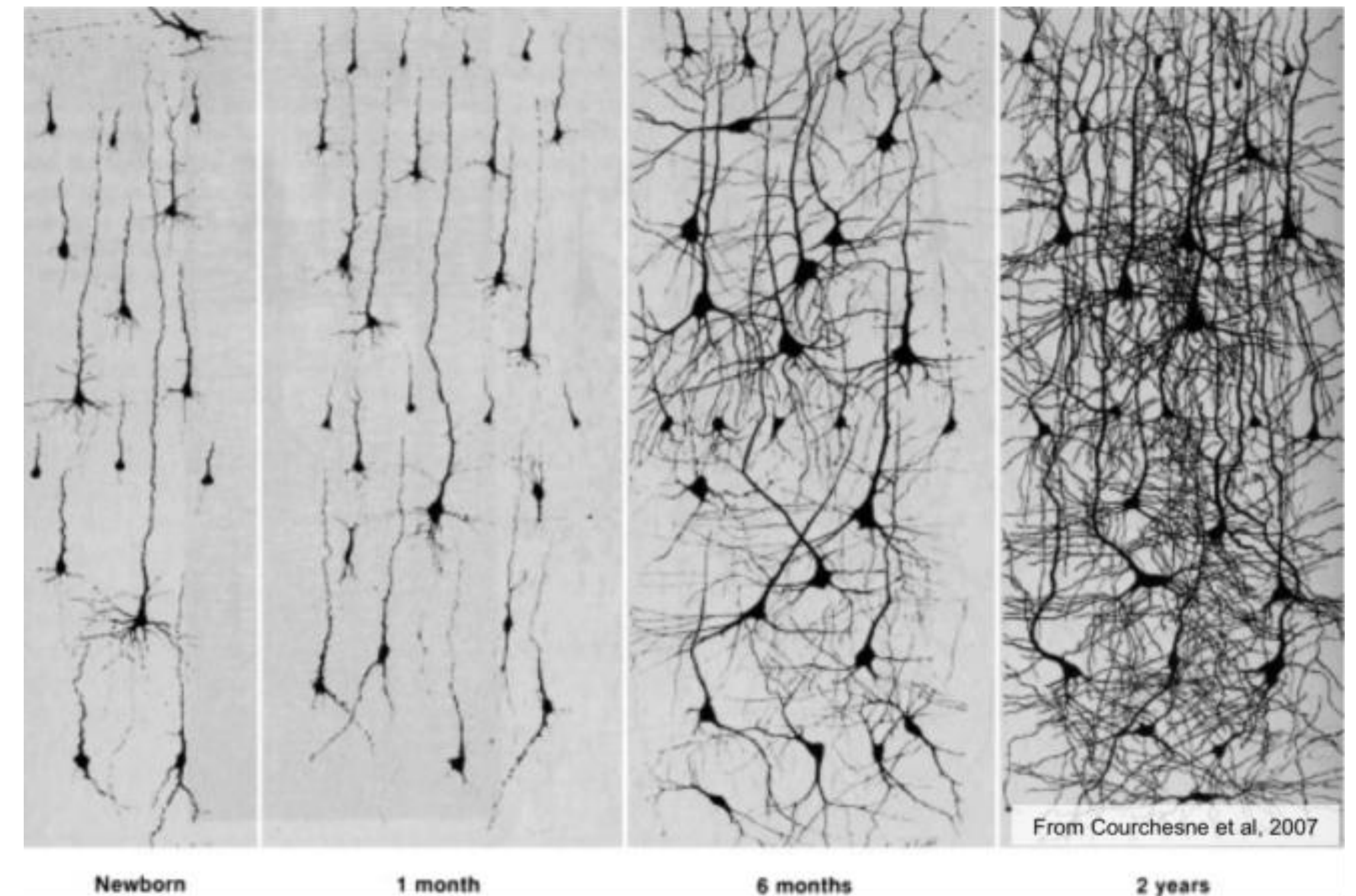
Turku PET Centre Brain Imaging Course 2025

Lauri Nummenmaa, Turku PET Centre



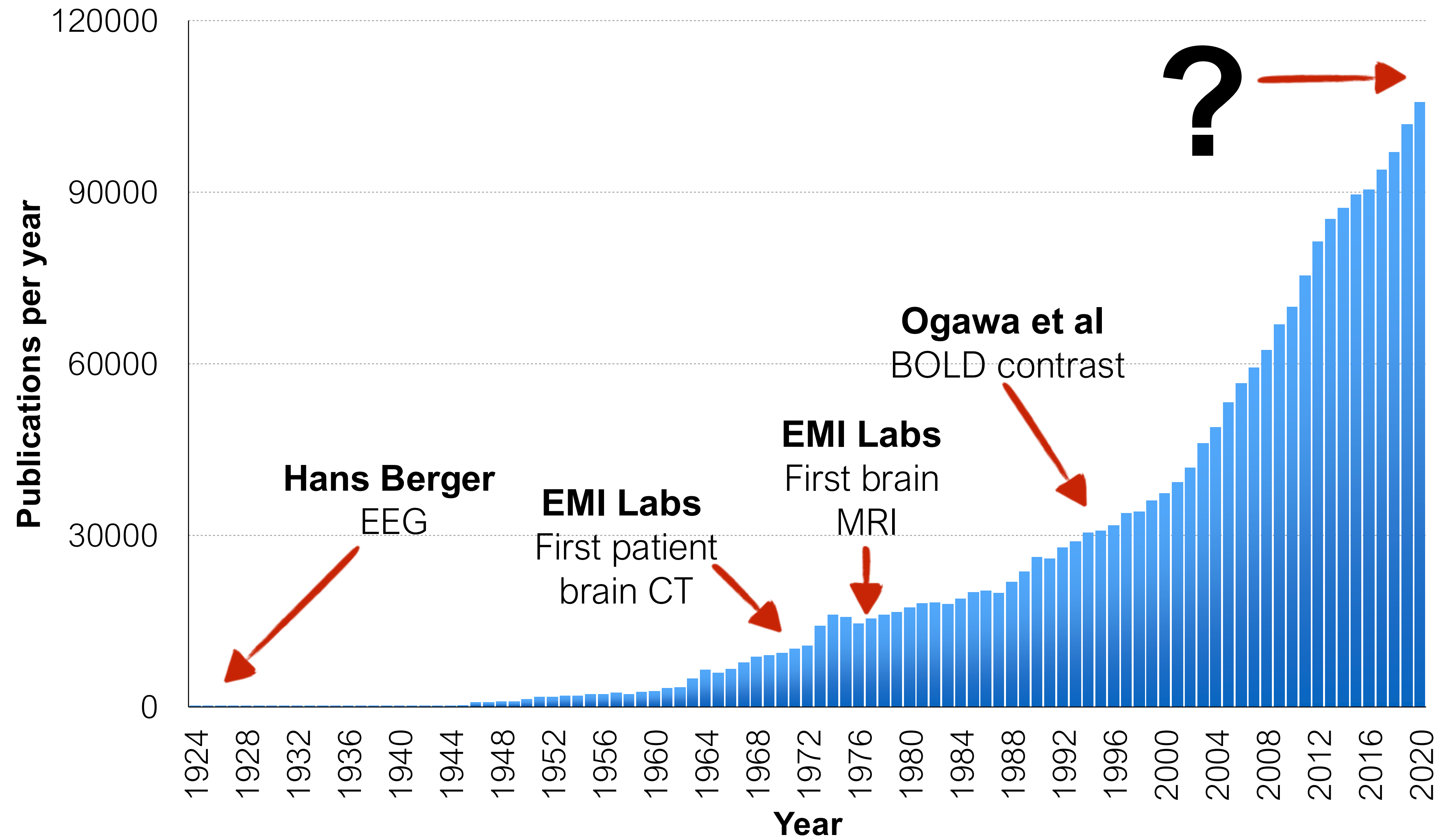
The human brain

- **Weight** 1.3 - 1.5 kg; volume ~ 1.3 l
- A total of **86 billion** neurons
- Main function: **to coordinate the human bodily functions** via spinal cord and its innervation
- Brains **receive, process and store** information gathered by the senses to **predict the future**
- Most important manifestation of brain function: **behaviour**
- **Protected** by skull, meninges and brain-blood barrier



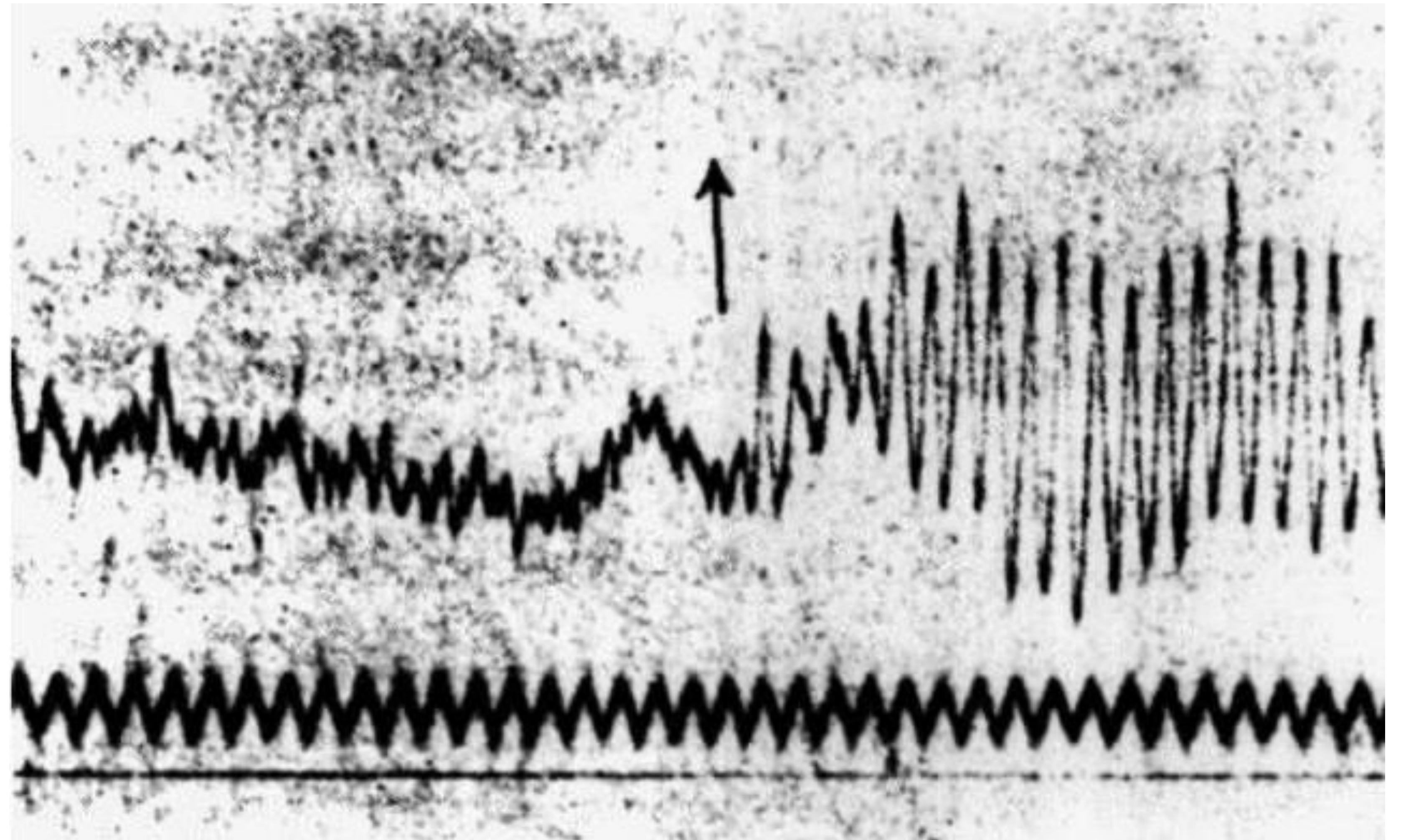
What do we want to know about brain?

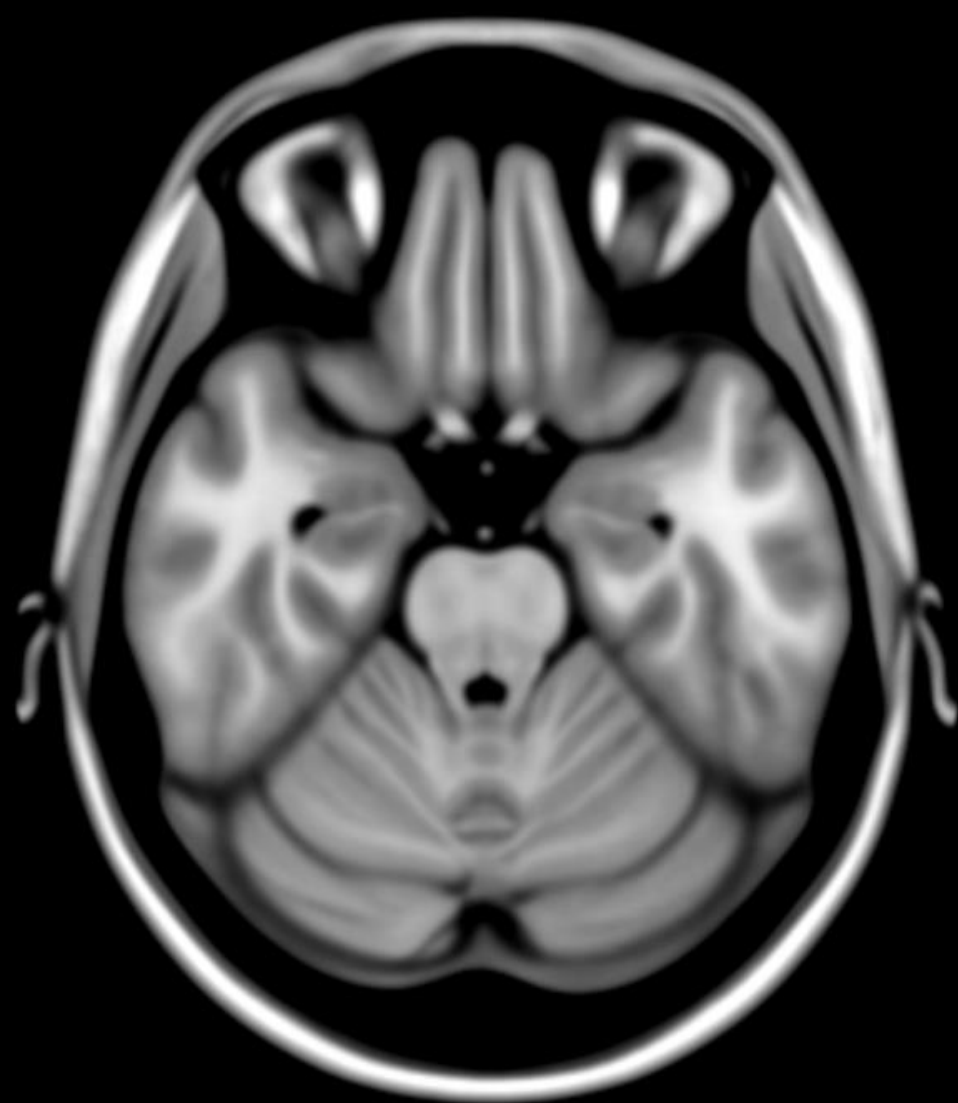
- **LOCATION:** Where different processes (consciousness, emotions, memory...) happen?
- **SPEED:** When and at which time scales different processes occur in the brain?
- **MECHANISMS:** How different processes occur in the brain?
- **INDIVIDUAL DIFFERENCES:** Do different groups (patients / controls; men / women...) differ in the above?
- **CAUSALITY:** How we can influence brain function with external manipulations (learning, experience, drugs...)



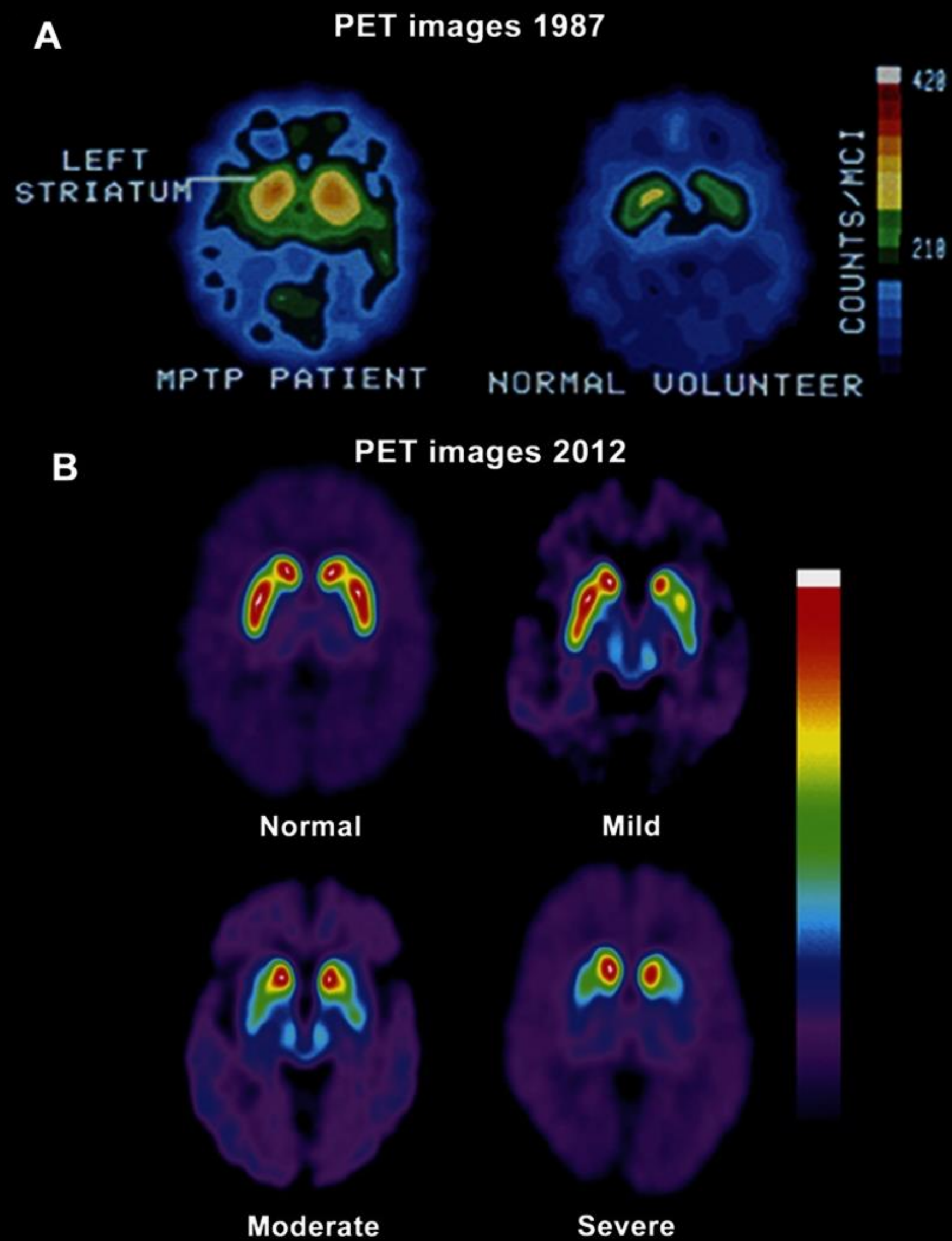
Mental arithmetic

Rest: Alpha waves return

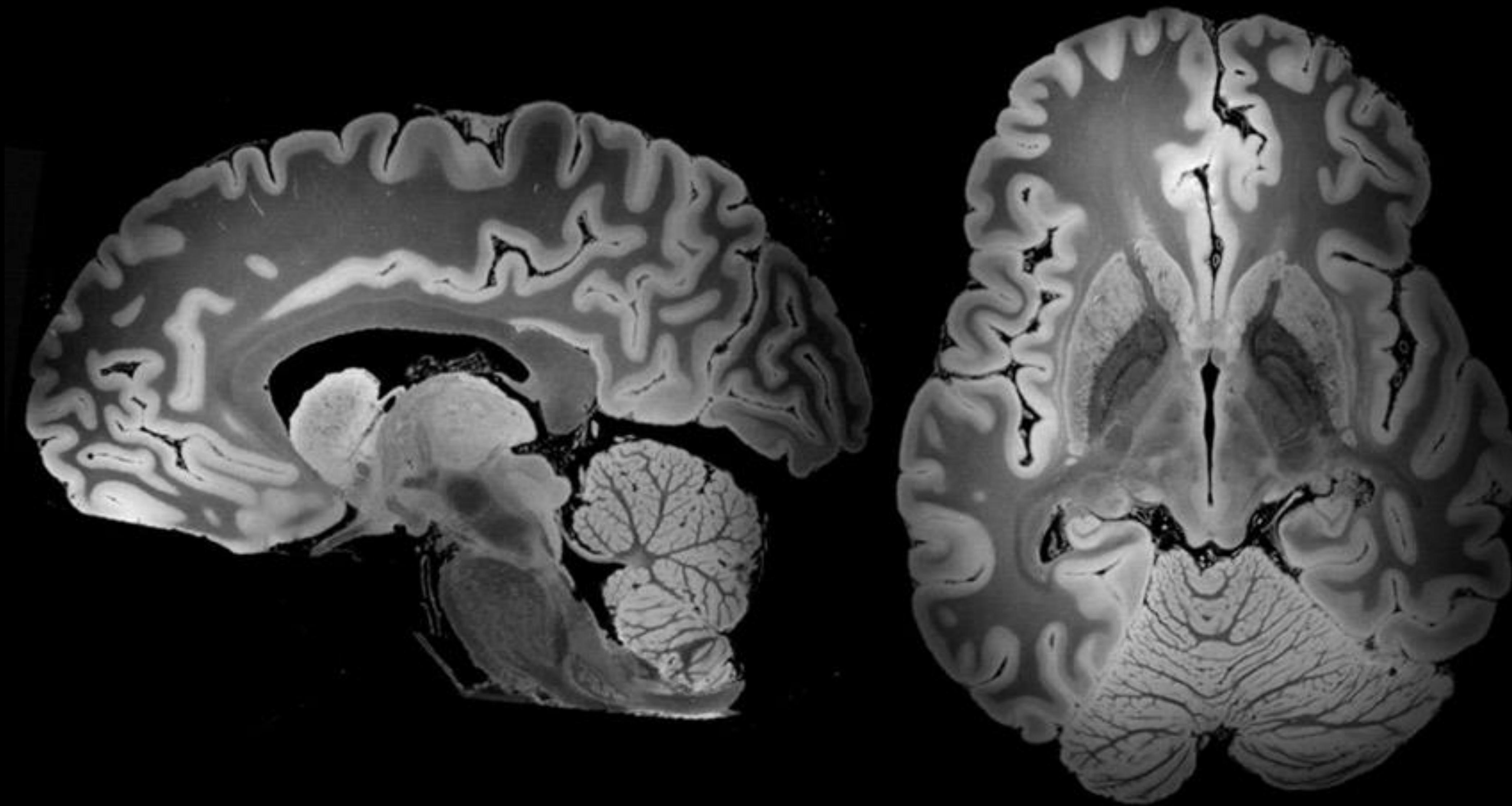




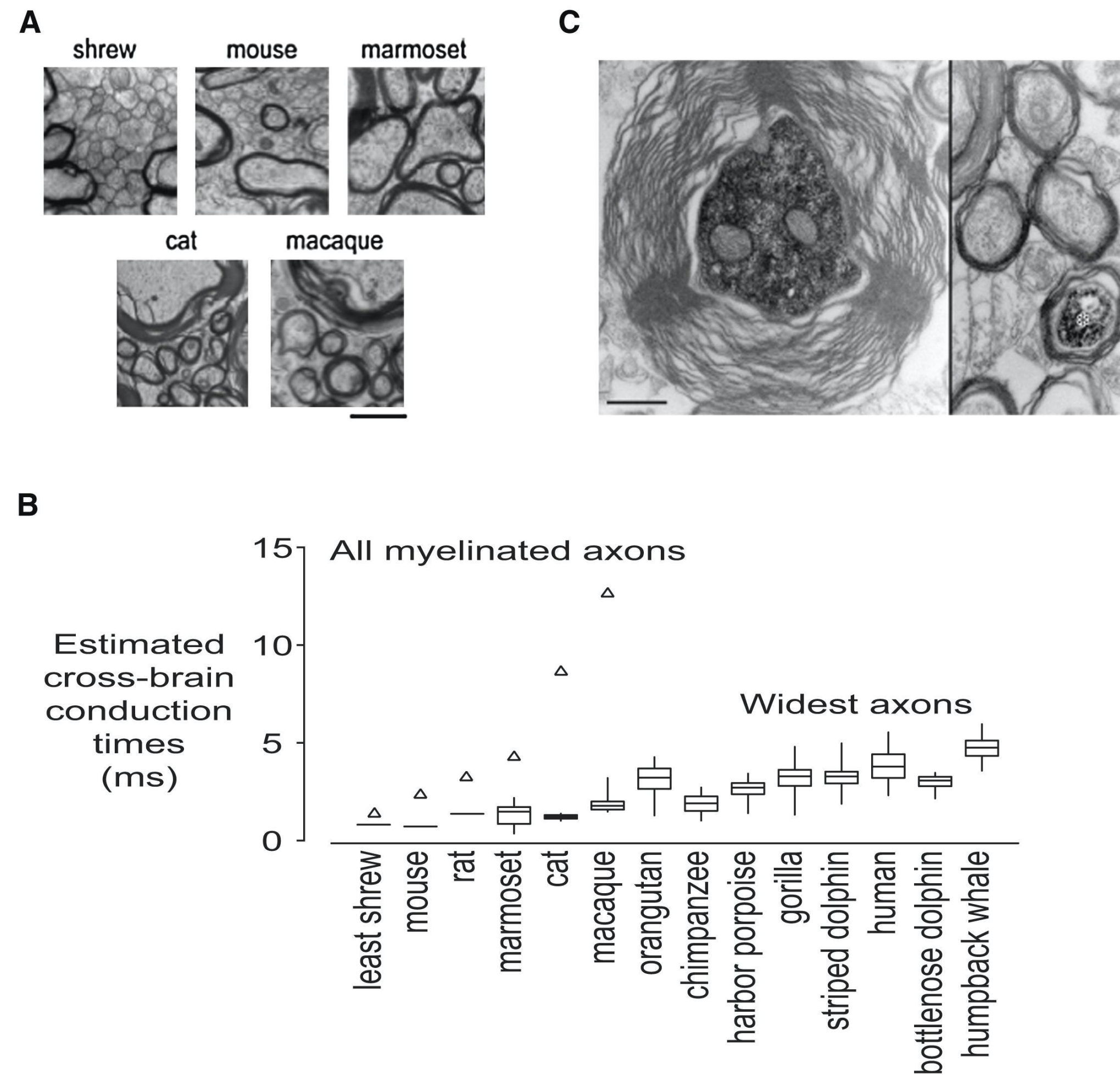
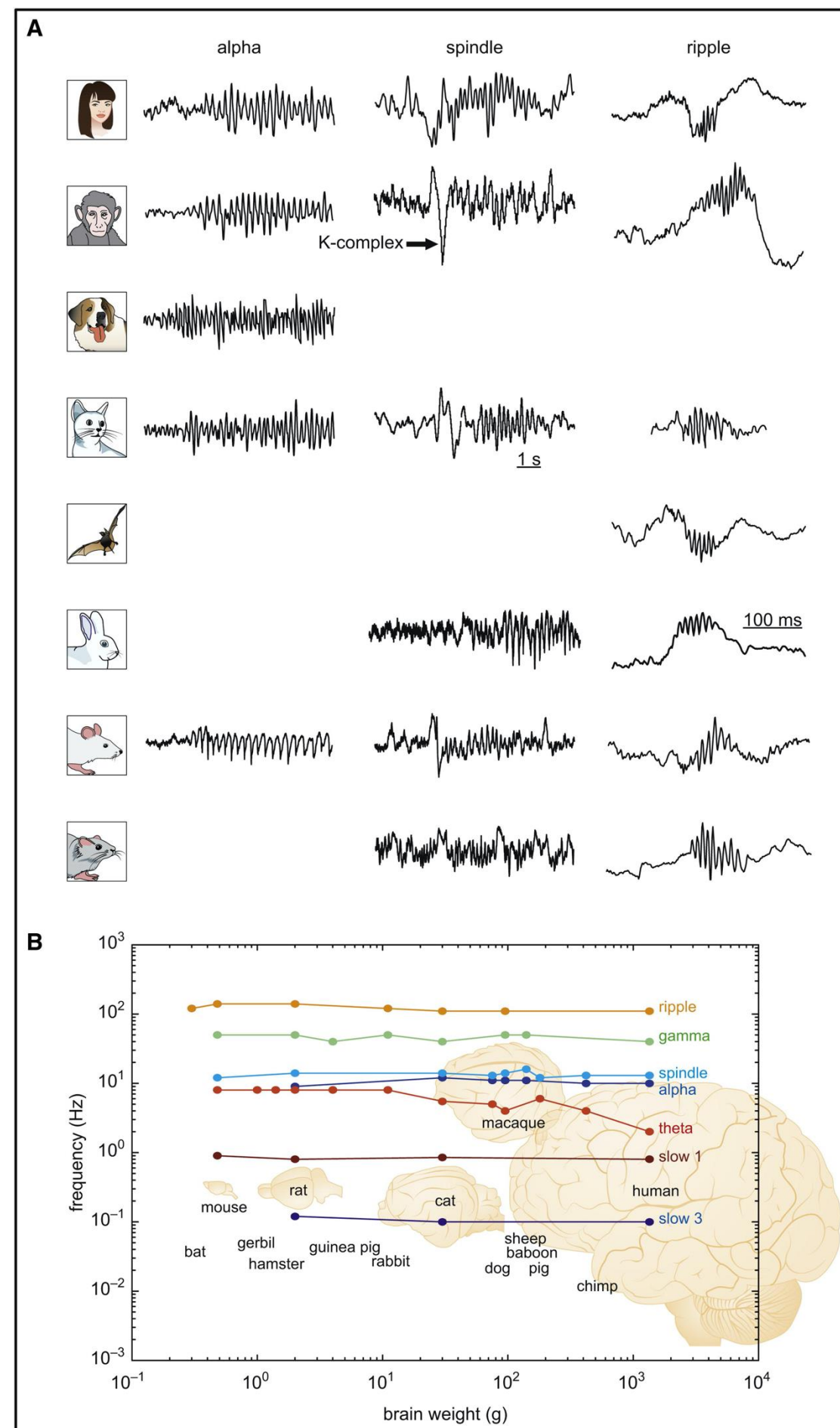
EMI central laboratories & MNI



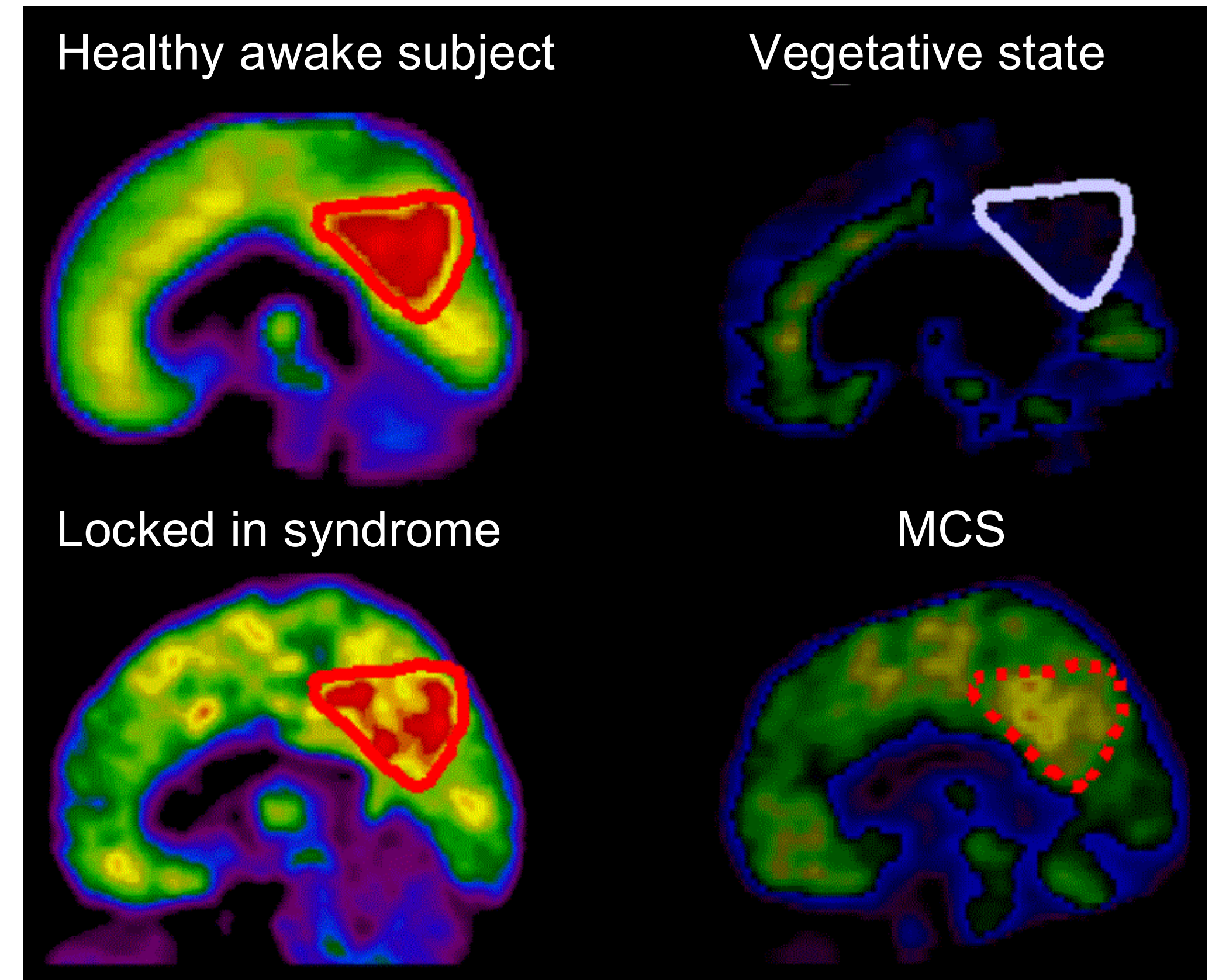
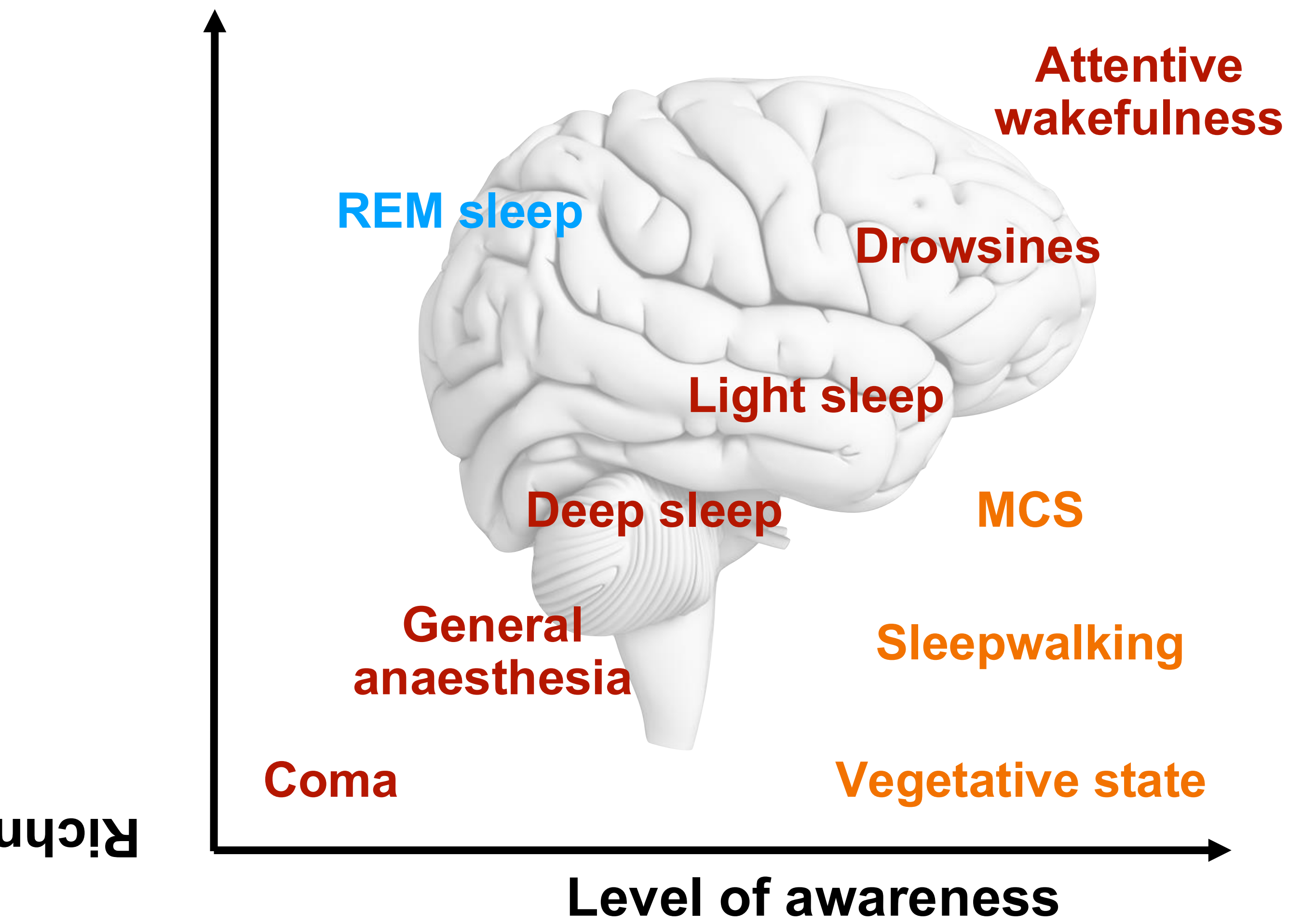
Portnow (Neurology 2013)



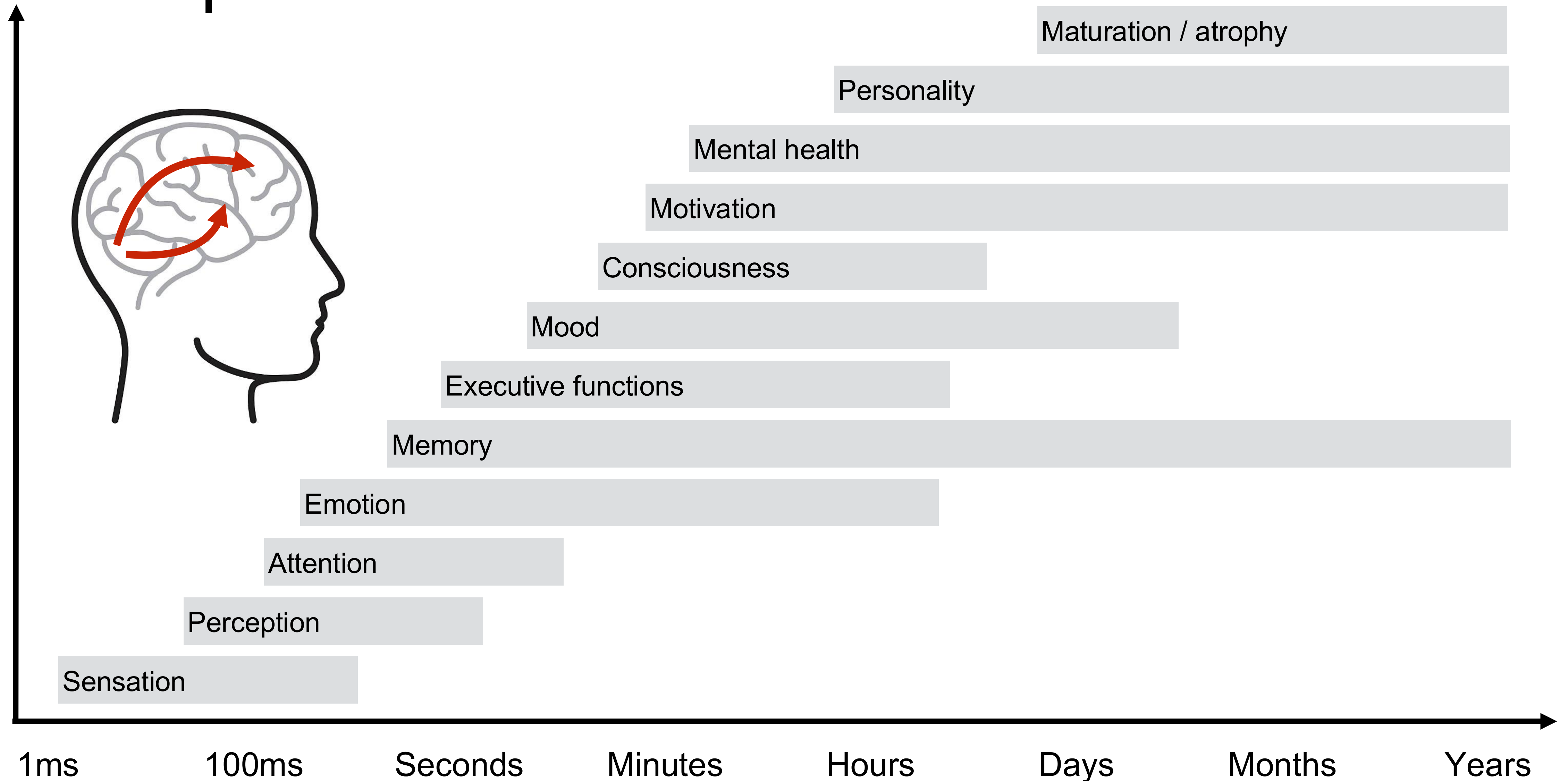
Fast reactions with slow brains



Buszaki et al (2013 Neuron)



Temporal windows in brain

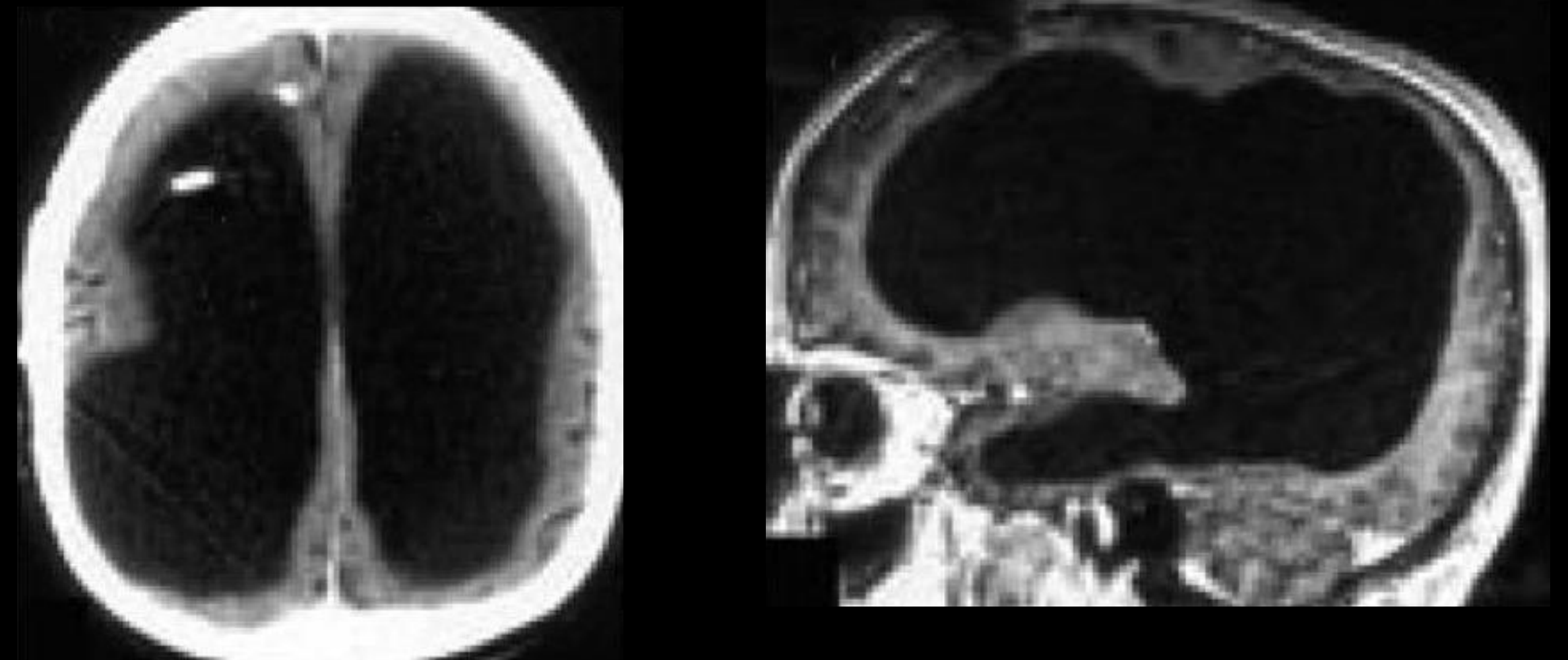


Gross anatomical changes occur in the absence of changes in behaviour and mental processes

Young epilepsy patient

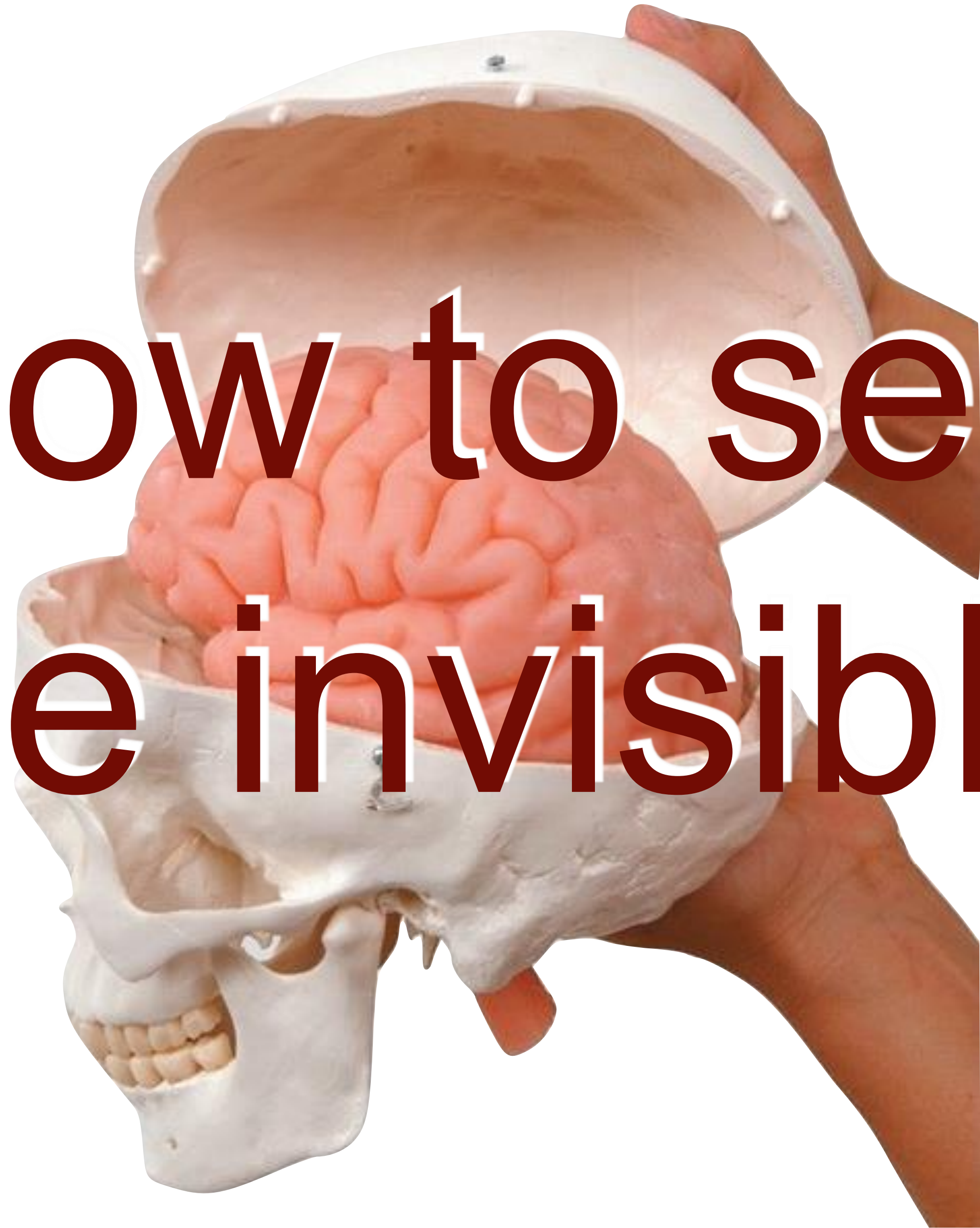


Extreme ventricular dilation

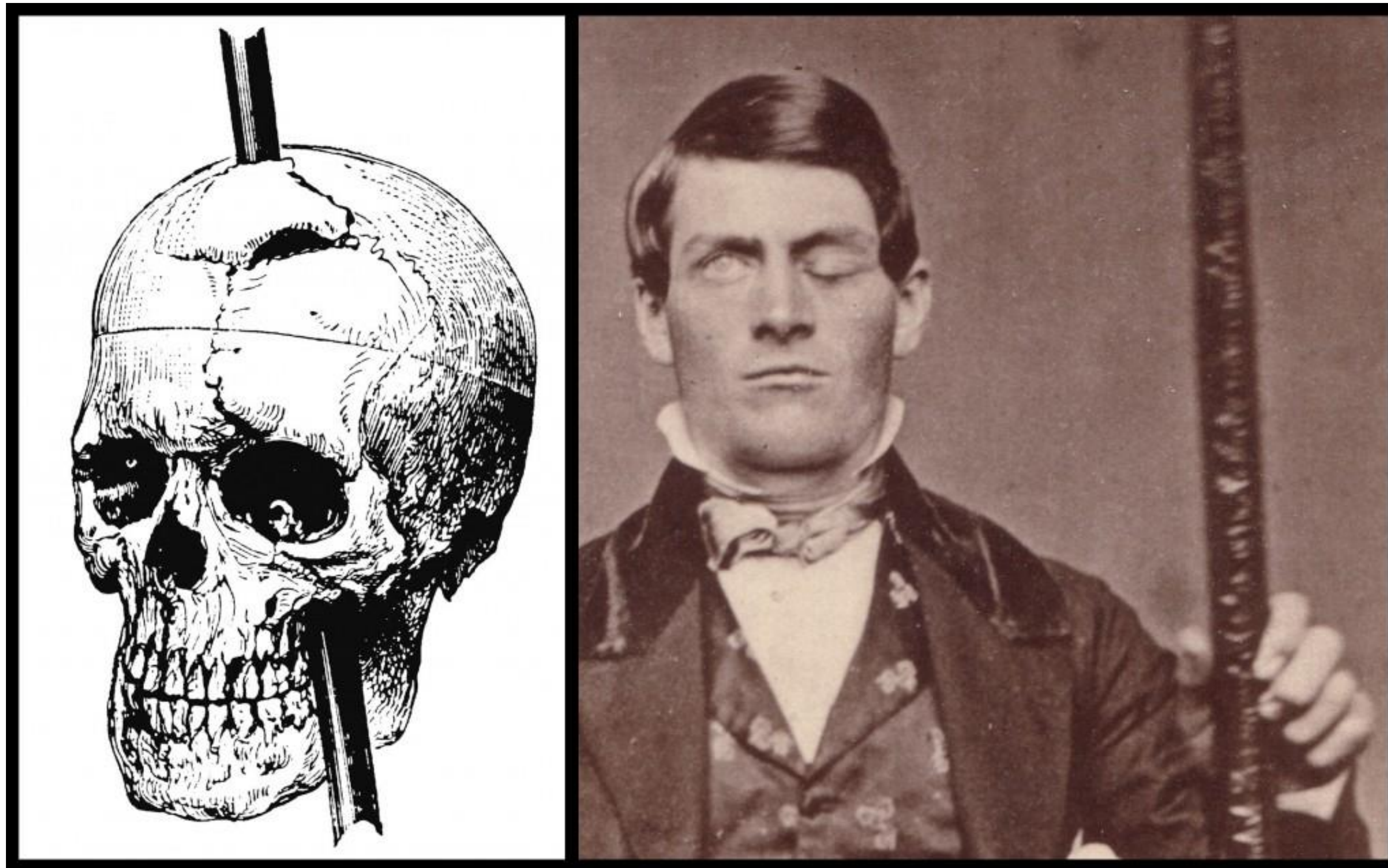


...and vice versa!

How to see
the invisible



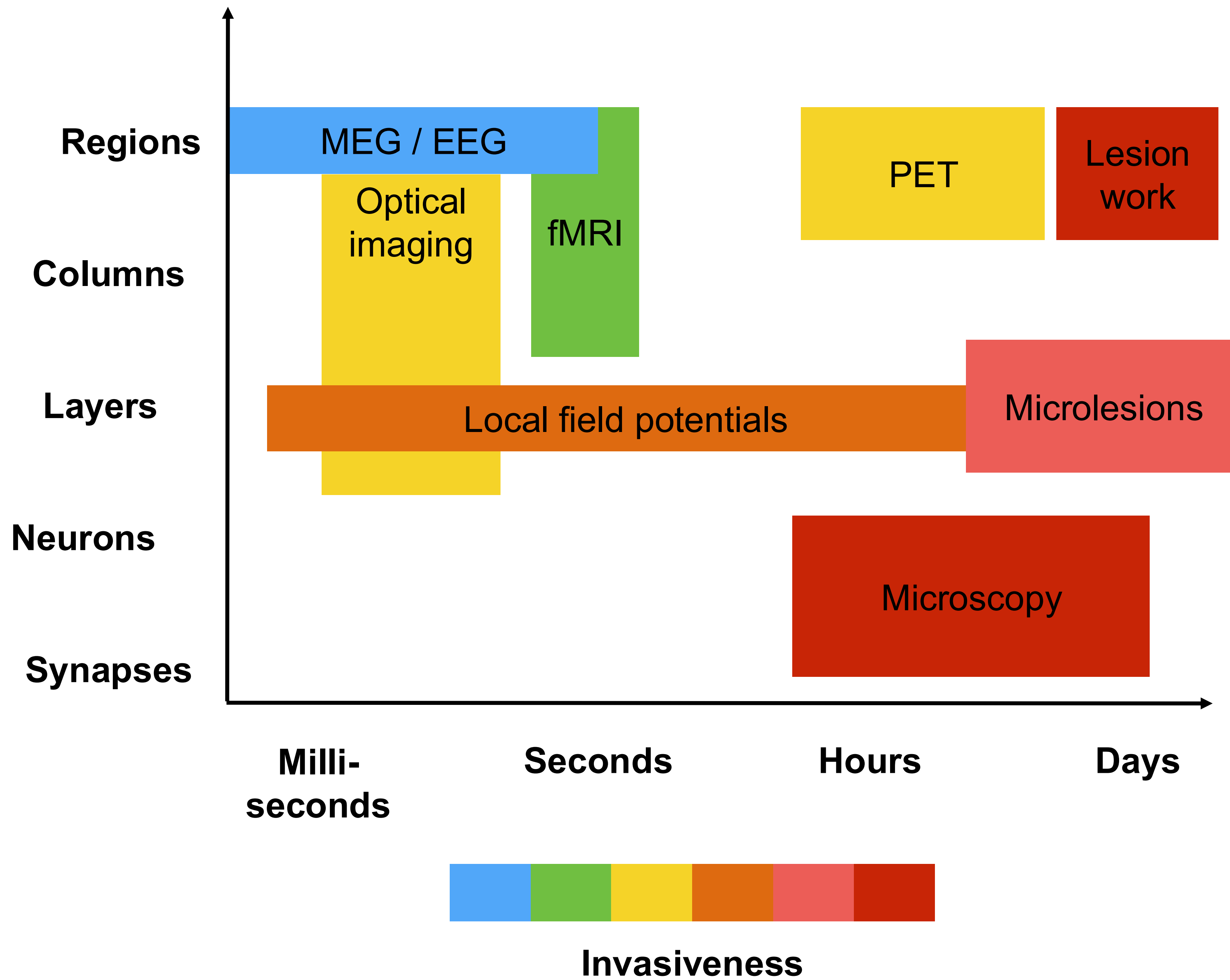
Old school cognitive neuroscience





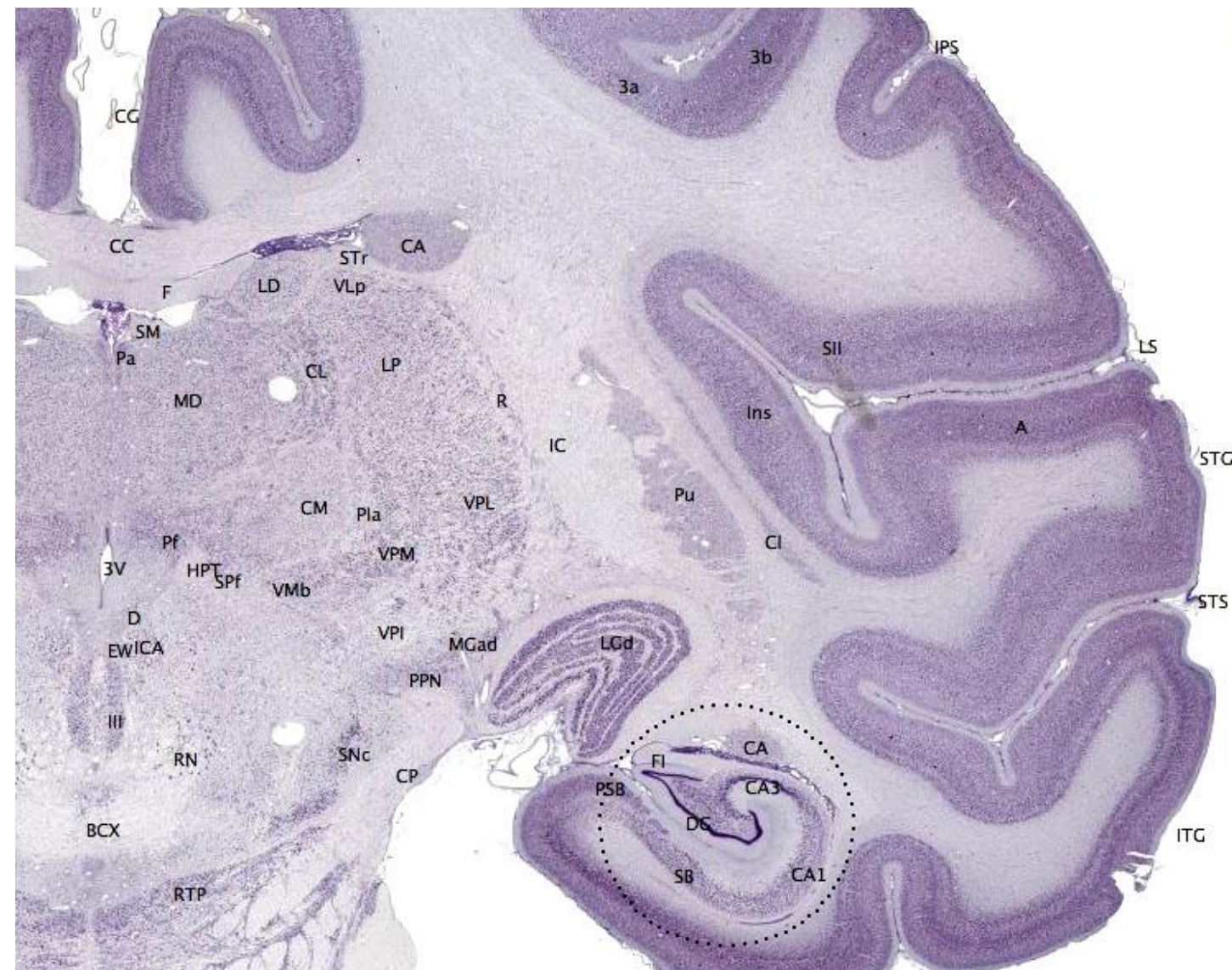
2000%

Video courtesy
of prof. Pirjo Nuutila

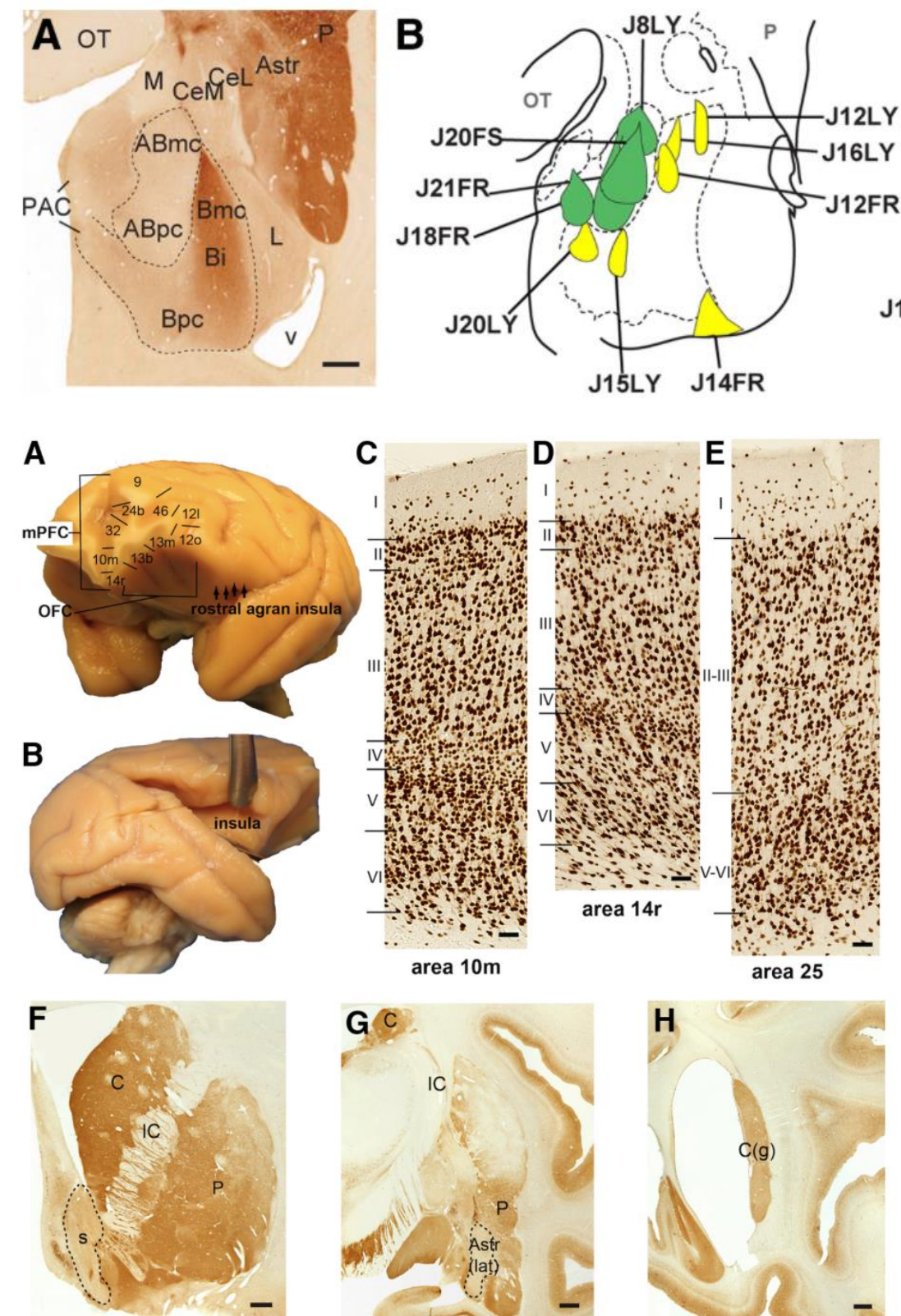


Structure

Histology

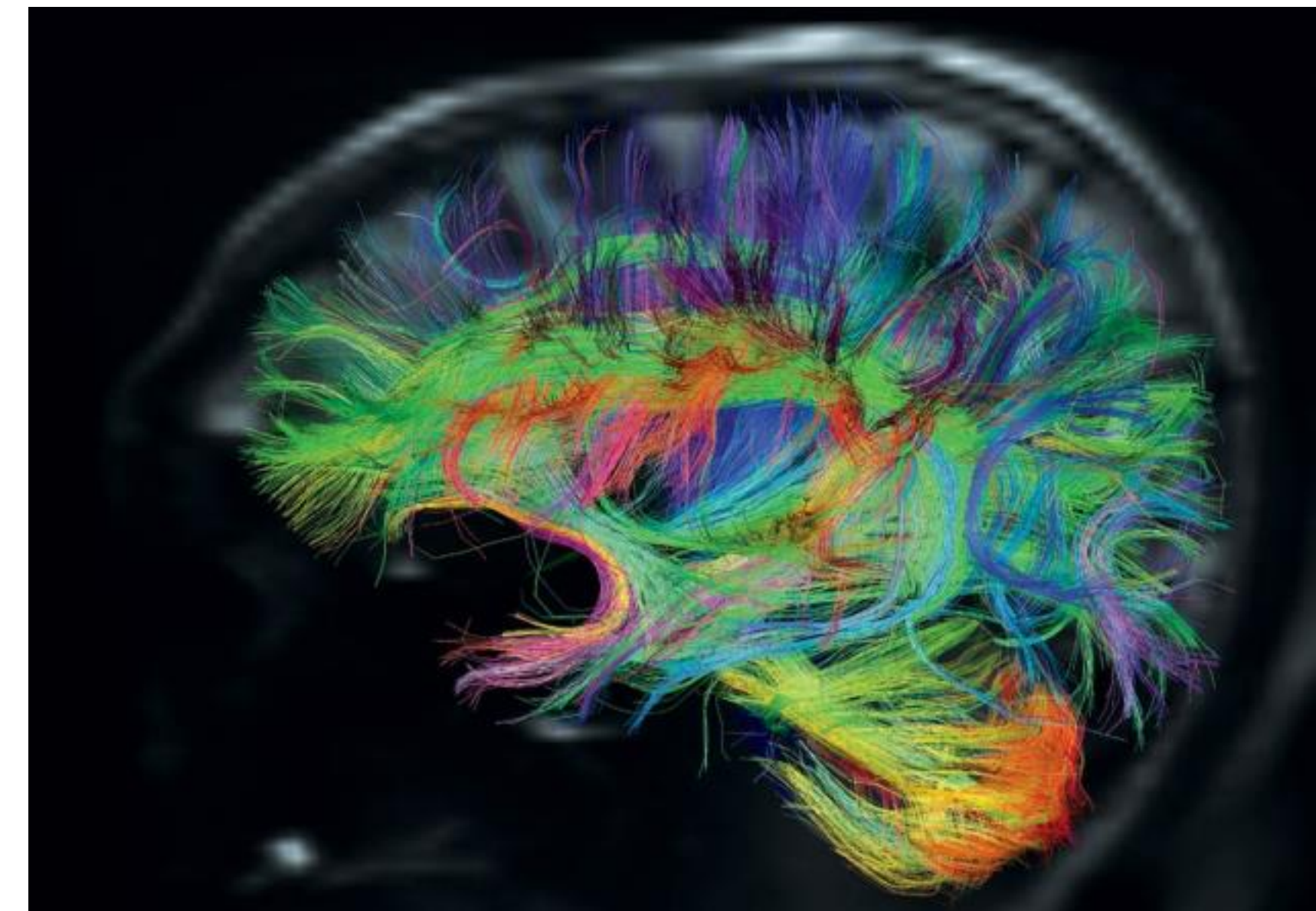


Tracing



Youngsun et al (2013 J Neurosci)

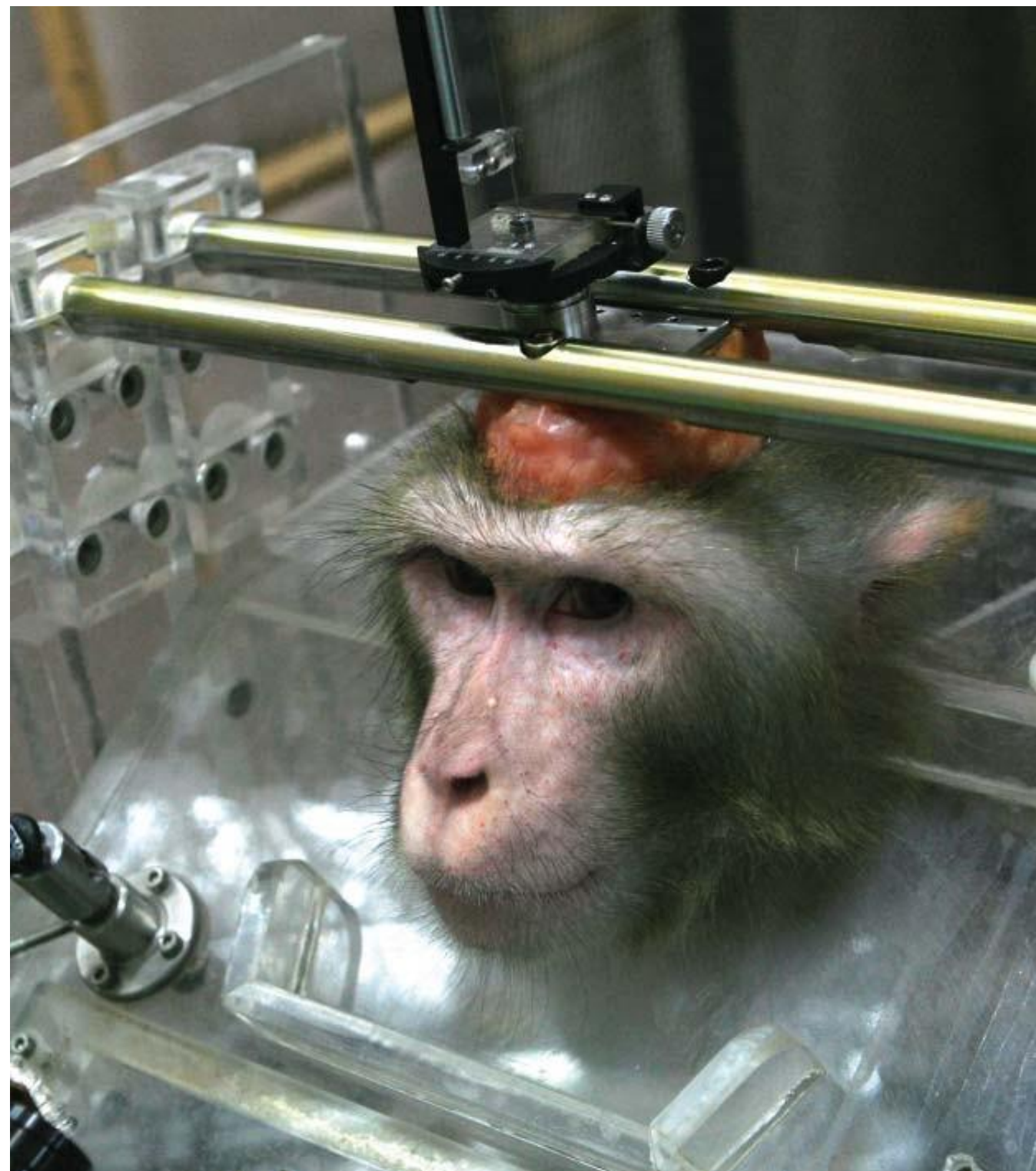
Diffusion imaging



A.G. Martinos Center

Brain states

Single cells



Cellular
resolution

MEG



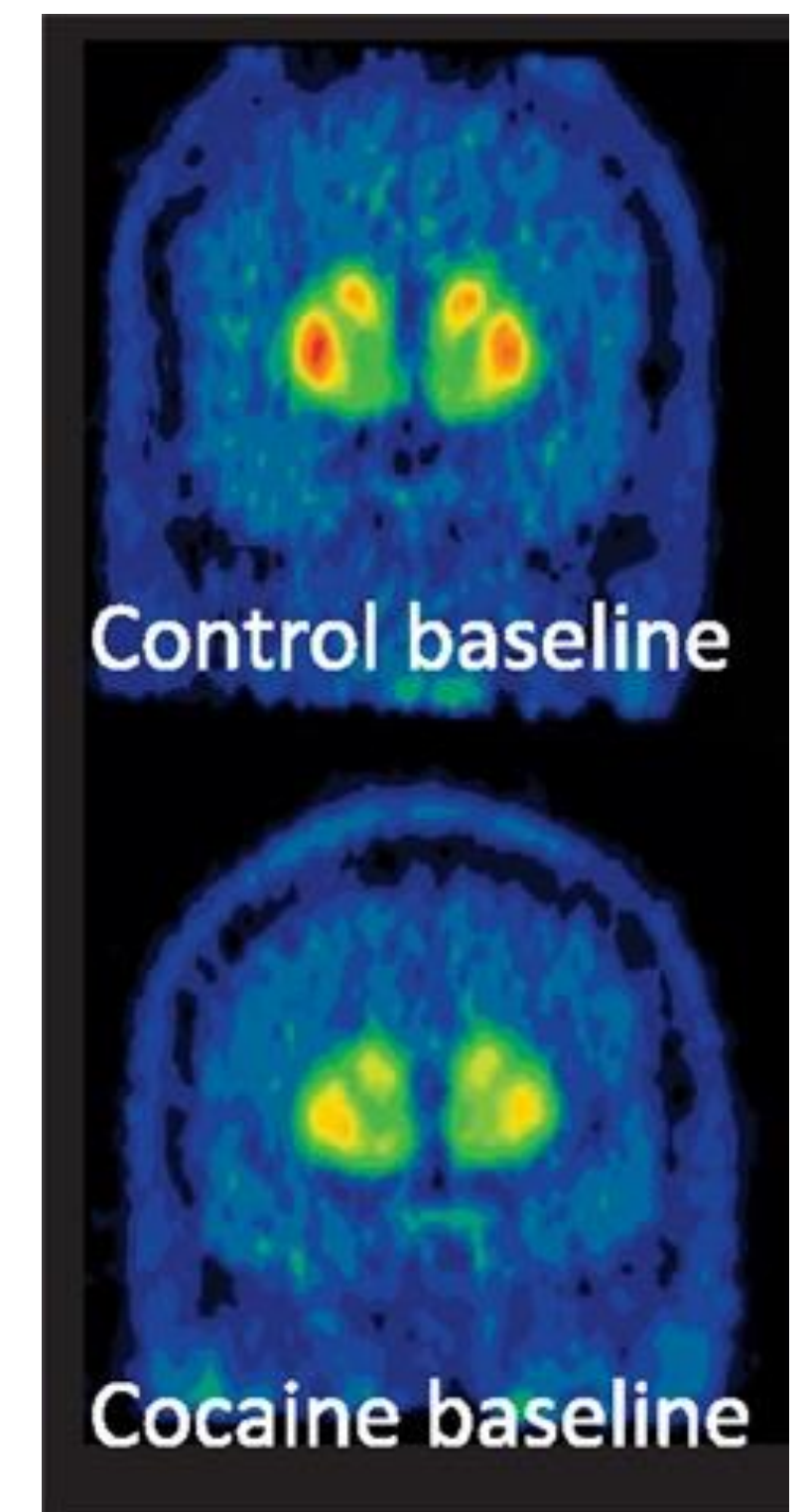
Temporal resolution

fMRI



Spatial
resolution

PET



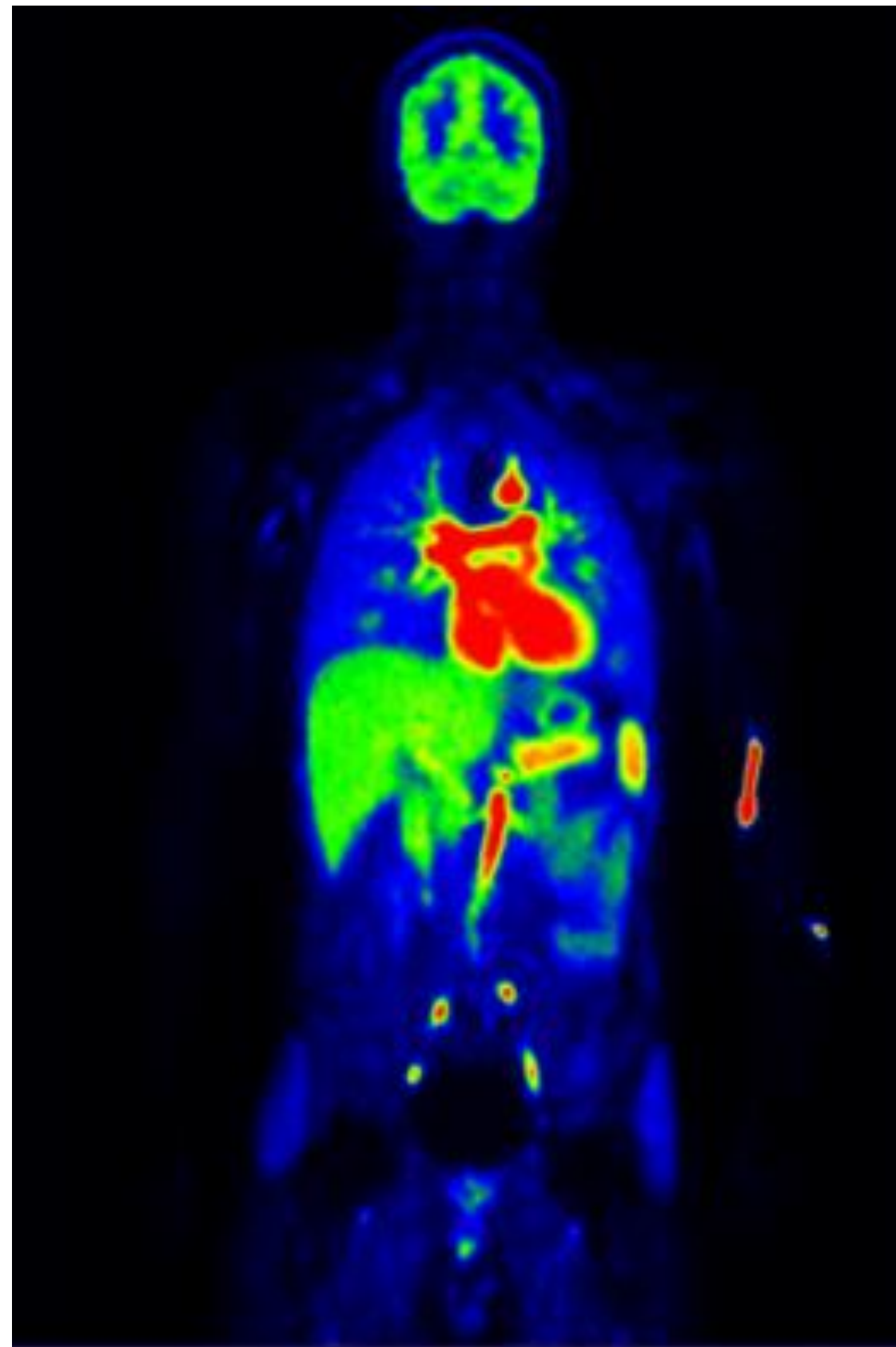
Molecular
resolution

Whole-body biological circuits

CT



PET



PET-CT

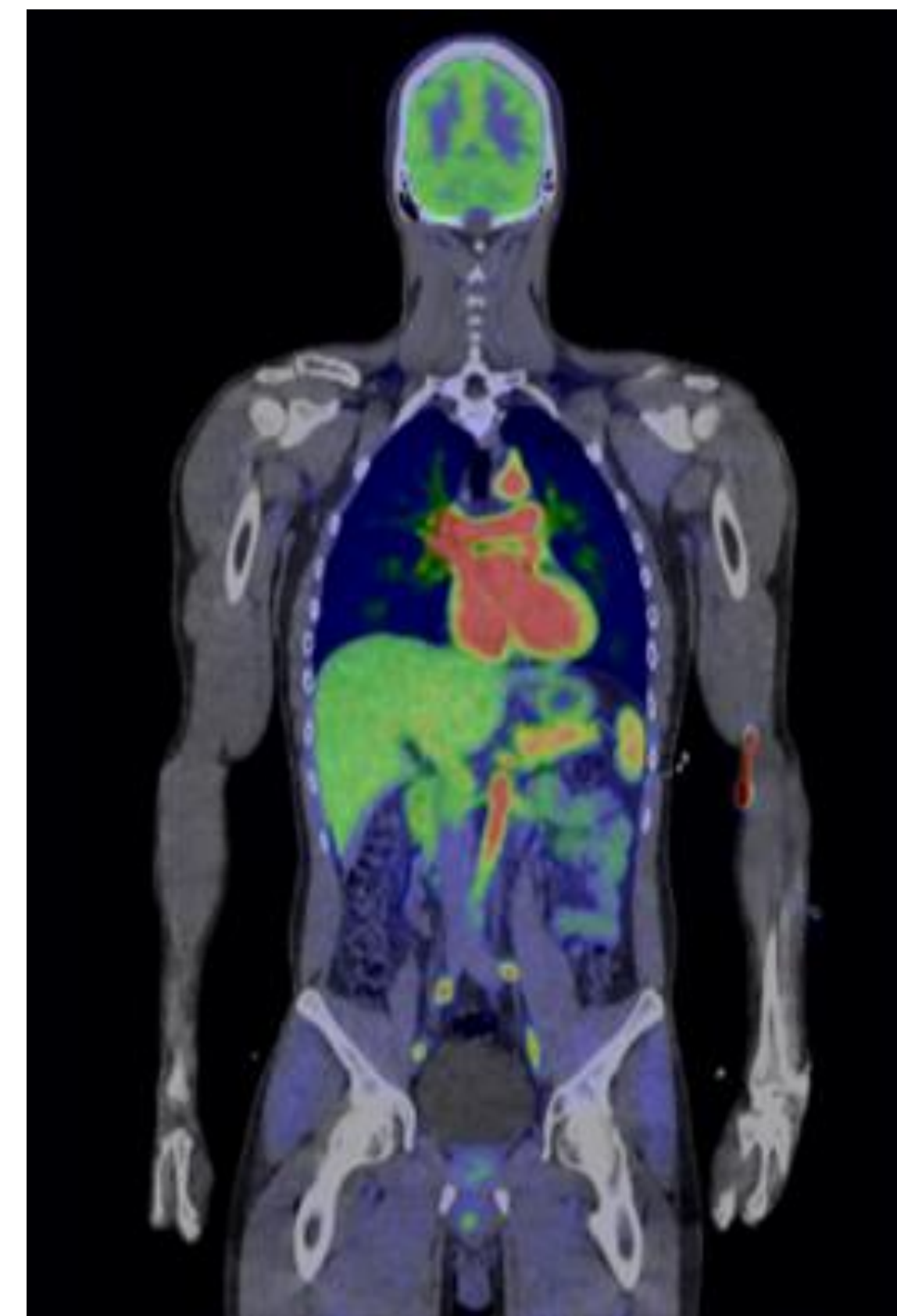
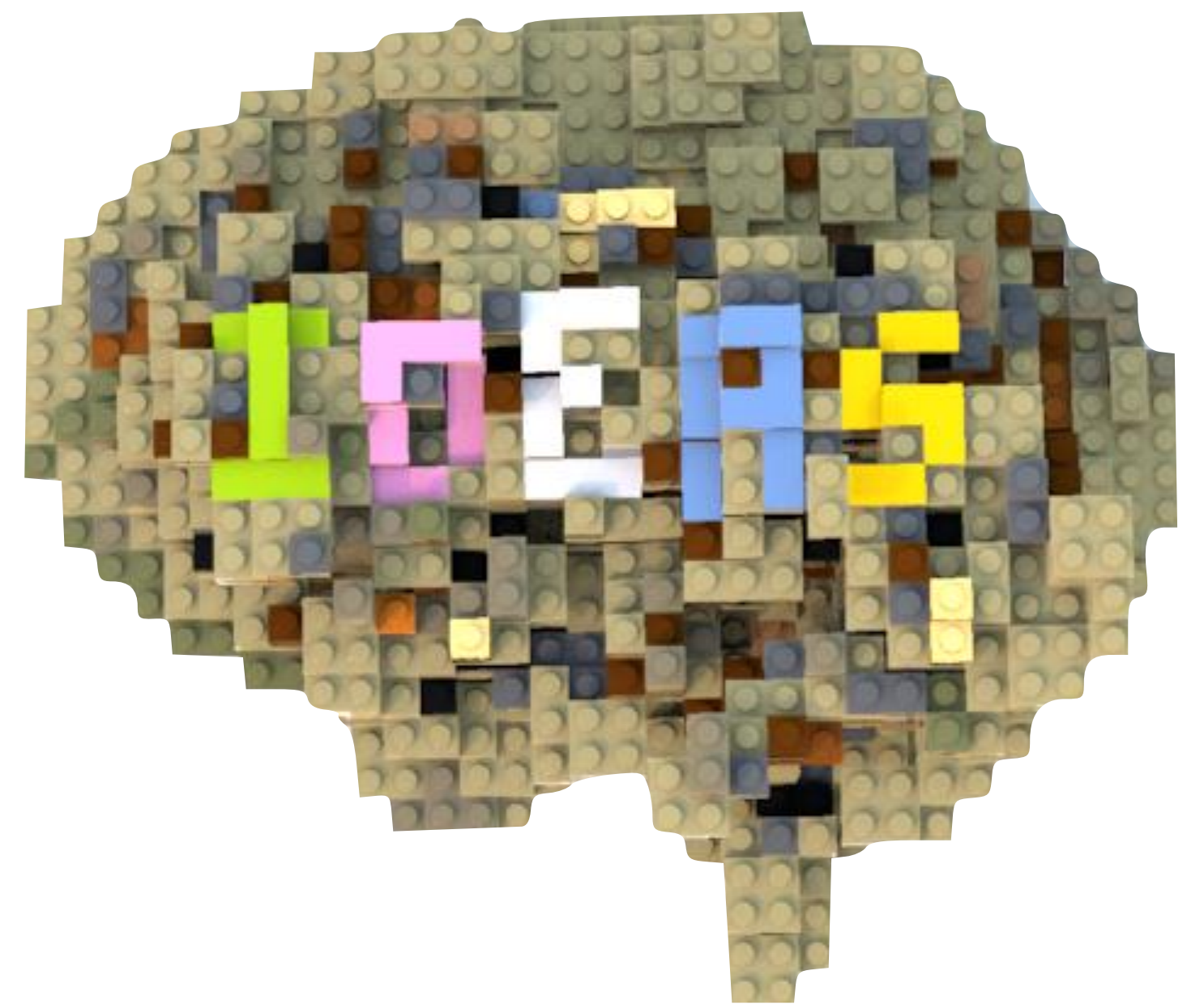
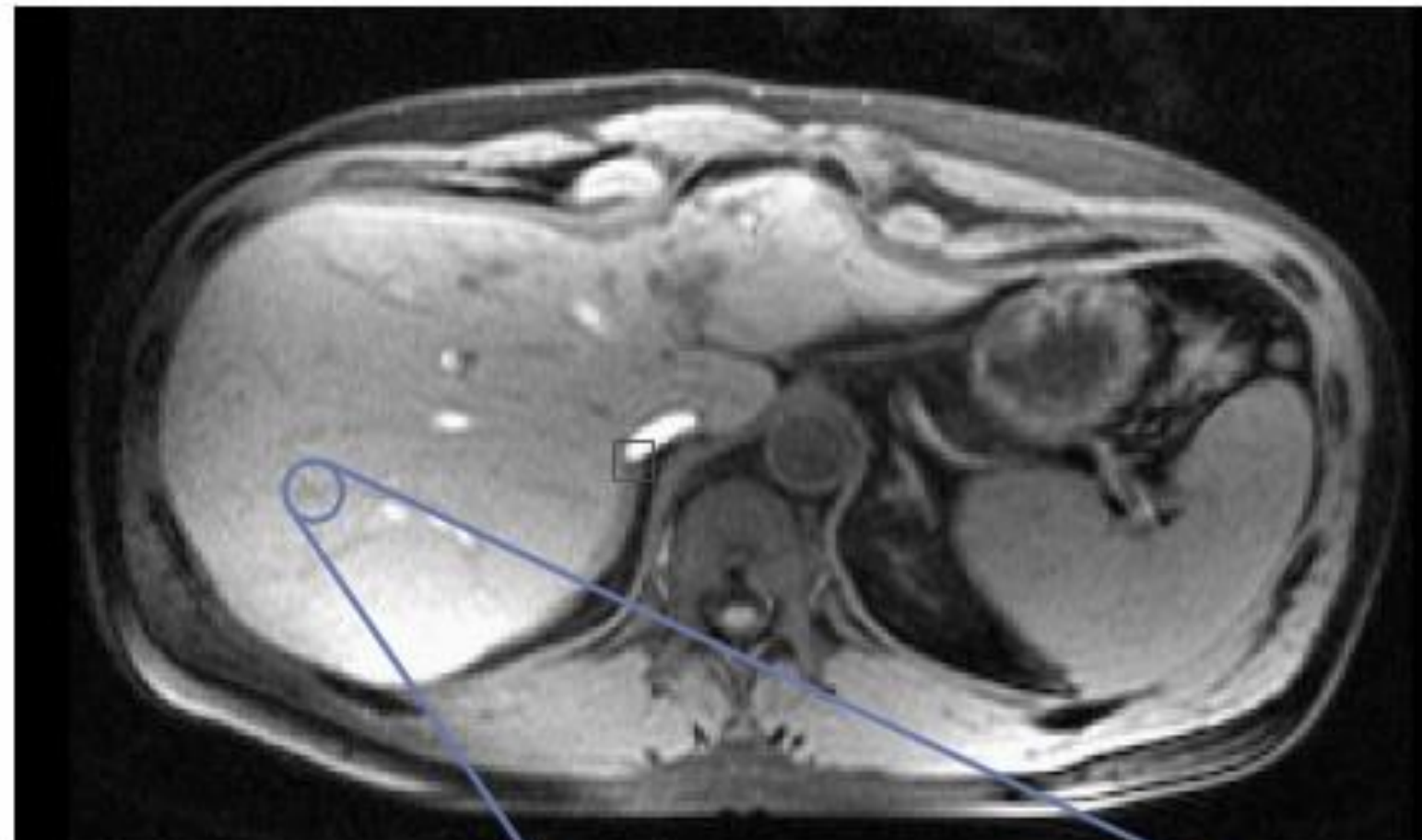


Image courtesy of Mueez U-Din 7 Turku PET Centre

Imaging: seeing the invisible



Tomographic imaging

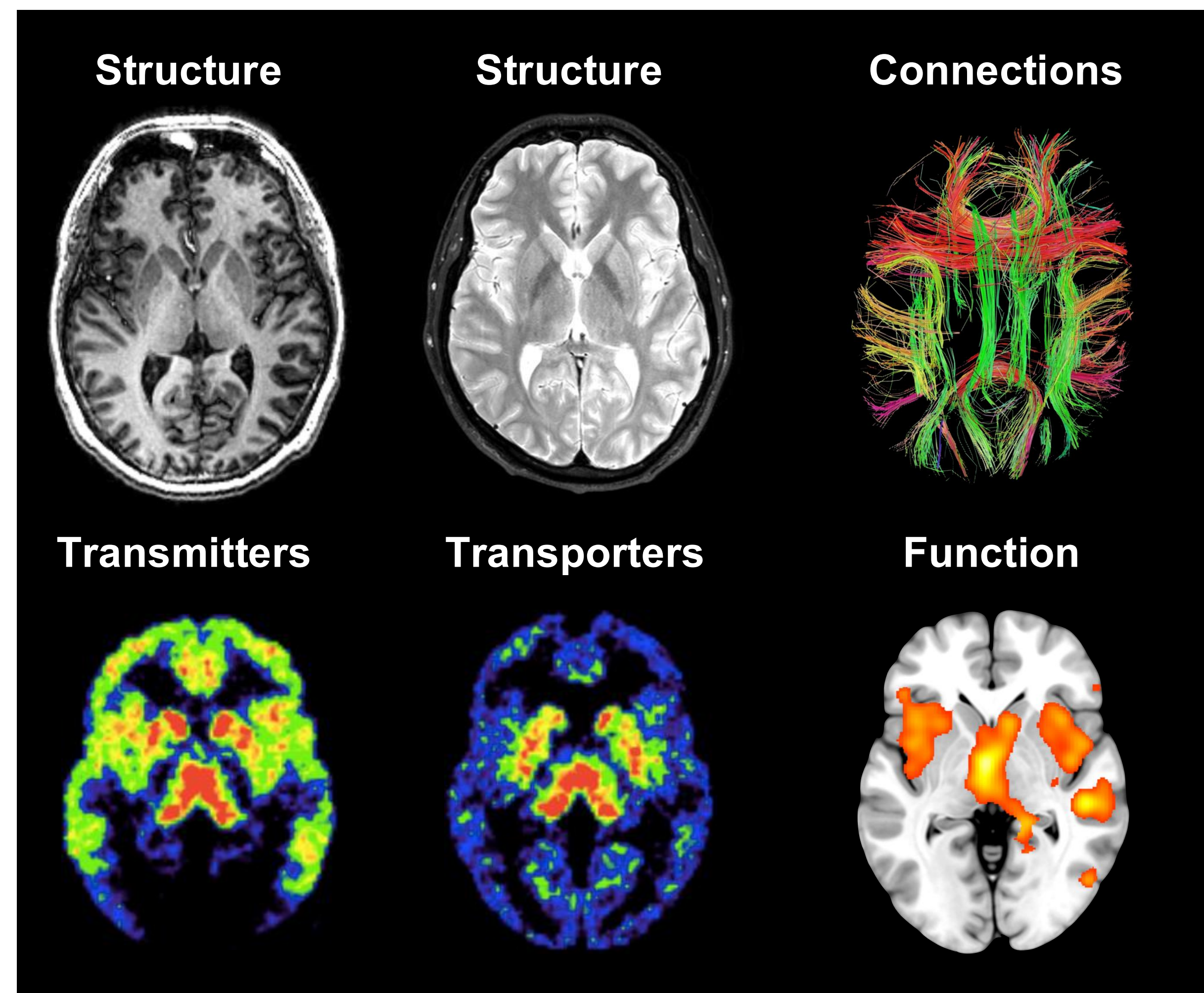
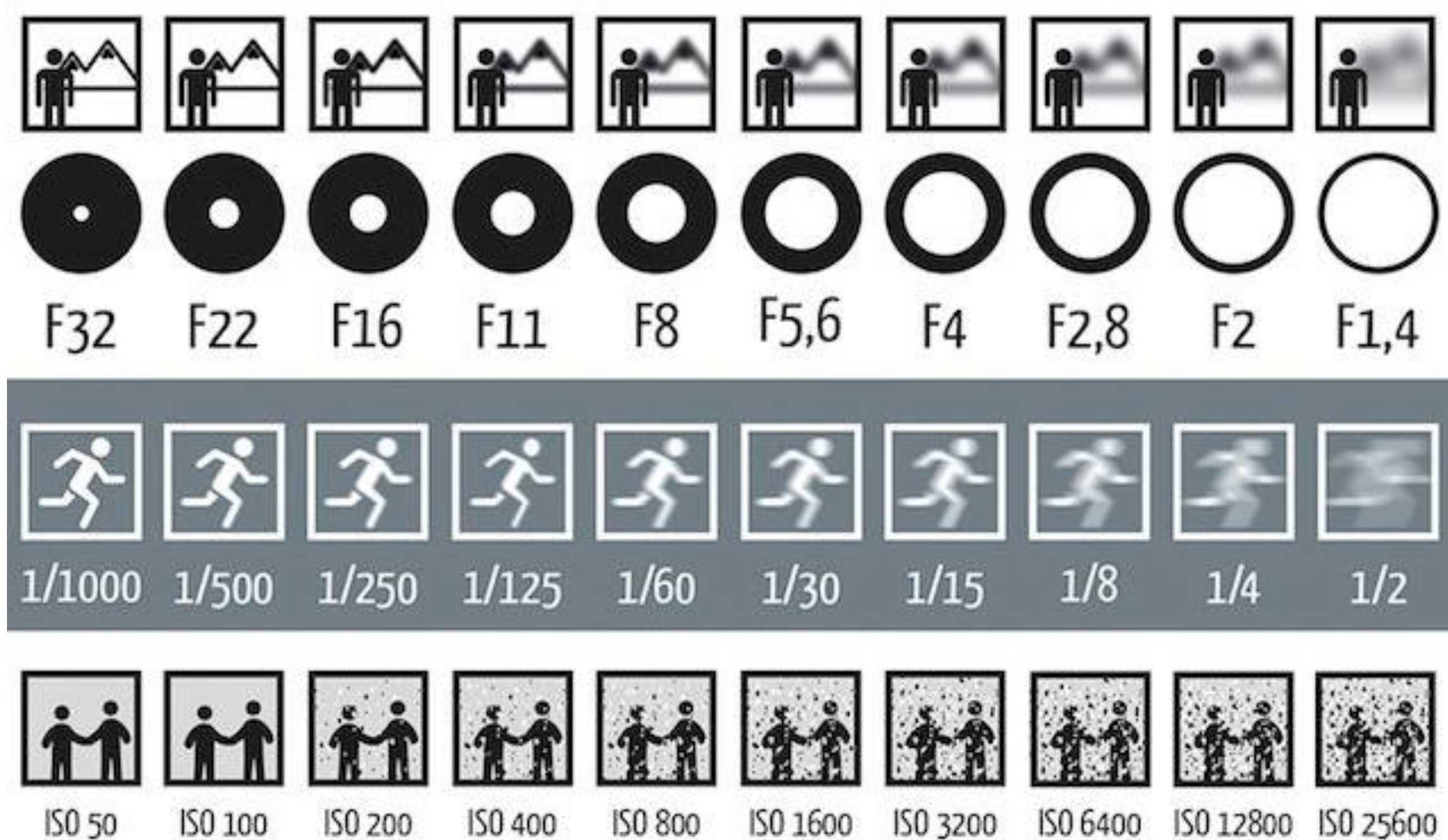


(a)

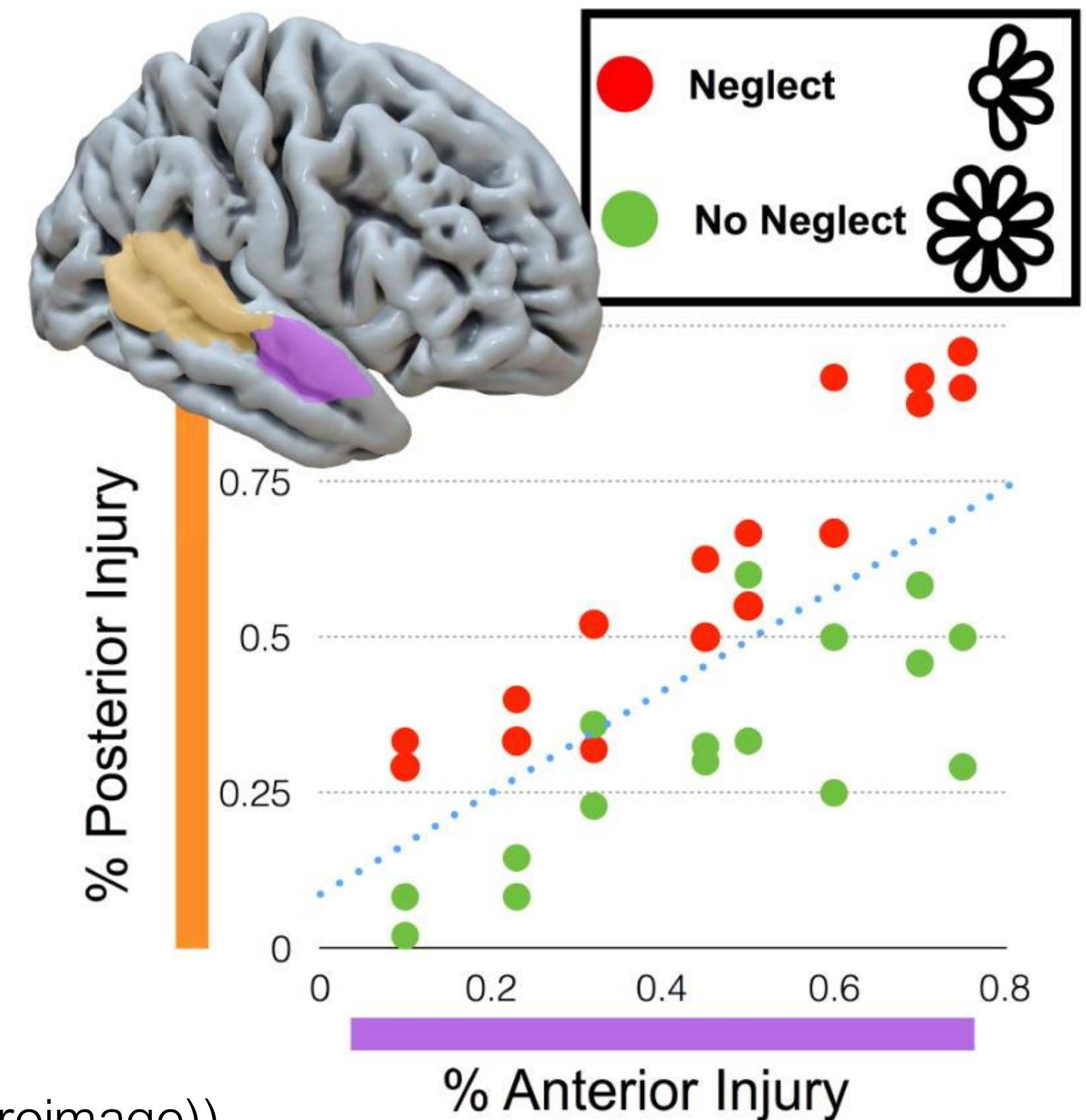
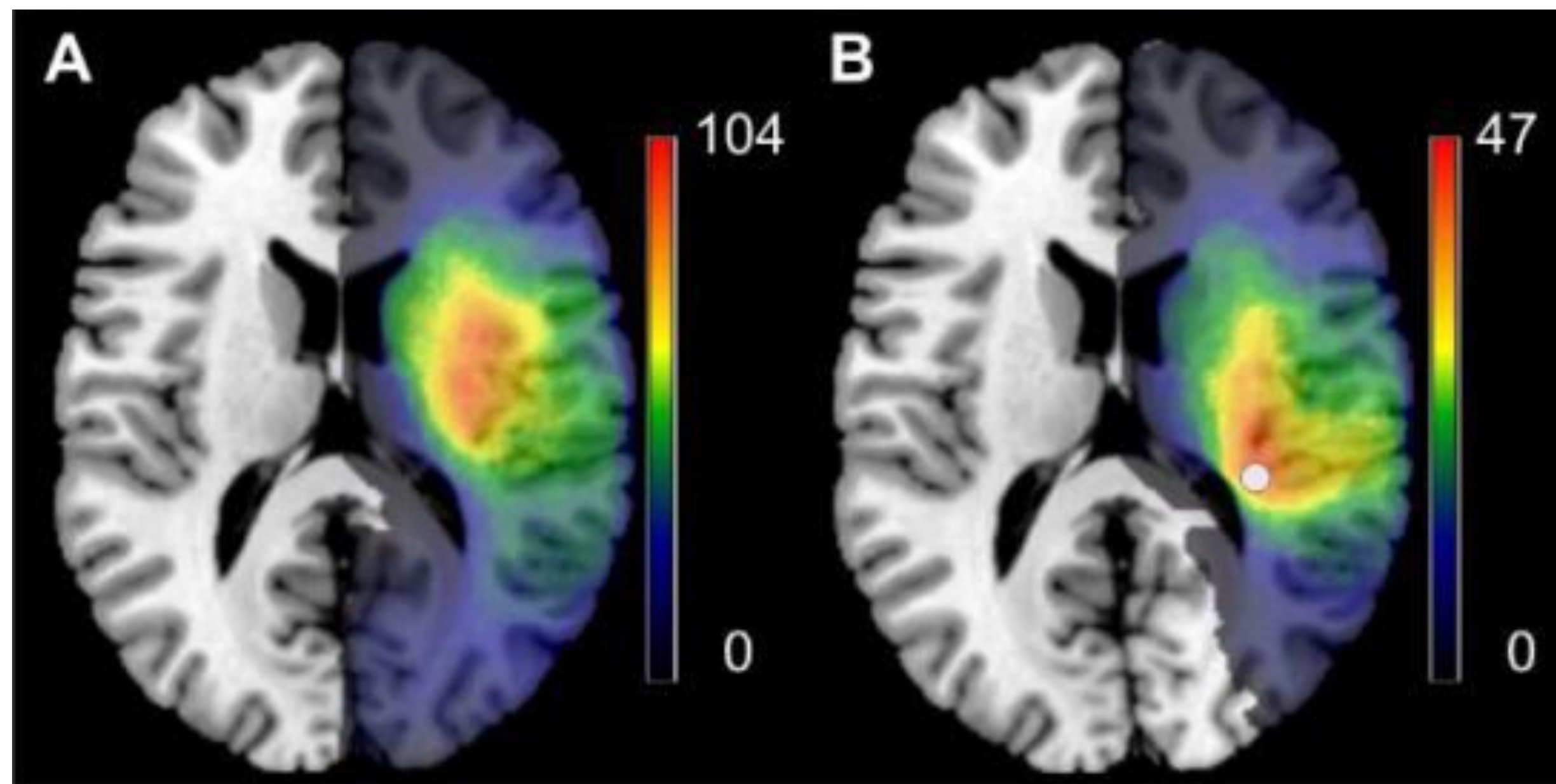


(b)

Same target - multiple contrasts



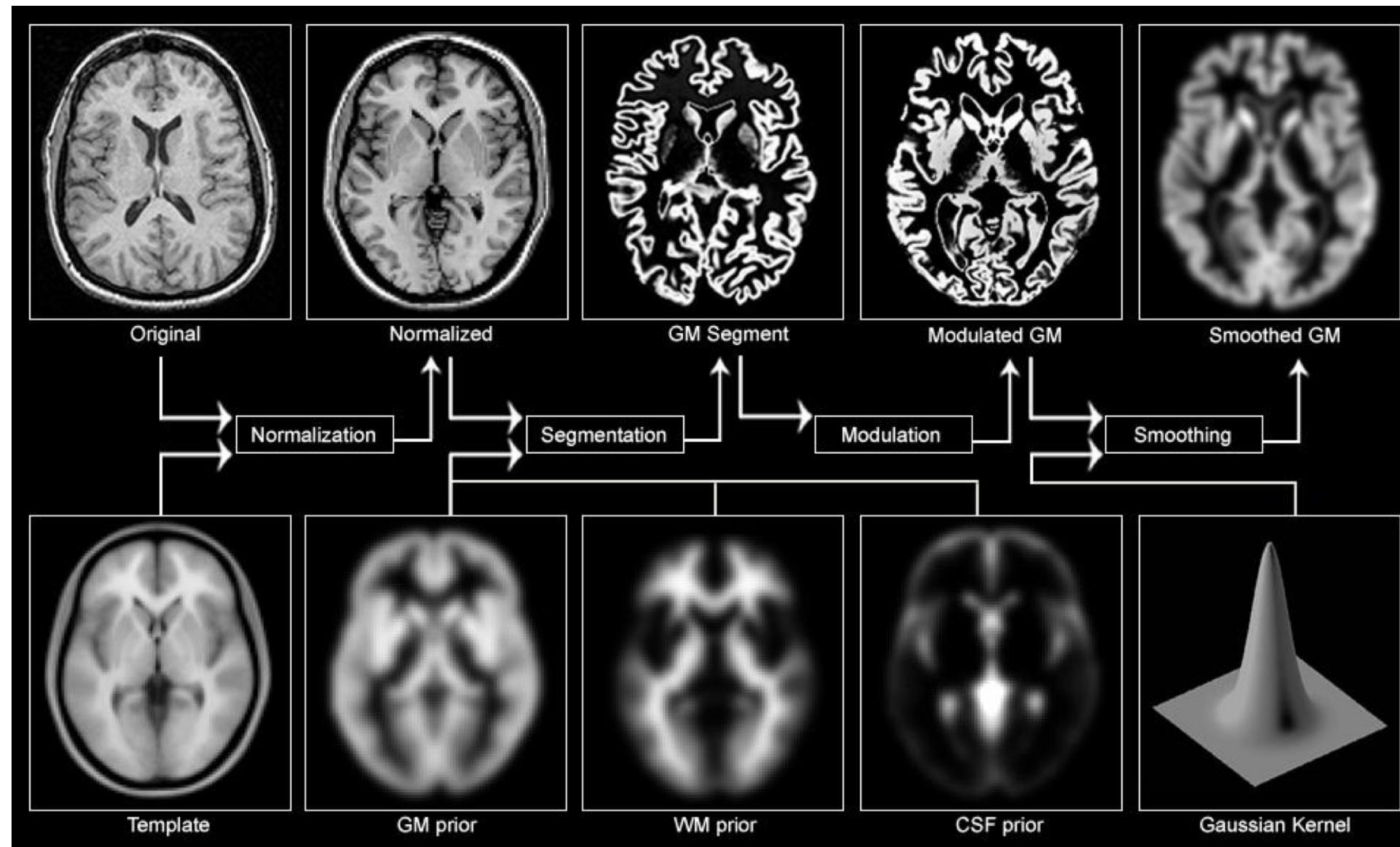
Lesion mapping



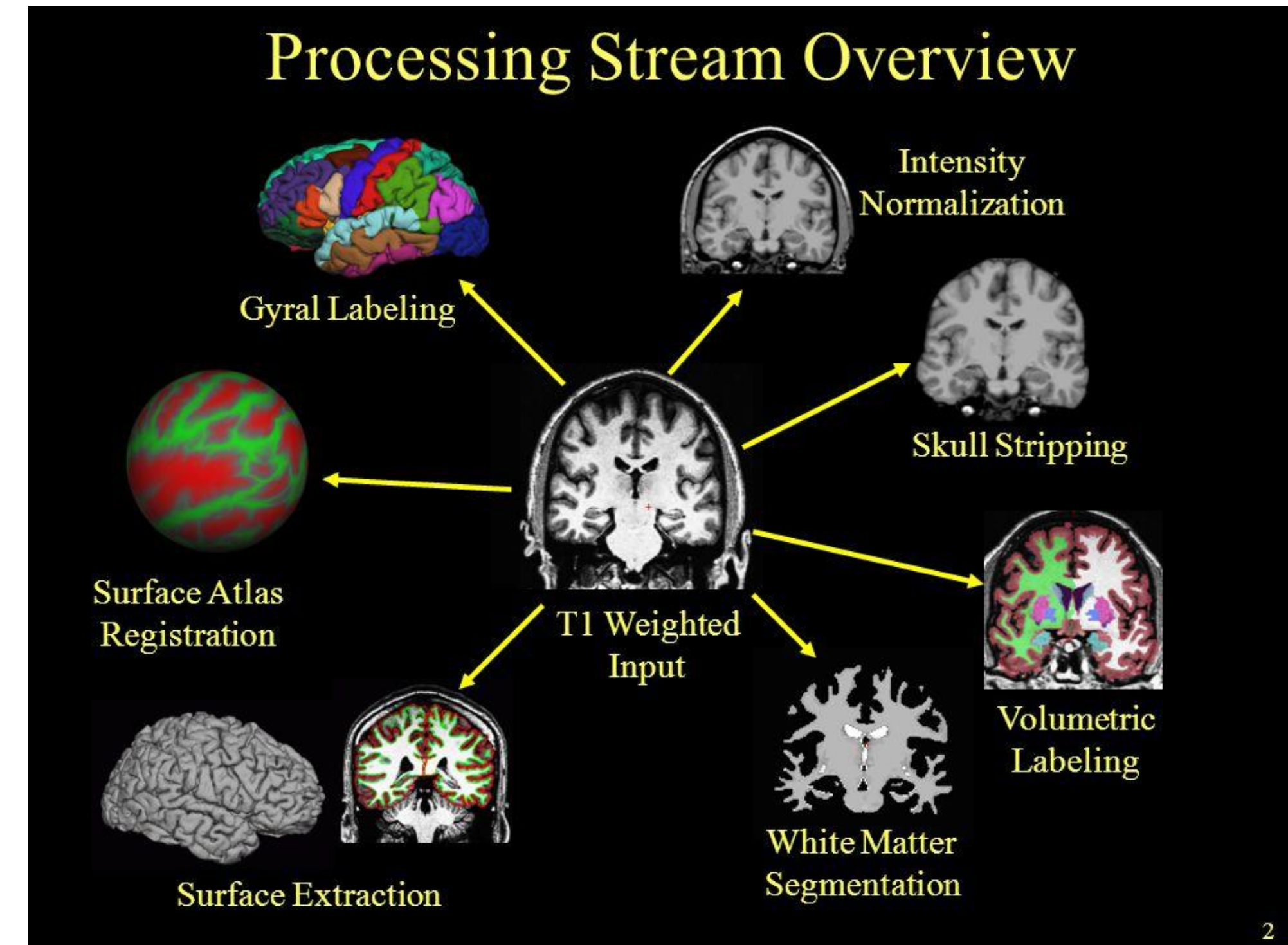
Karnath et al (2018 Neuroimage))

Morphometric analysis

Voxel-based morphometry (VBM)

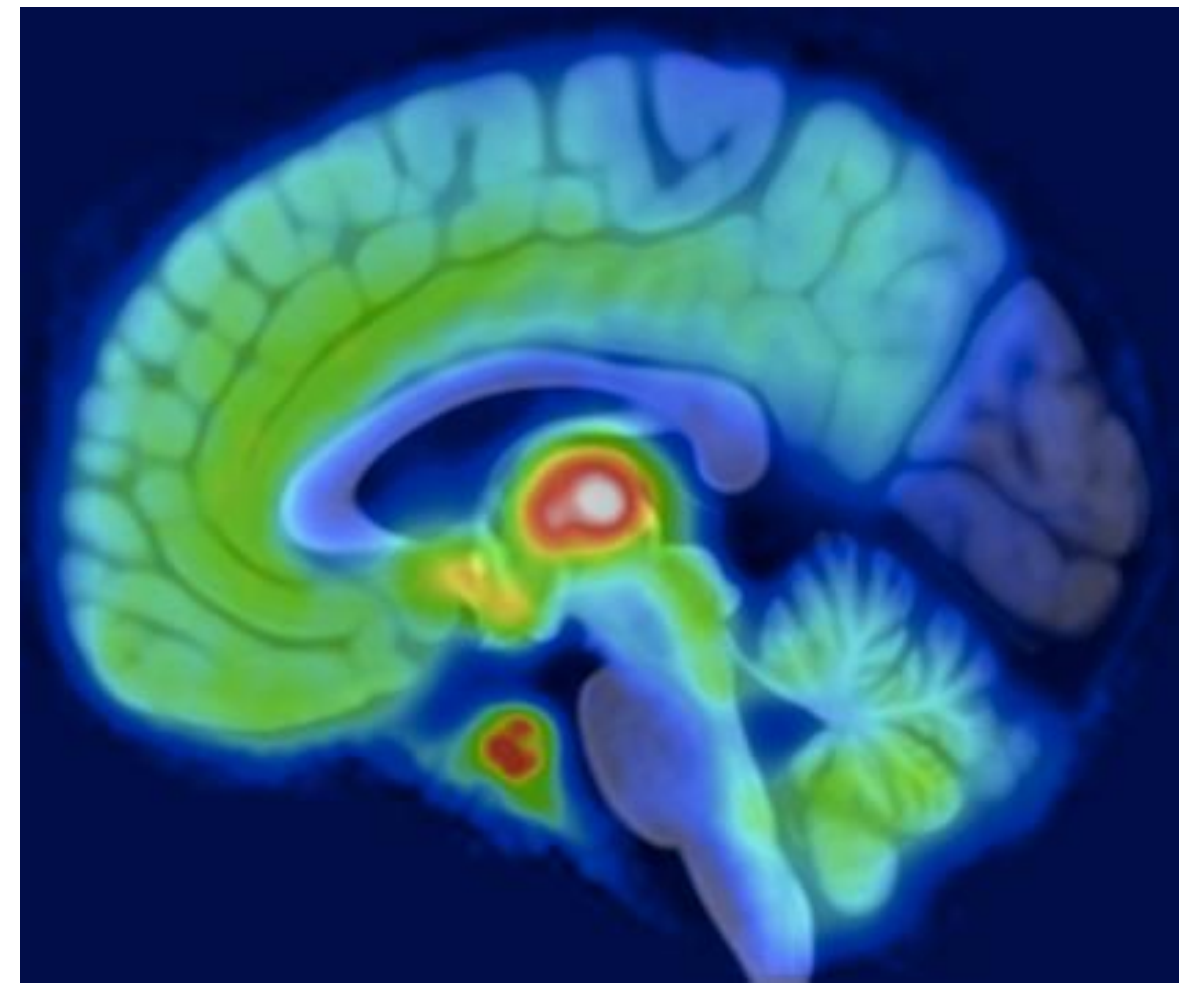


Surface analysis (FreeSurfer)



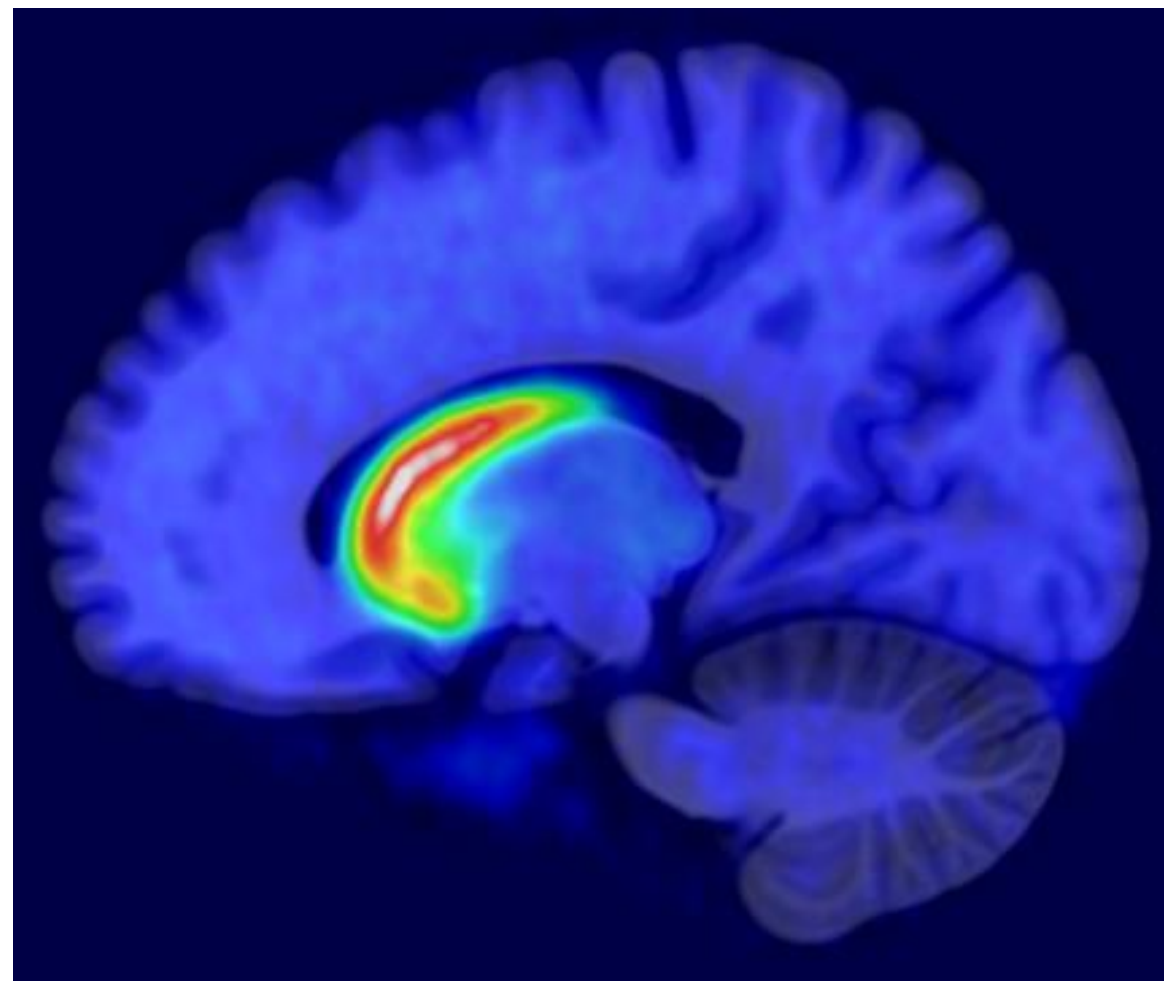
Positron emission tomography

Mu-opioid receptors



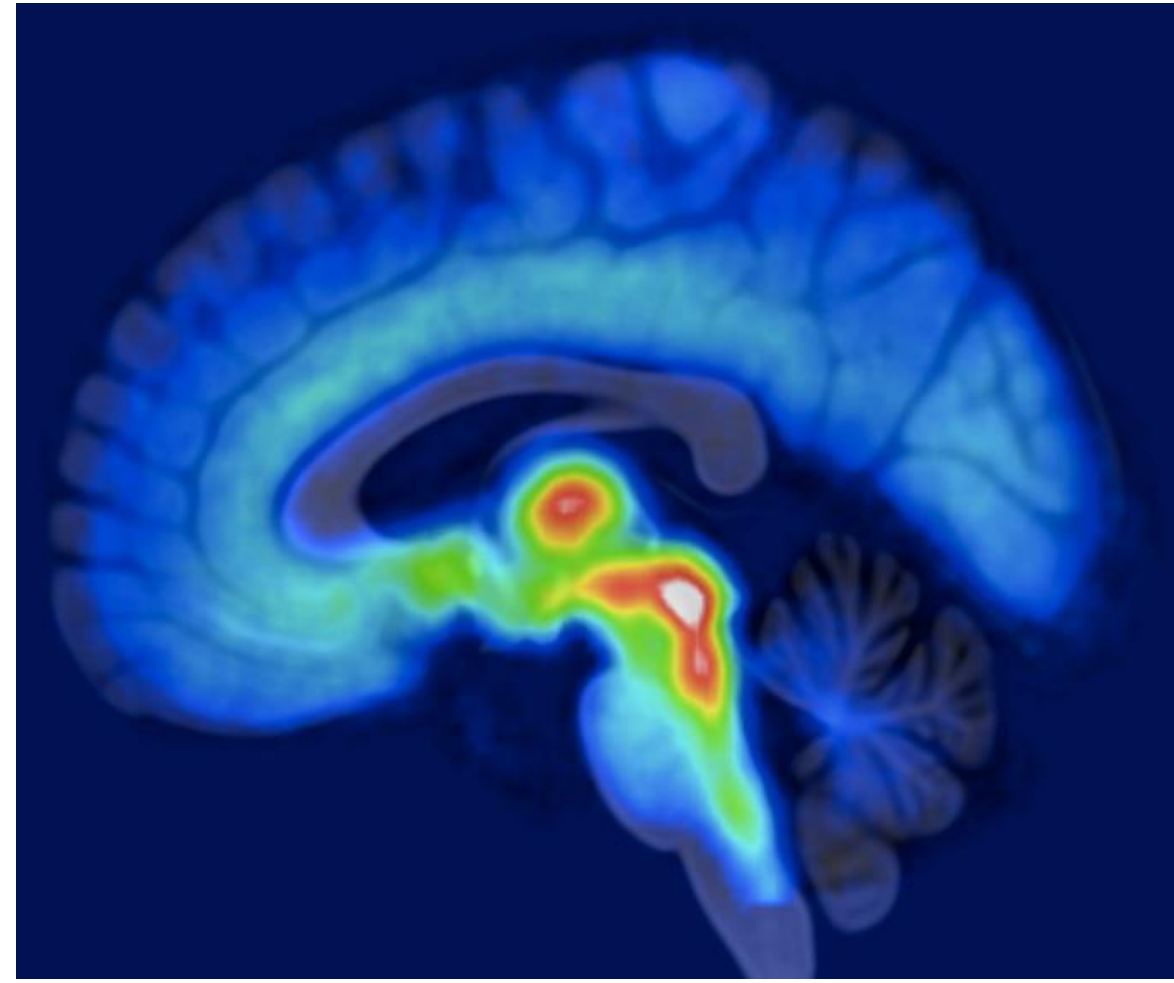
[¹¹C]carfentanil

Type 2 dopamine
receptors



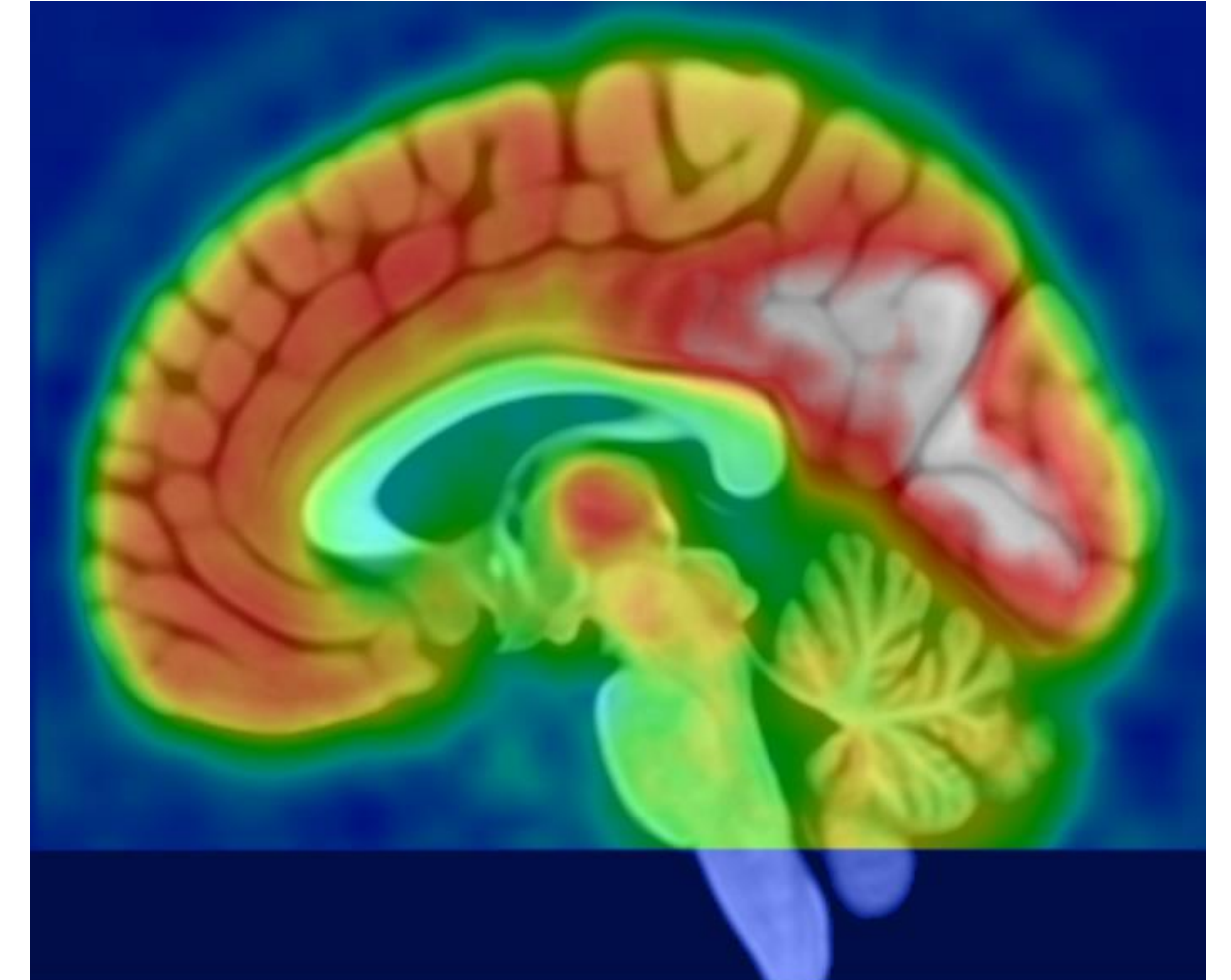
[¹¹C]raclopride

Serotonin
transporters



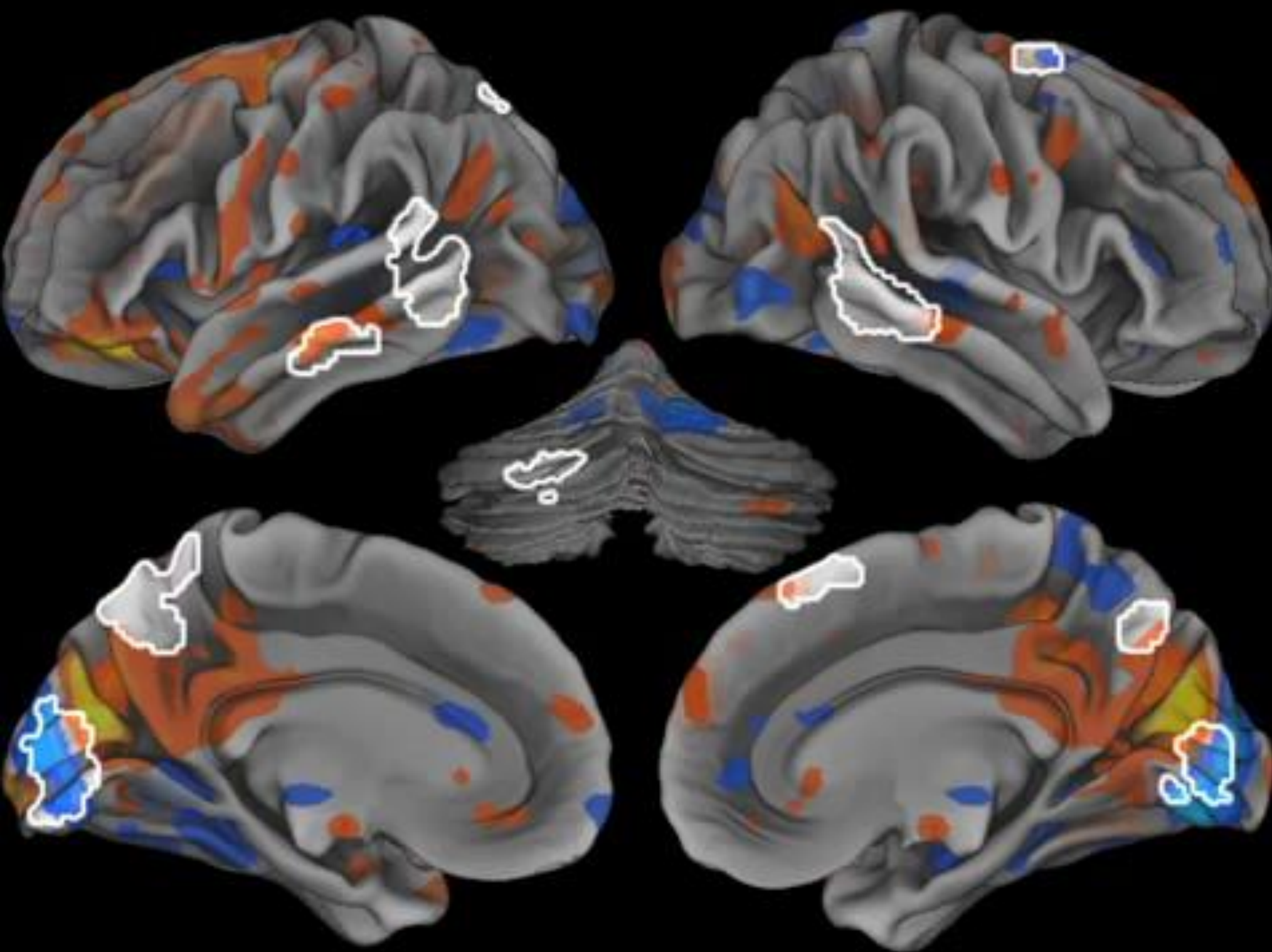
[¹¹C]MADAM

Glucose metabolism



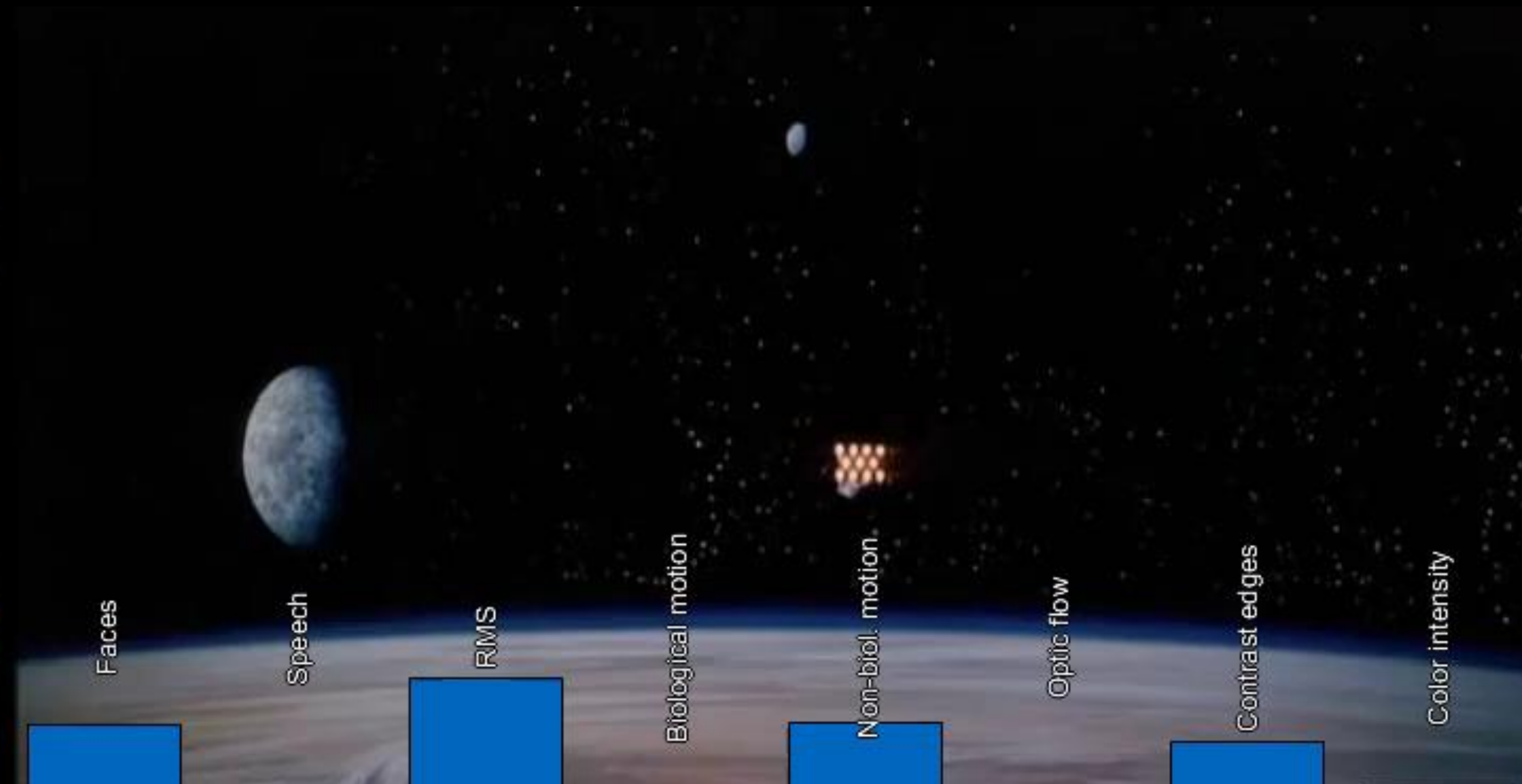
[¹⁸F]FDG

Brain activity



■ Activation ■ Deactivation

Sensory stimulus (Star Wars Episode IV)



Movie features