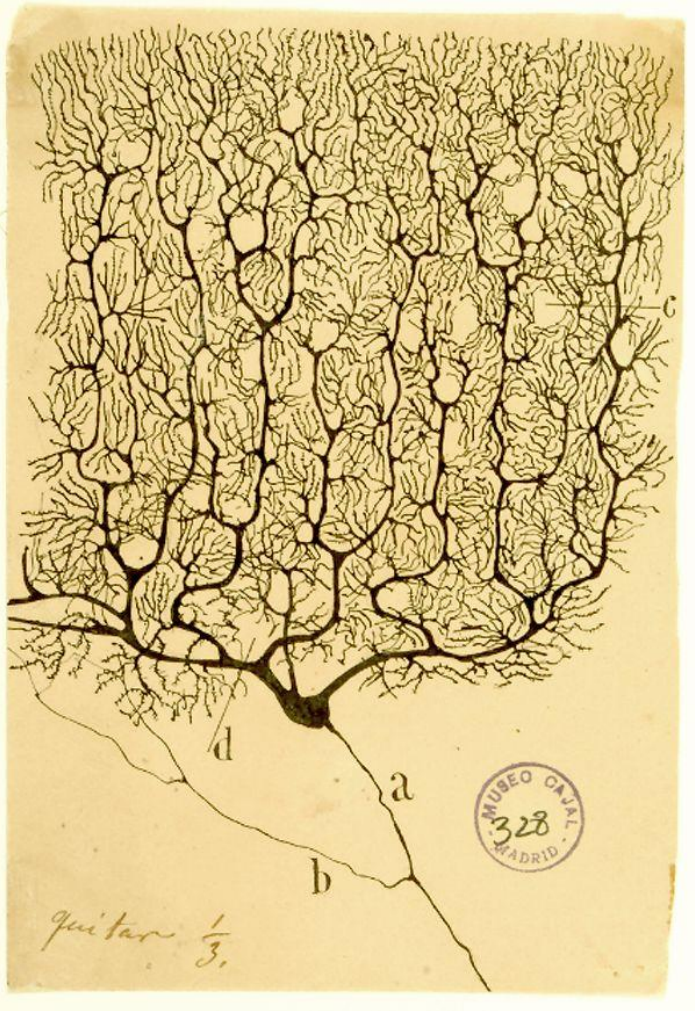
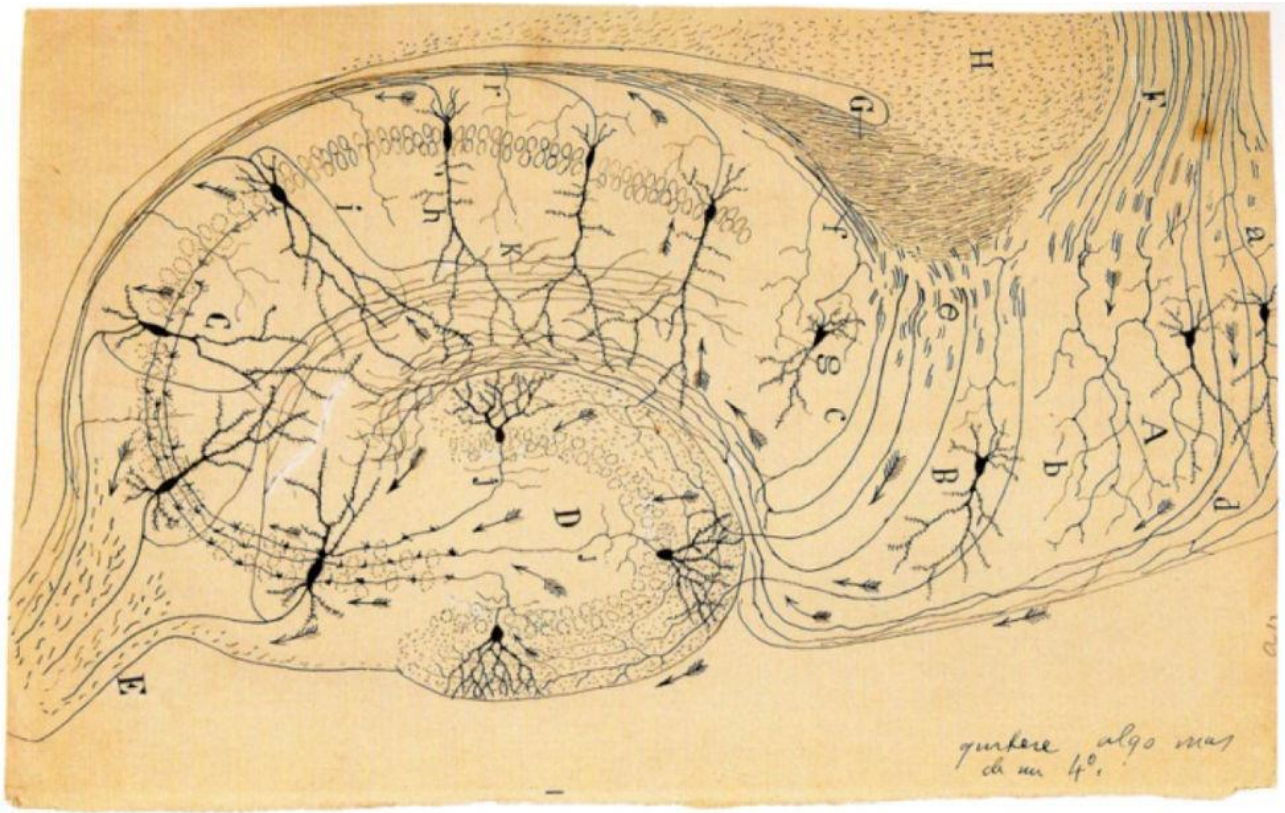
Brain and Art

Guiomar Niso

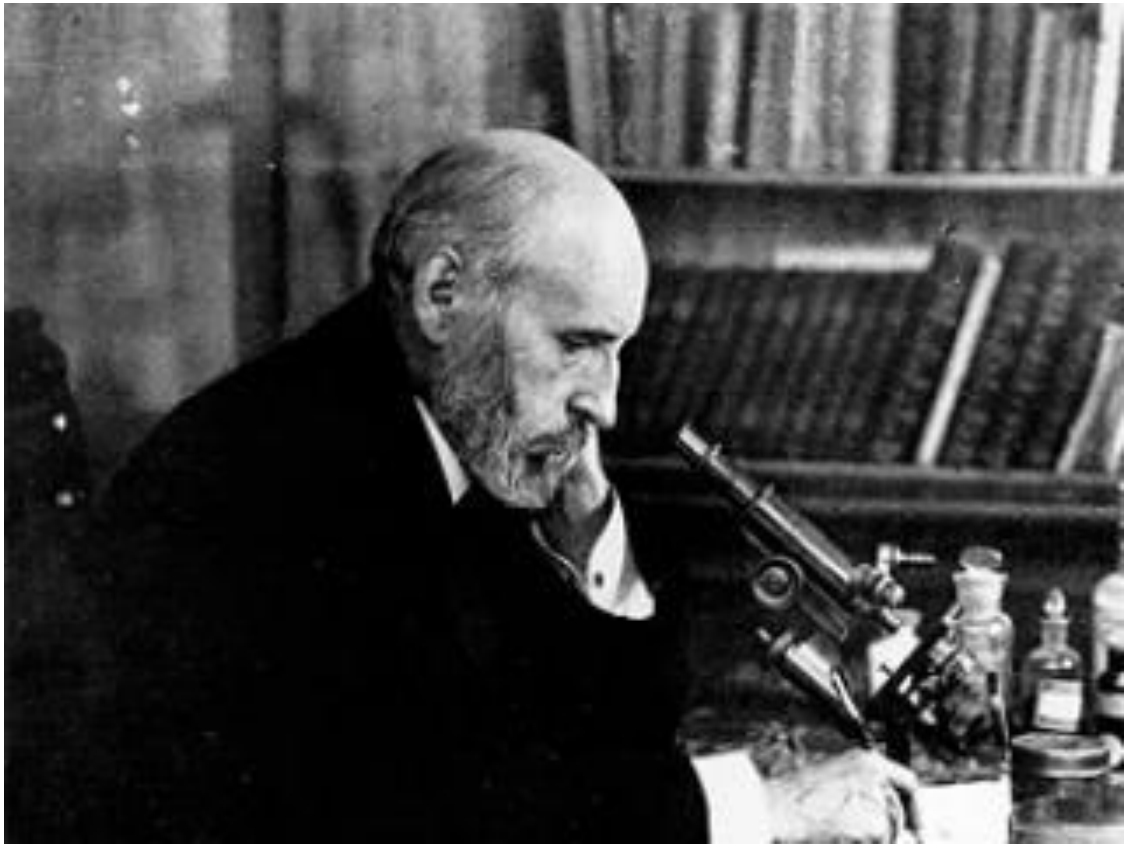
December 15, 2017

Santiago Ramón y Cajal



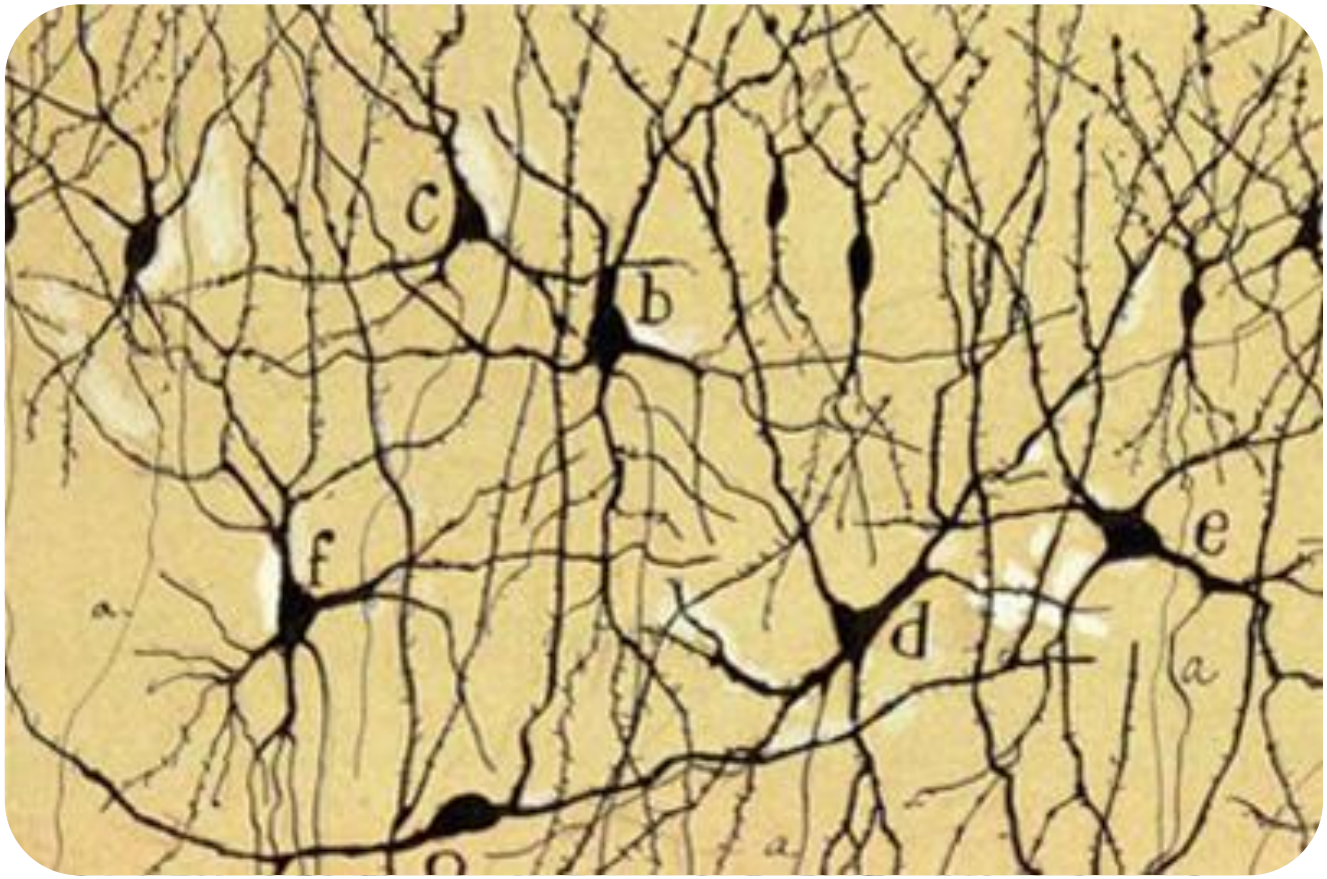


Santiago Ramón y Cajal



Premio Nobel
1906

Human Brain



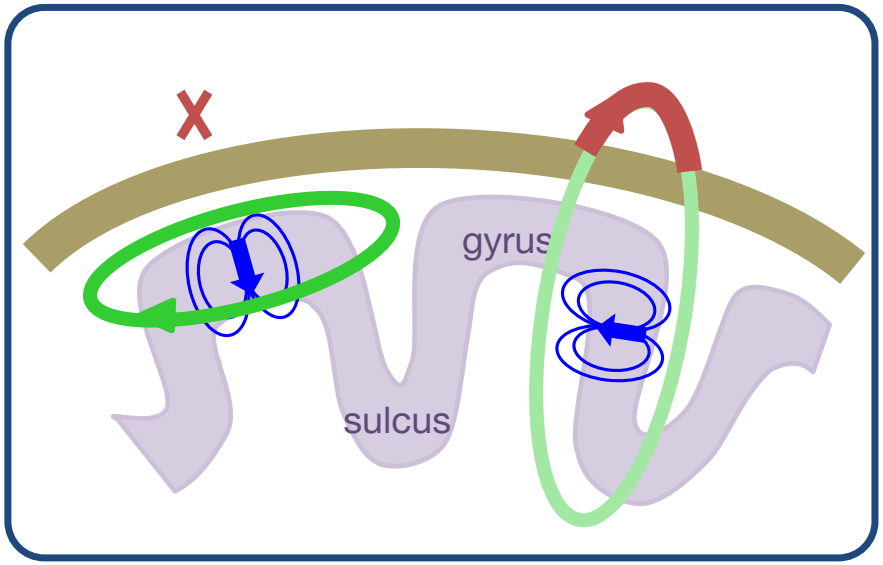
In the brain
~86.000.000.000
interconnected neurons

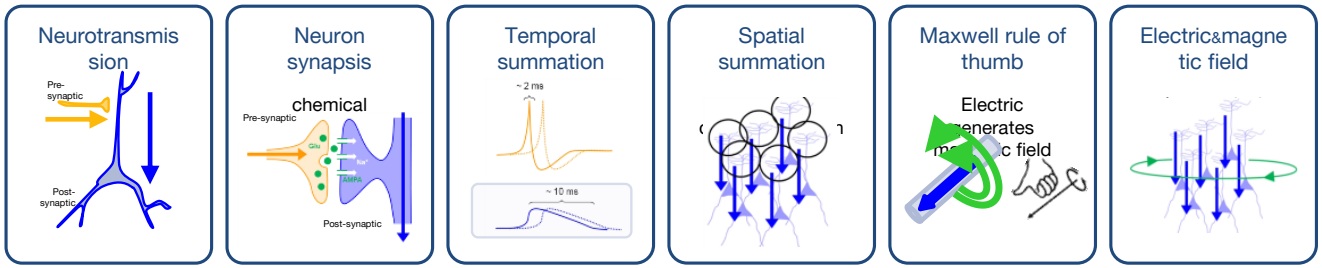
each with
1000 synaptic connections

White and Grey Matter

Brain electric and magnetic fields

- Scalp
- Cortex
- Current dipole
- Magnetic field
- Magnetic field outside



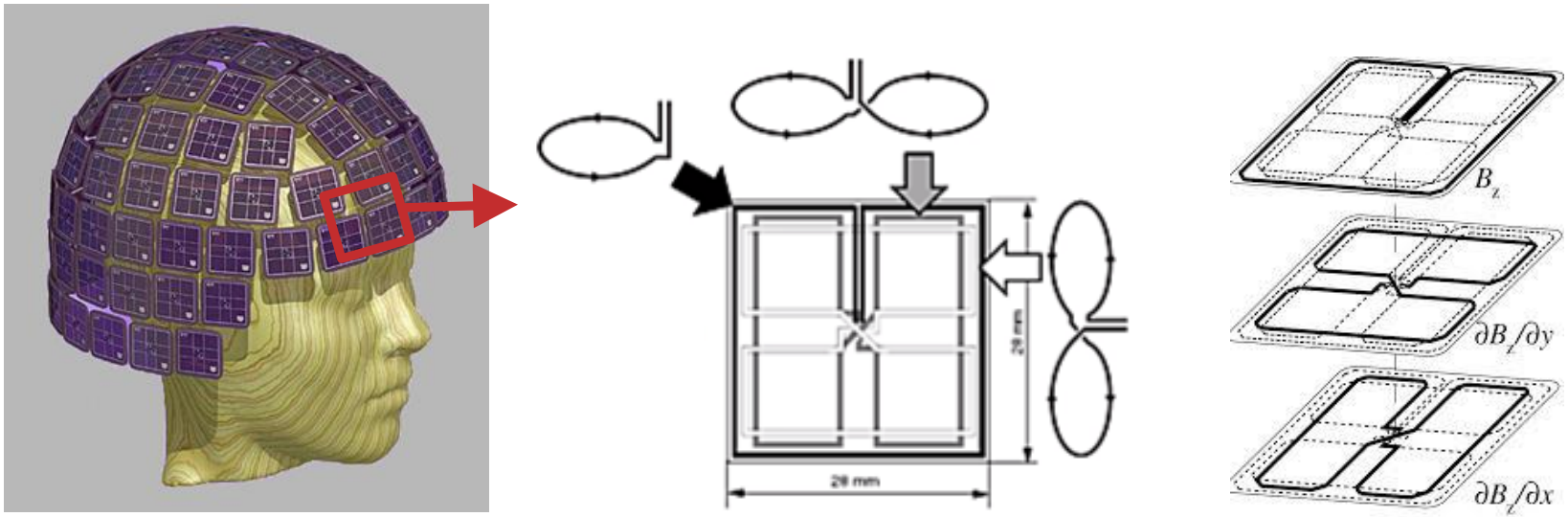


(Niso et al. 2013, modified from Fieldtrip video 2013; Cohen 2009)

Sensors

Elekta Neuromag

306 channels (102 magnetometers, 204 planar gradiometers)

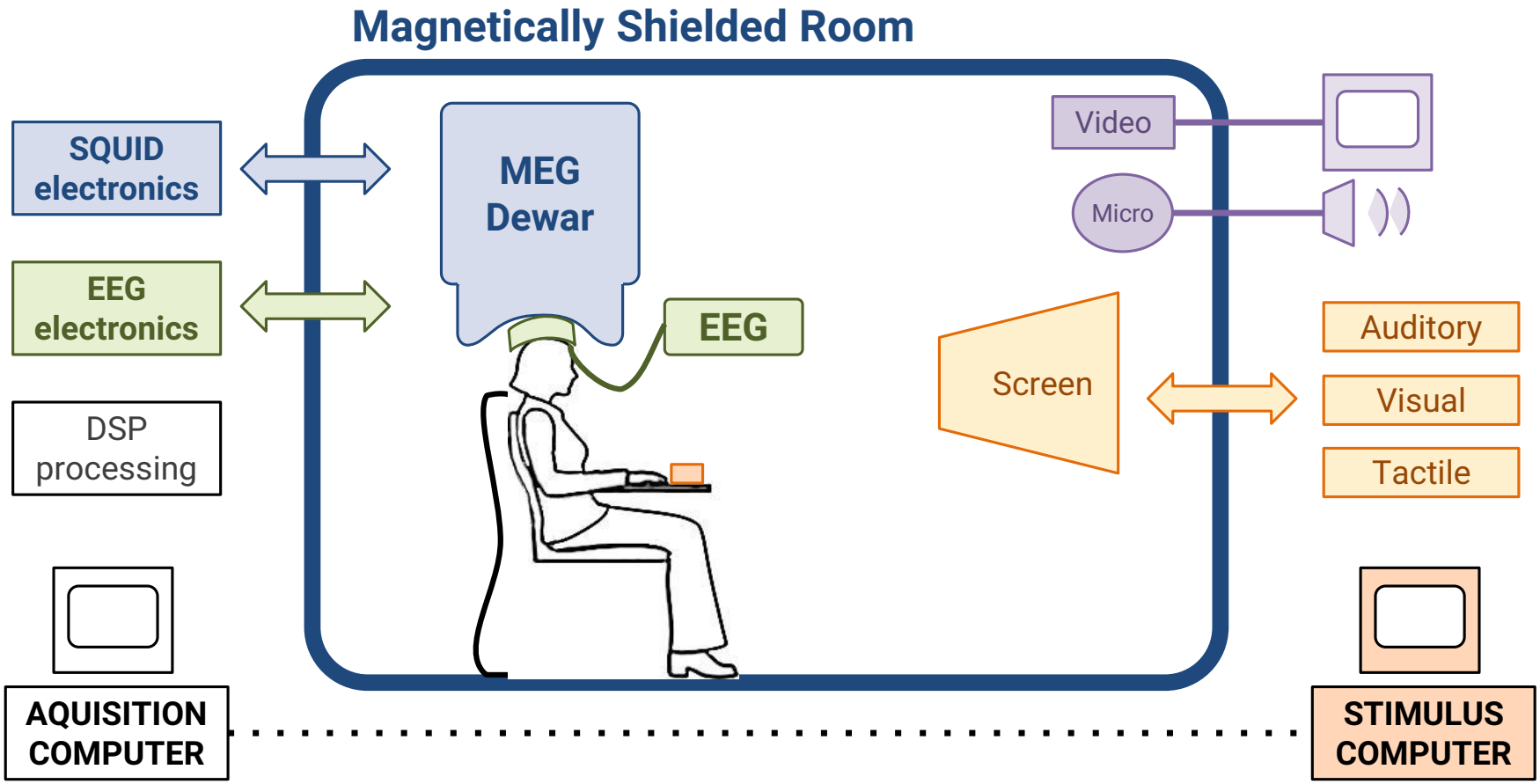


Magnetic Fields

MAGNETIC FIELDS

- 1 ~Tesla MRI systems
- 10^{-3} ~mili Tesla Typical refrigerator magnet
- 10^{-5} ~micro Tesla Earth's magnetic field
- **10^{-12} ~pico Tesla Human brain**

Magnetoencephalography (MEG)

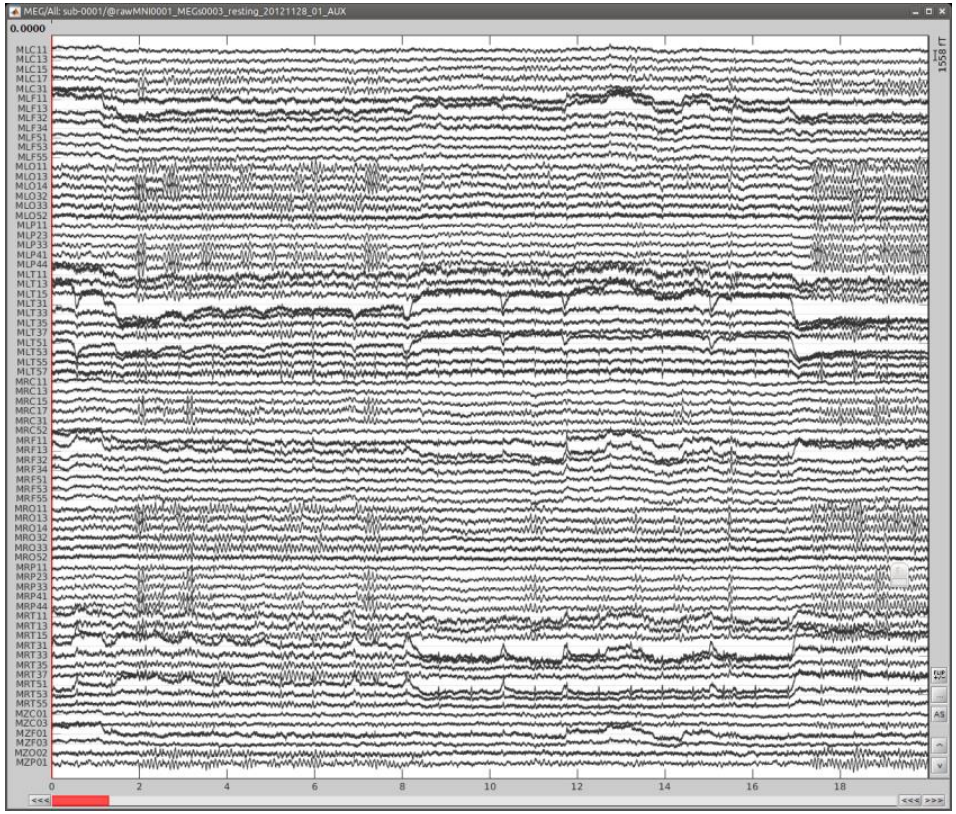


(Niso et al. 2013)

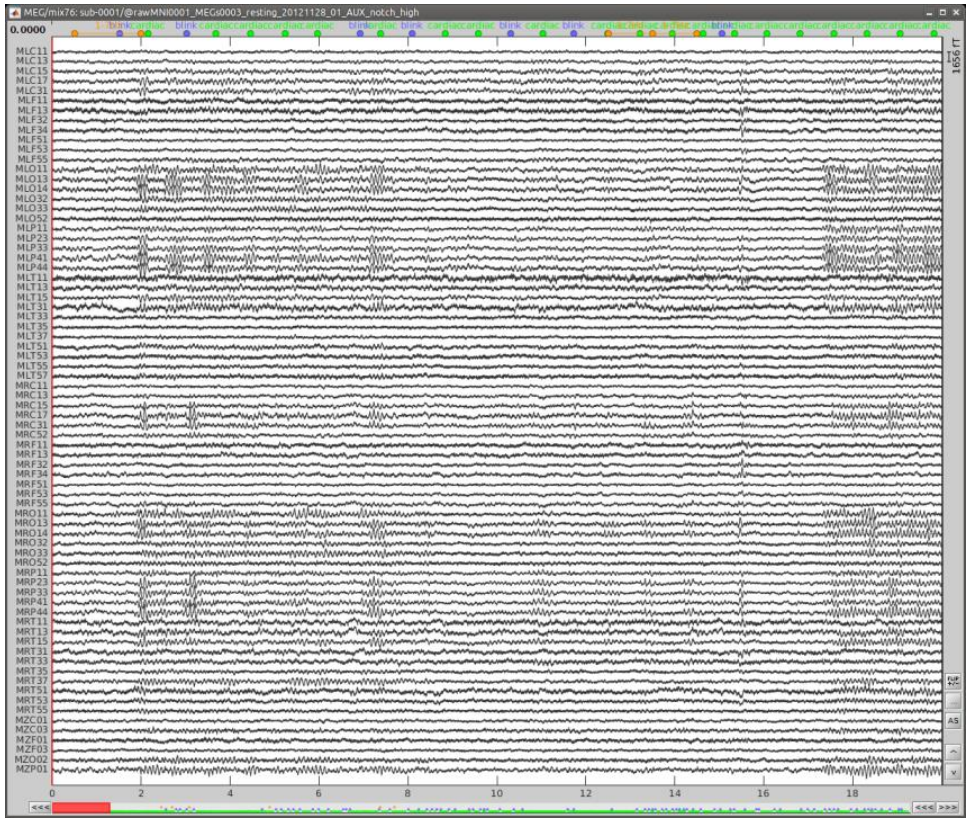
Center for Biomedical Technology (CTB)

Preprocessing

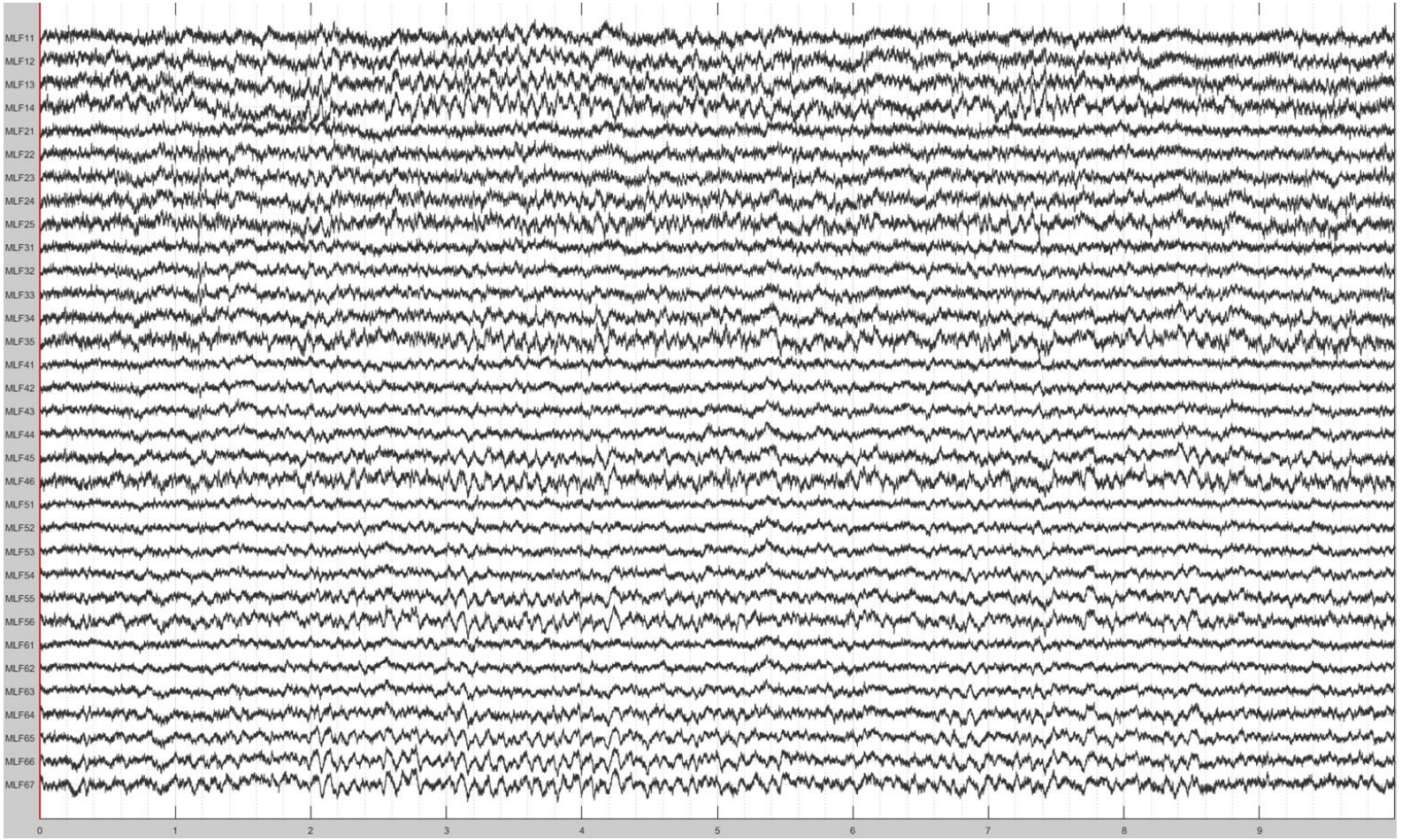
Raw MEG



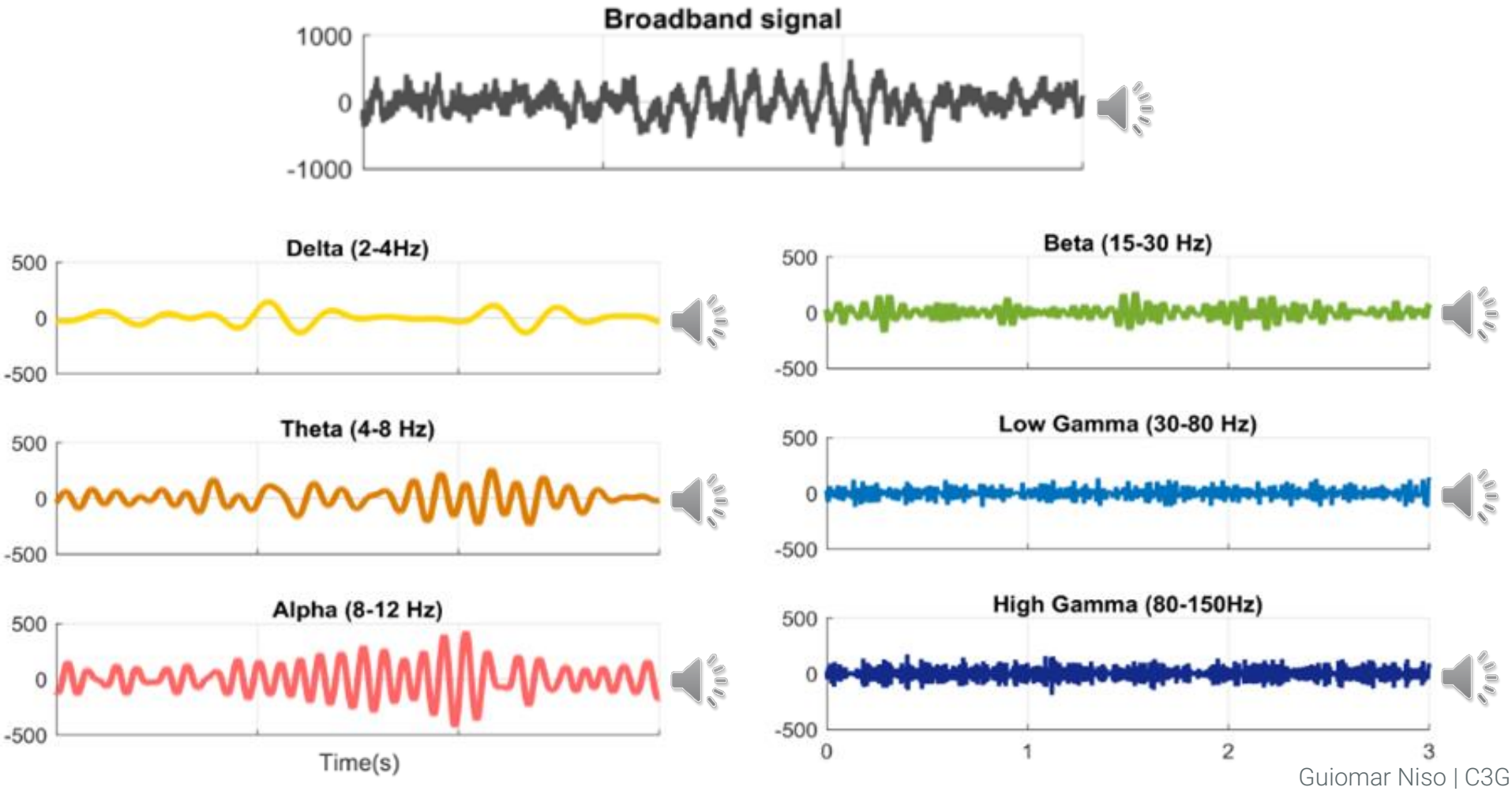
Filtered and removed blinks and cardiac artifacts



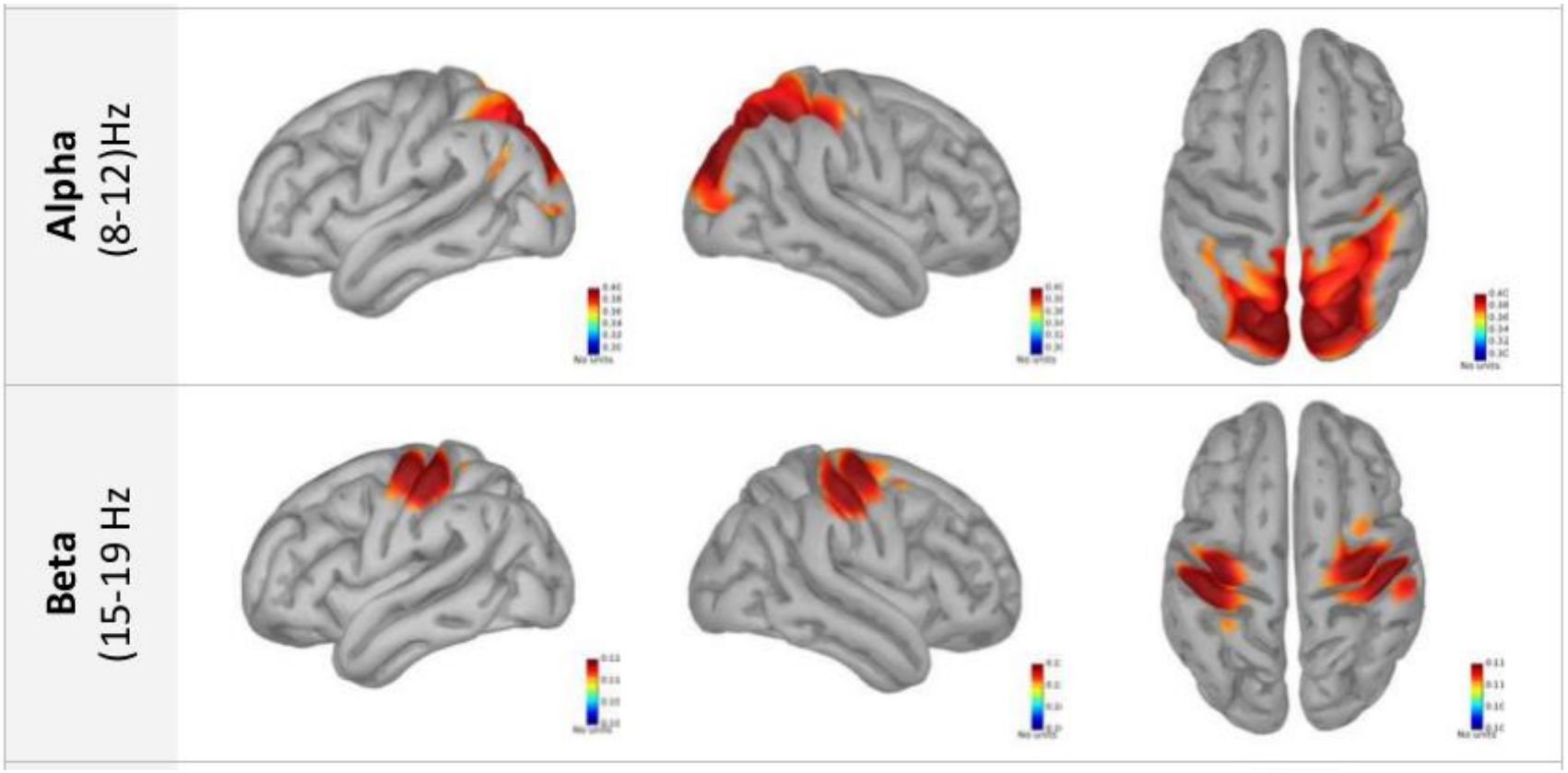
Brain Signals



Oscillations

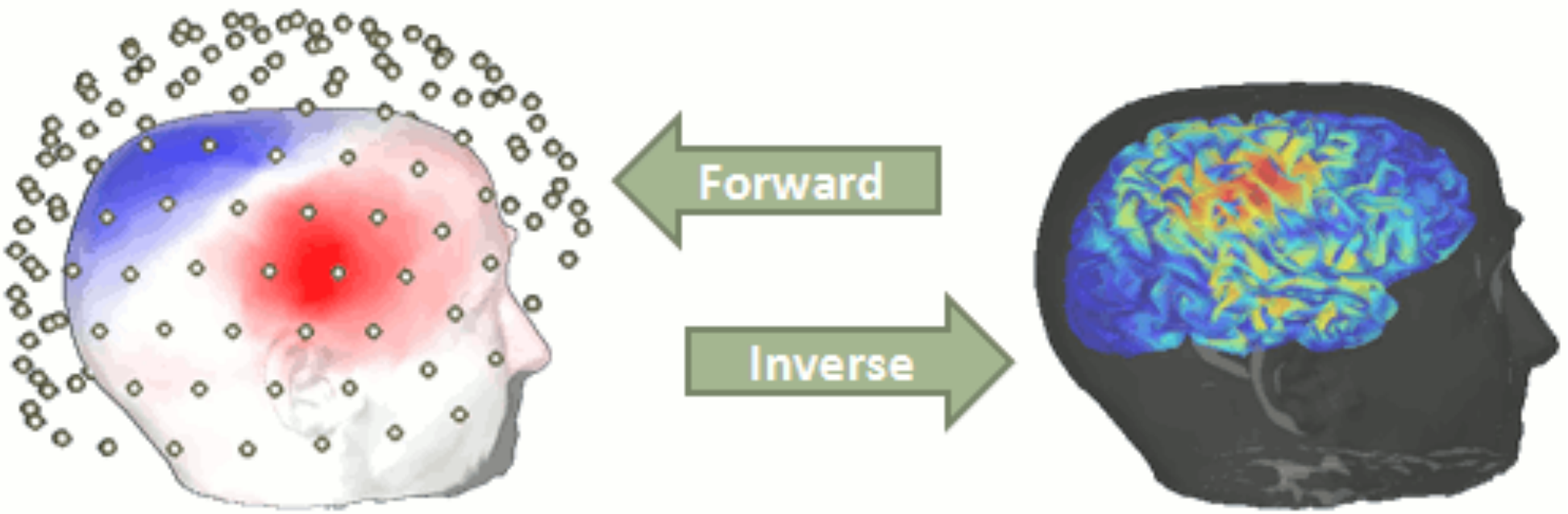


Rythms of the brain



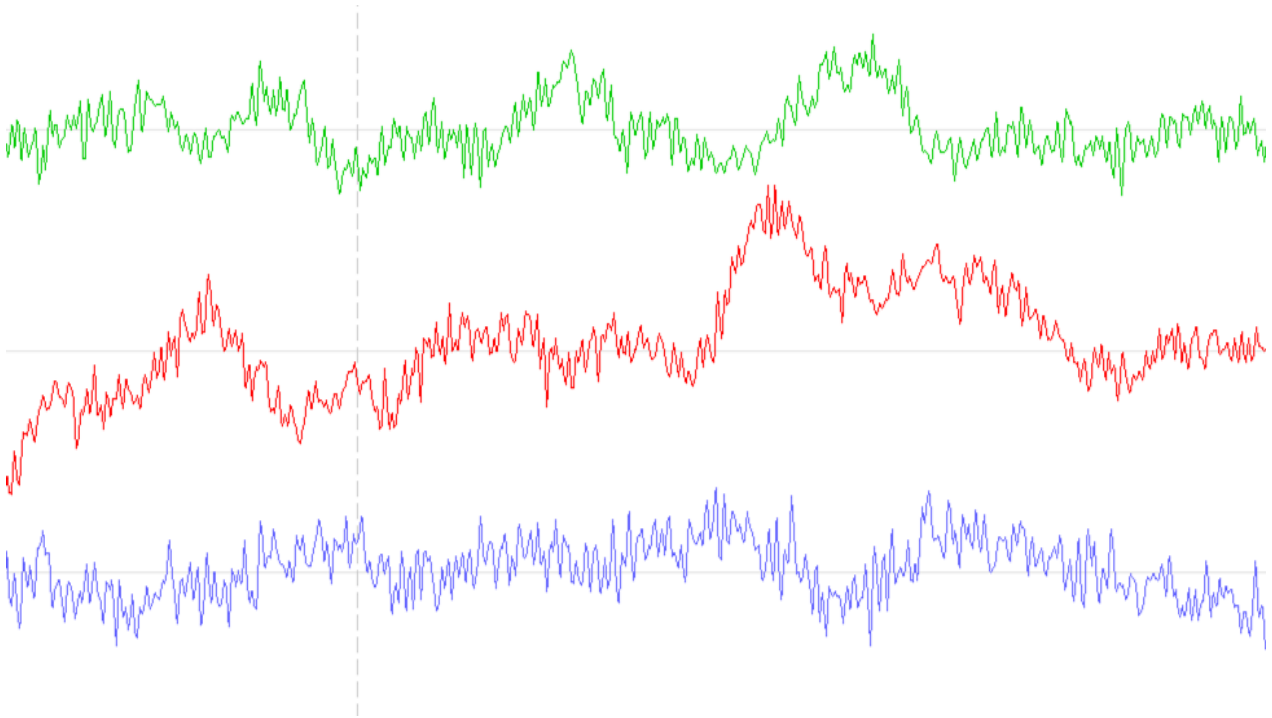
(Niso et al. *Neuroimage*, 2015)

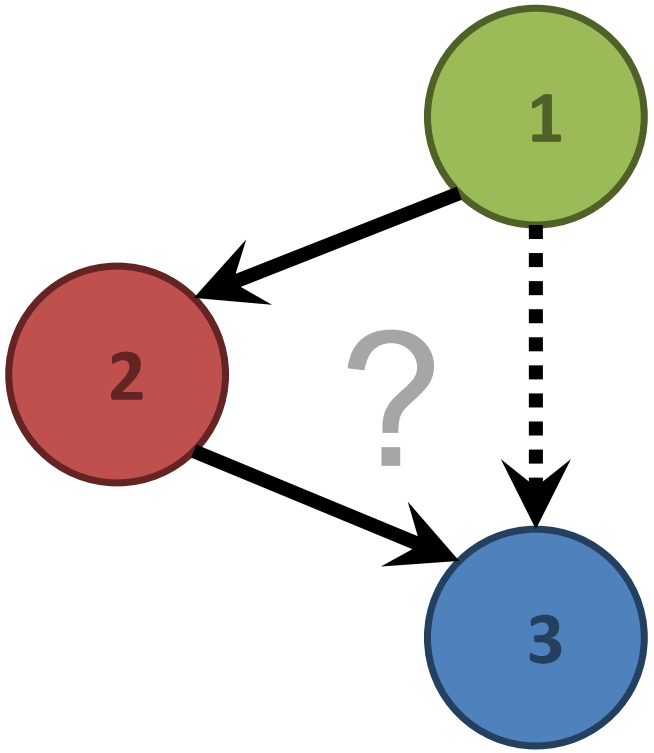
Source reconstruction



(Brainstorm, Tadel et al. 2011)

Brain Connectivity



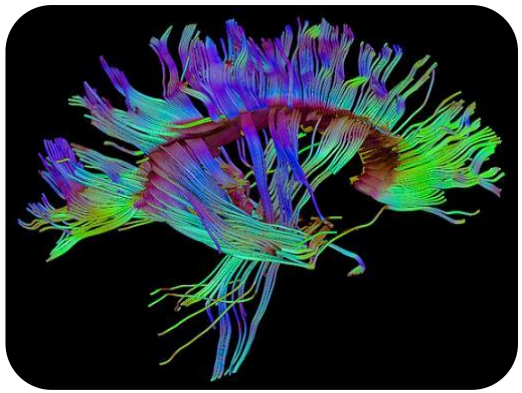


For a comprehensive review on functional and effective connectivity metrics: **(Niso et al. *Neuroinformatics*, 2013)**

Brain Connectivity

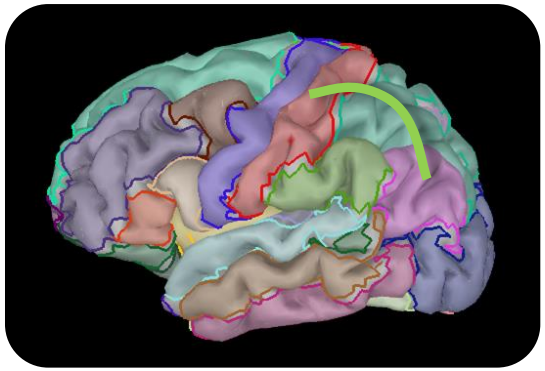
Structural

physical connections



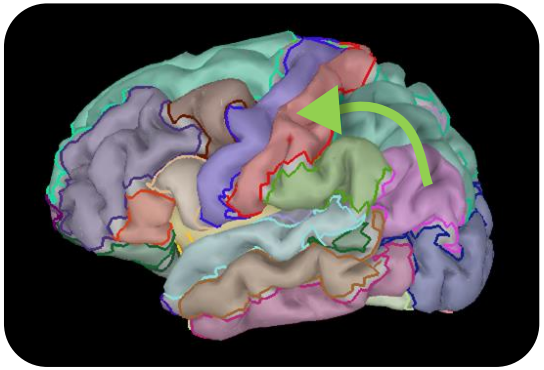
Functional (FC)

relationship bt signals



Effective (EC)

causal interactions



(Niso et al. 2013)

Synchronization

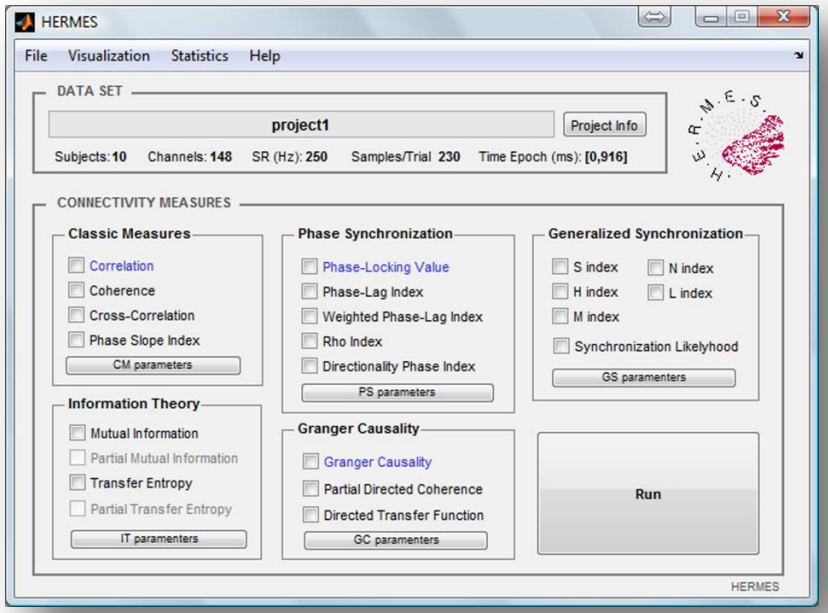
SYNCHRONIZATION

σύν χρόνος

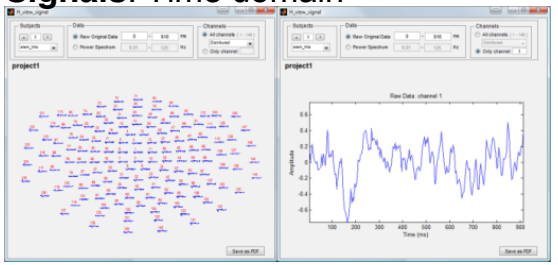
(*sin* = common, *cronos* = time)

HERMES

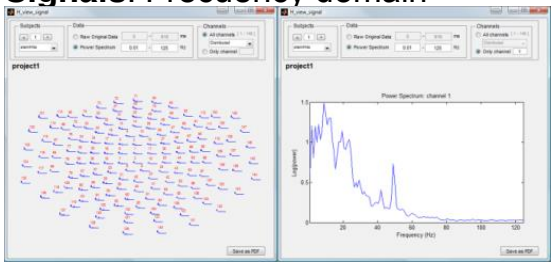
Integrated toolbox to characterize
functional and effective brain connectivity



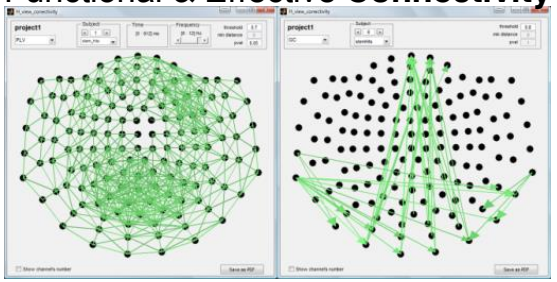
Signals: Time domain



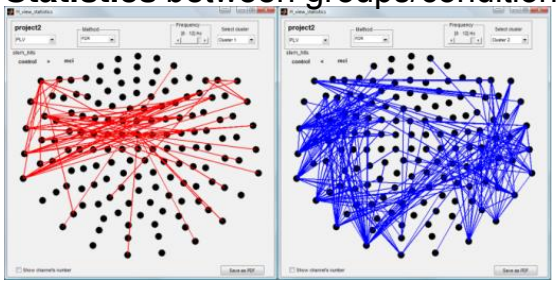
Signals: Frecuency domain



Functional & Effective **Connectivity**



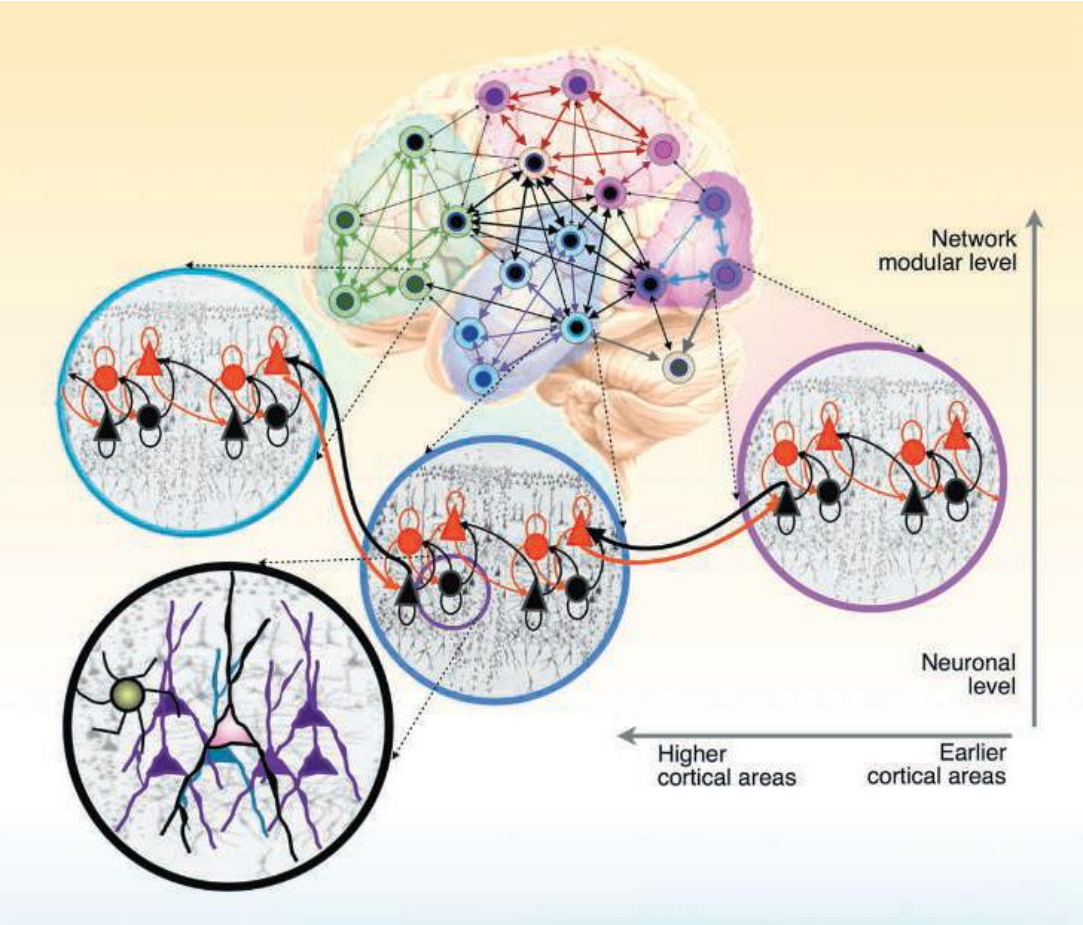
Statistics between groups/conditions



http://hermes.ctb.upm.es

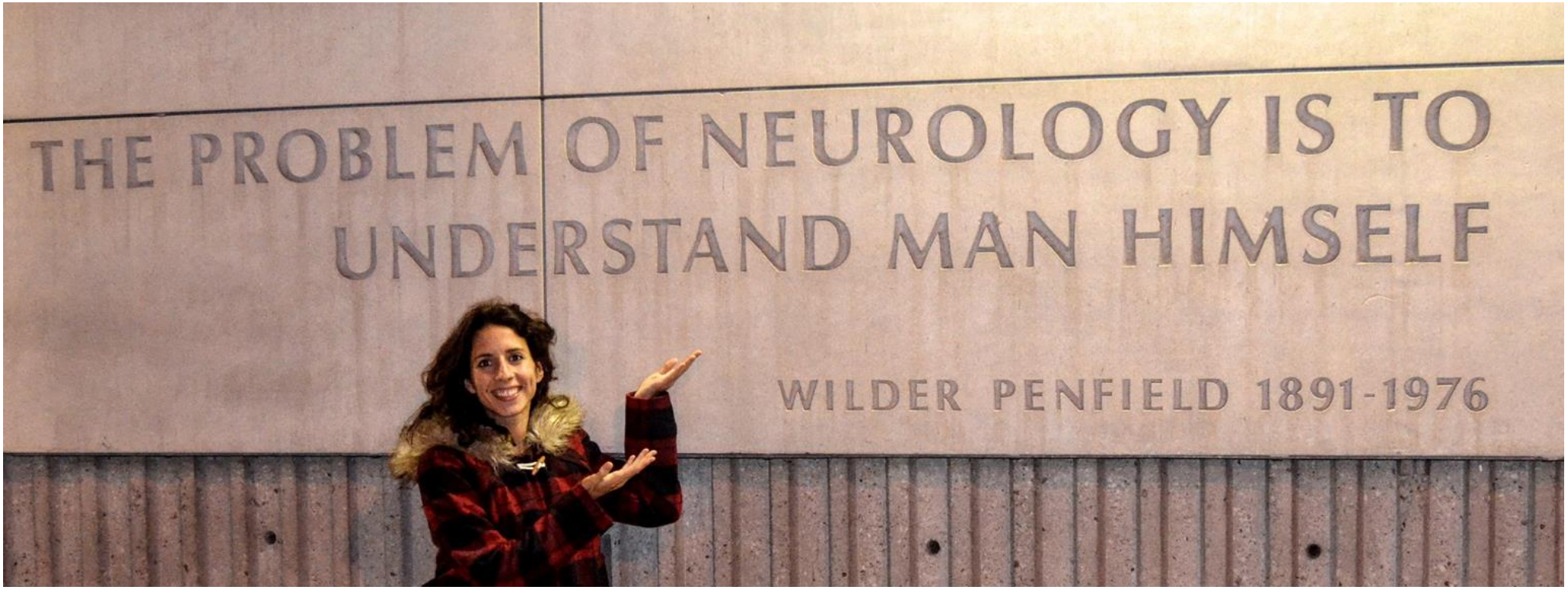
(Niso et al. *Neuroinformatics*, 2013)

Brain Networks



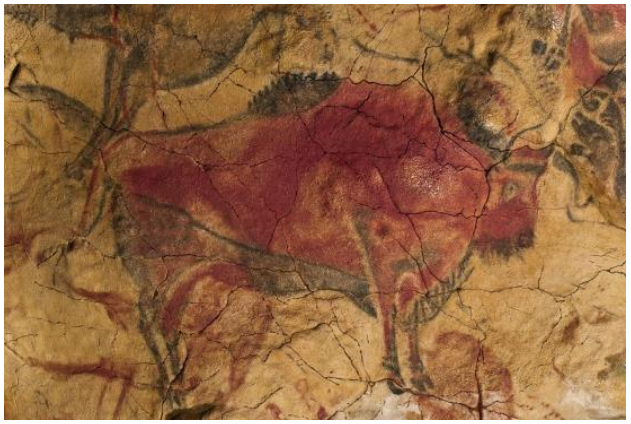
(Park & Friston, *Science*, 2013)

Wilder Penfield



Prehistoric Art

Saharan petroglyphic
~50,000 BCE



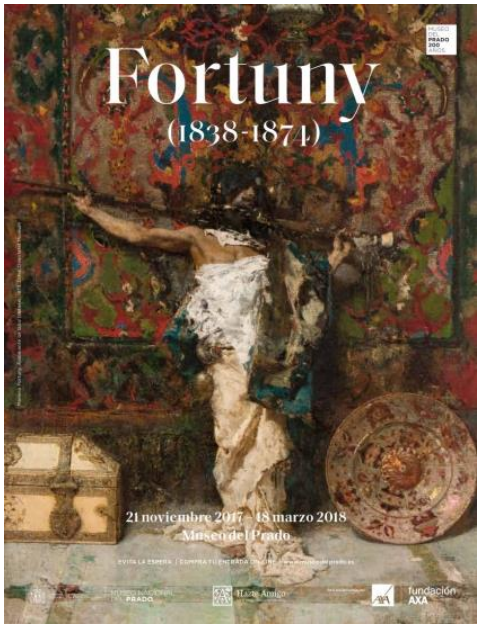
Altamira Bison
~30,000 BCE

Venus of Willendorf
~25,000 BCE

Geisenklösterle flute
~40,000 BCE

Jiahu gǔdí
~6,000 BCE

Art



Museums

Concerts

Films

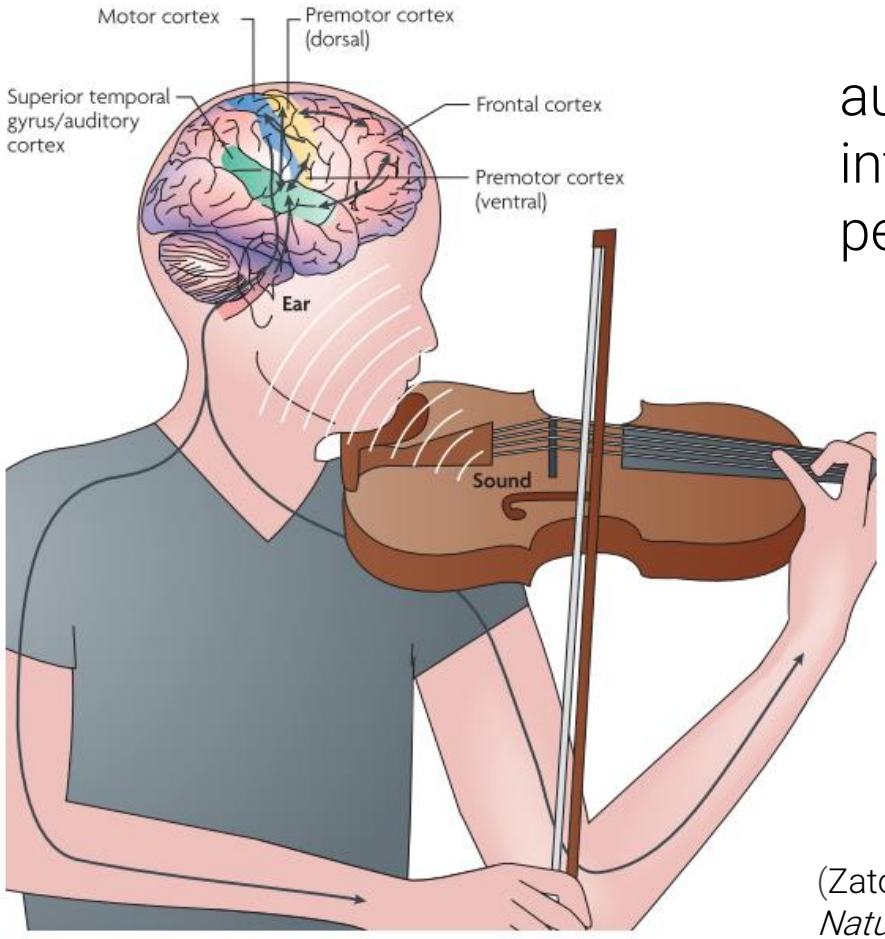
Dance Performances

Theathers

Robert Zatorre

International Laboratory for
Brain, Music, and Sound Research

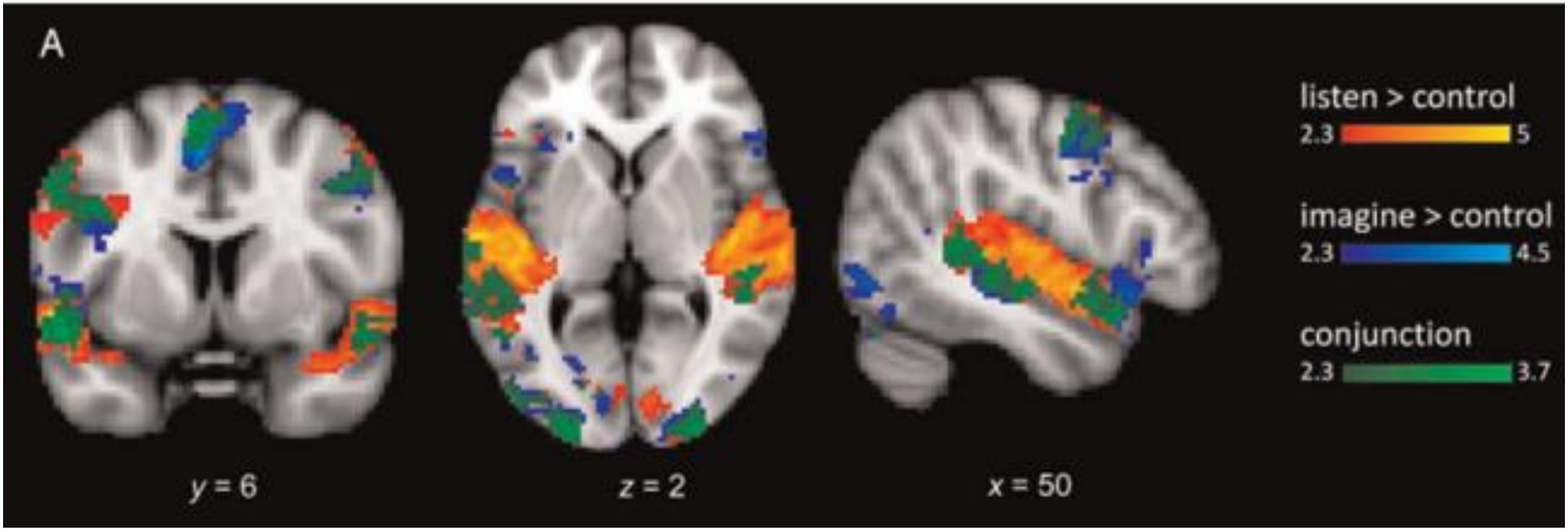
Music Performance



auditory–motor interactions in music perception and production

(Zatorre, Chen & Penhune, *Nature Neuroscience*, 2007)

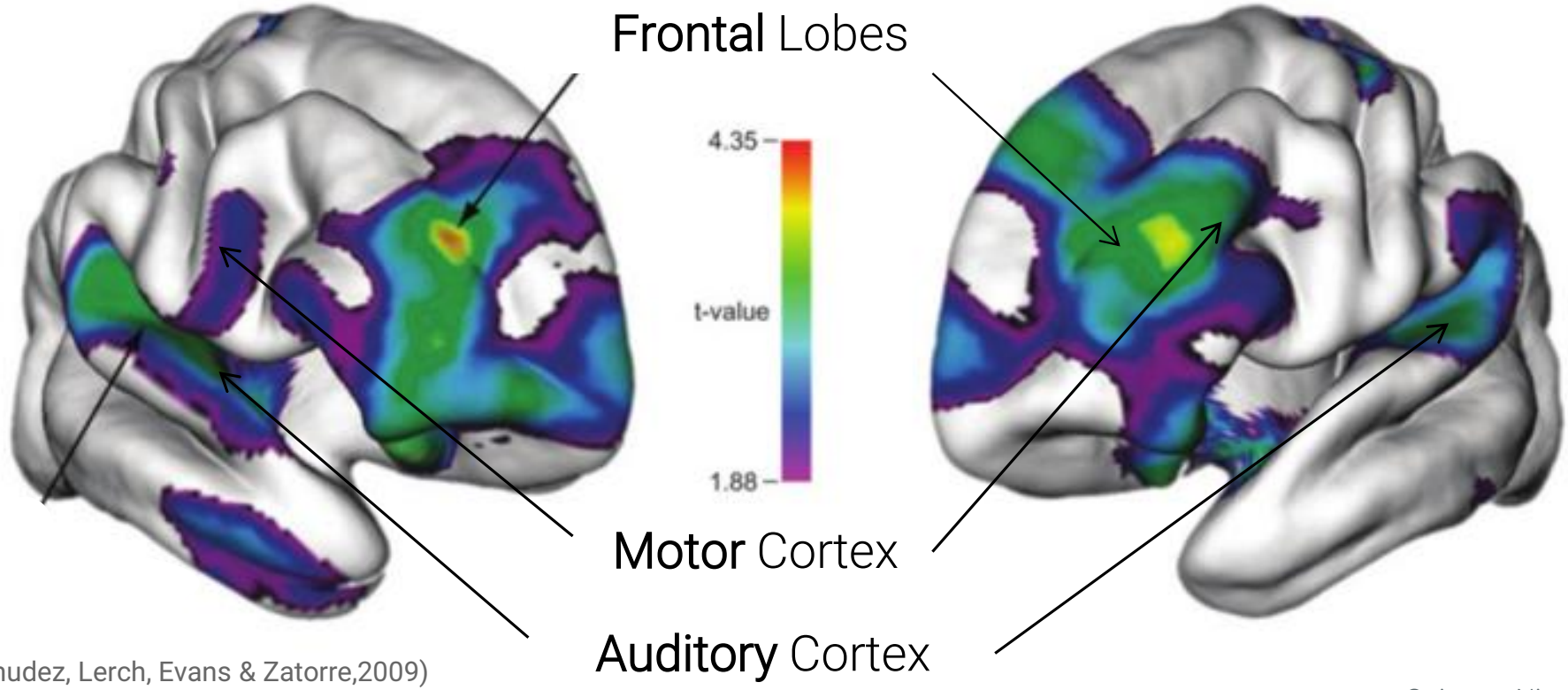
Musical Imagery



(Herholz, Halpern & Zatorre,2012)

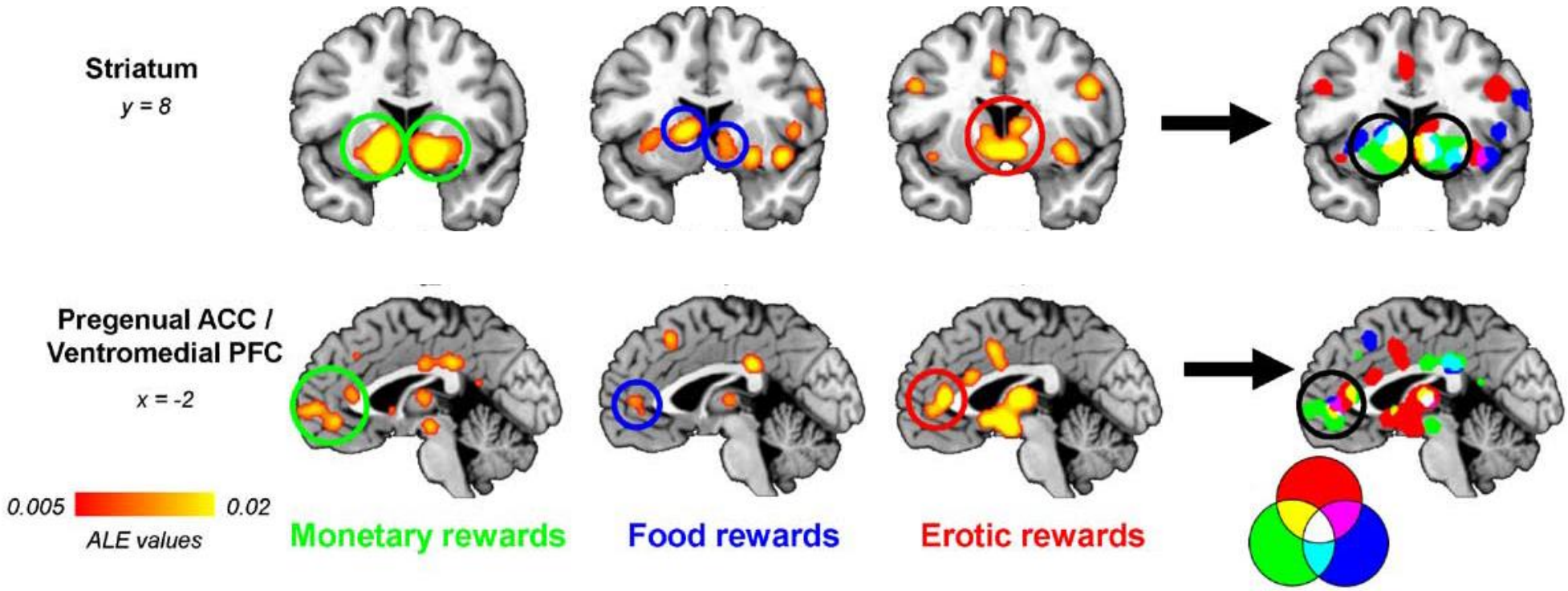
Brain Plasticity

CORTICAL THICKNESS: musicians > non-musicians



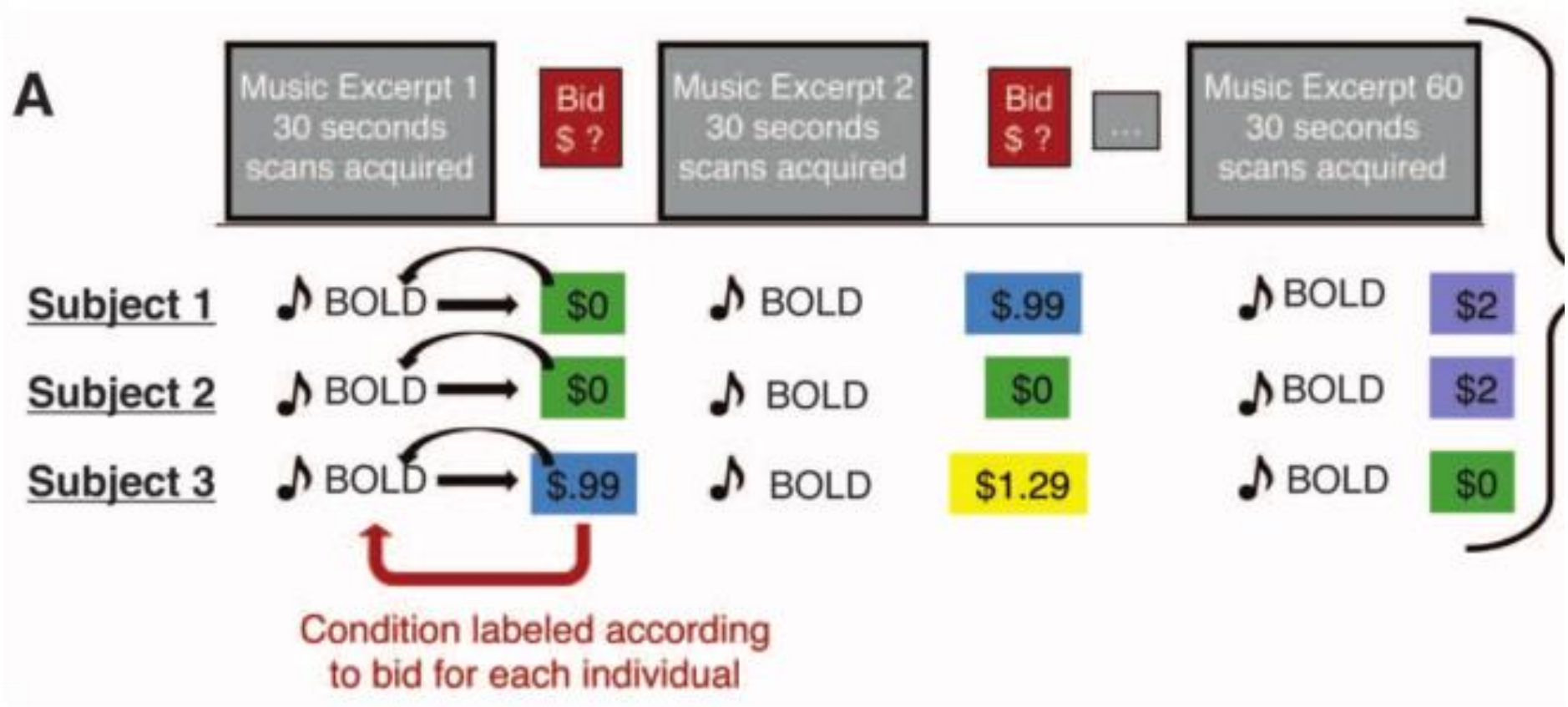
(Bermudez, Lerch, Evans & Zatorre,2009)

Pleasure



(Sescousse et a. 2013)

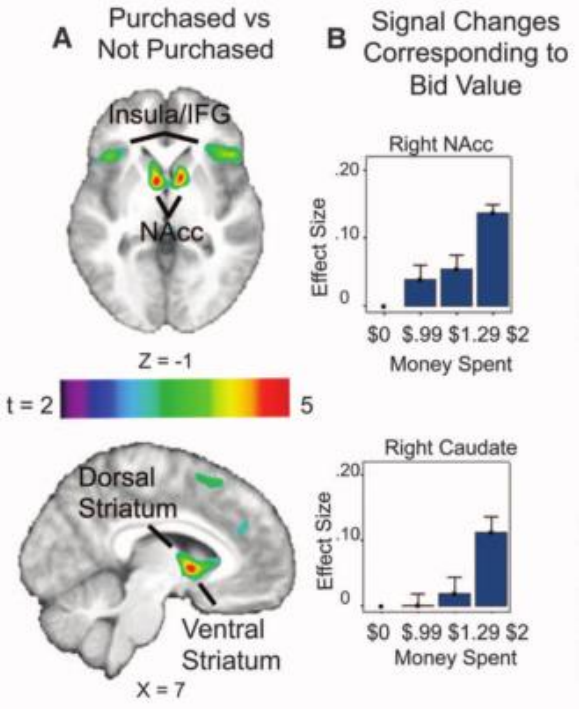
Music Reward

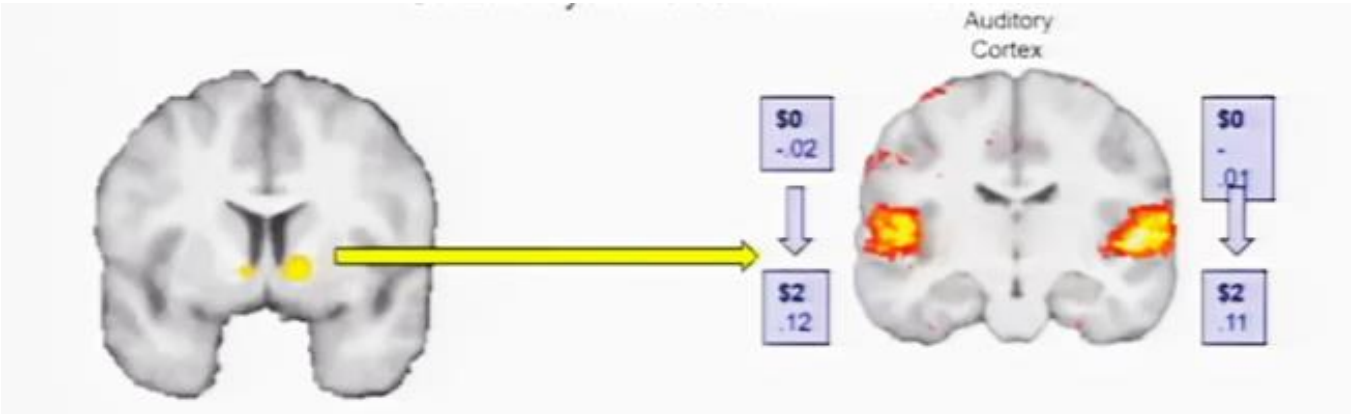


(Salimpoor et al. Science, 2013)

Music Reward

Interactions Between the Nucleus Accumbens and Auditory Cortices Predict Music Reward Value

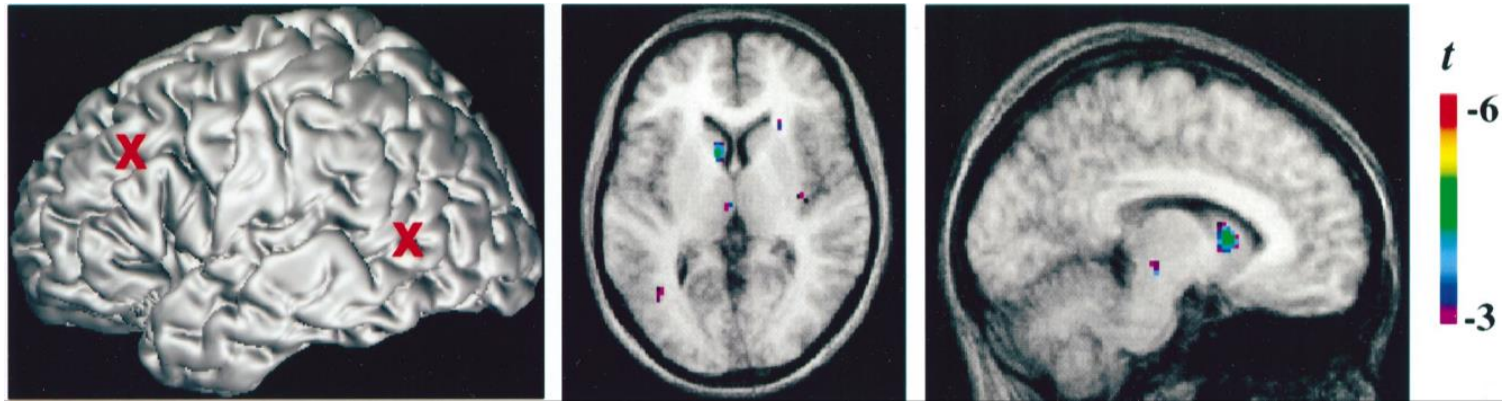




(Salimpoor et al. Science, 2013)

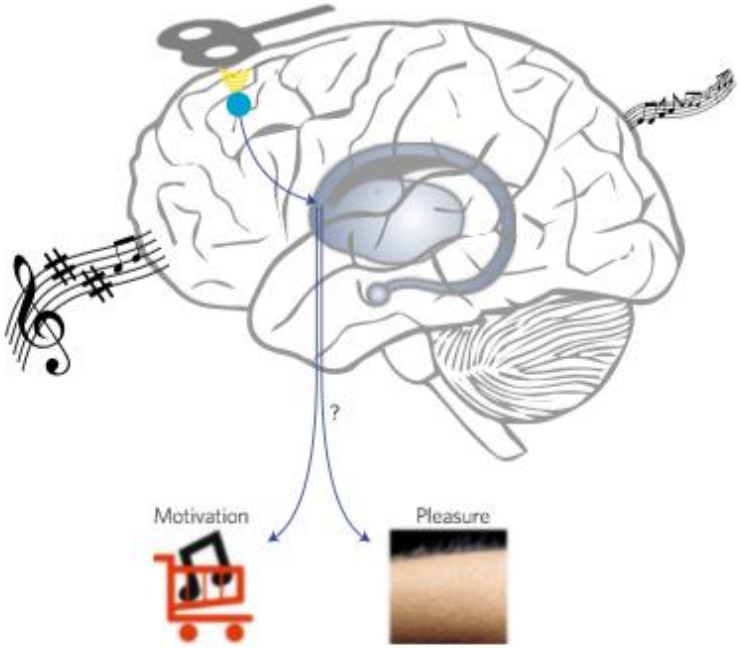
Modulate Musical Experience

Repetitive Transcranial Magnetic Stimulation of the Human Prefrontal Cortex Induces Dopamine Release in the Caudate Nucleus

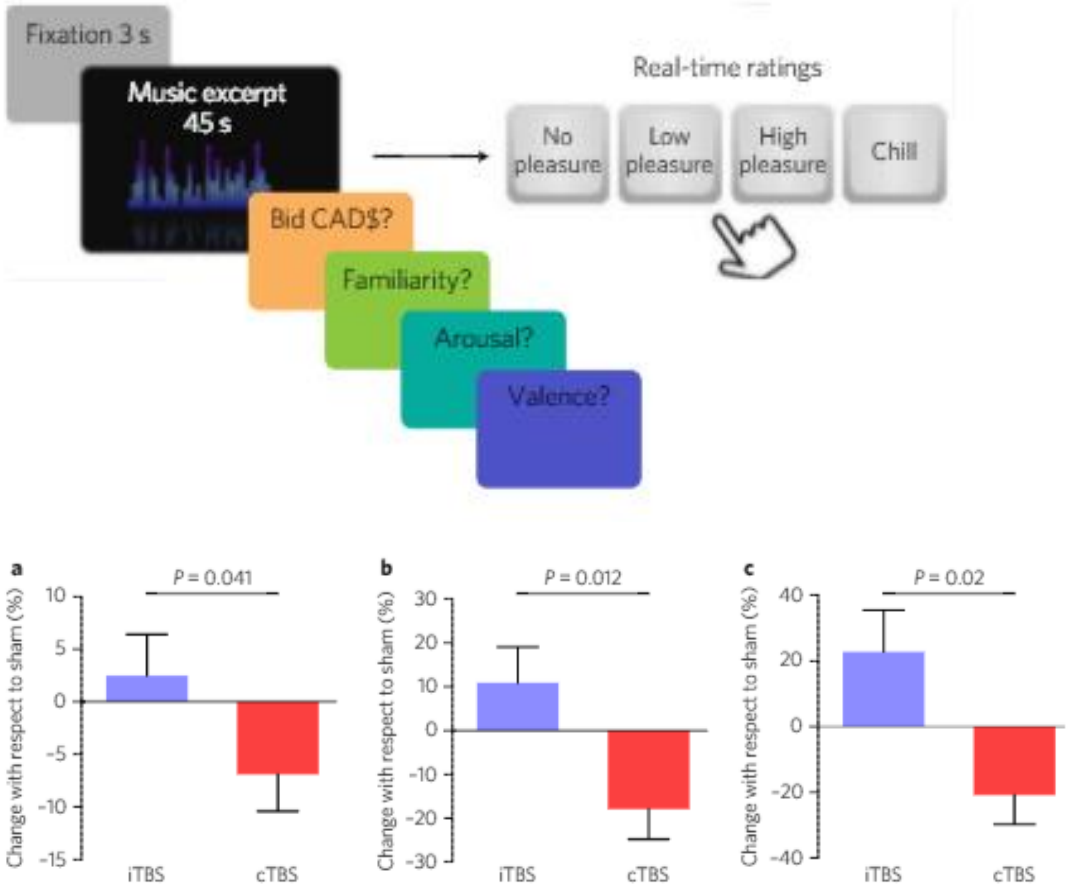


(Strafella et al. J Neurosci. 2001)

Modulate Musical Experience



(Mas-Herrero, Dagher & Zatorre, Nature Human Behav. 2017)



Aesthetics appreciation

Variety of artistic styles to increase their choice of aesthetic judgment:

- Abstract art (40)
- Classic art (40)
- Impressionist art (40)
- Postimpressionist art (40)
- Photographs of landscapes, artifacts, urban scenes (160)

Brain functional connectivity dynamics for “beautiful” and “not beautiful”

(Cela-Conde at al. PNAS, 2013)

Aesthetics appreciation

Aesthetic appreciation relies on the activation of two different networks:

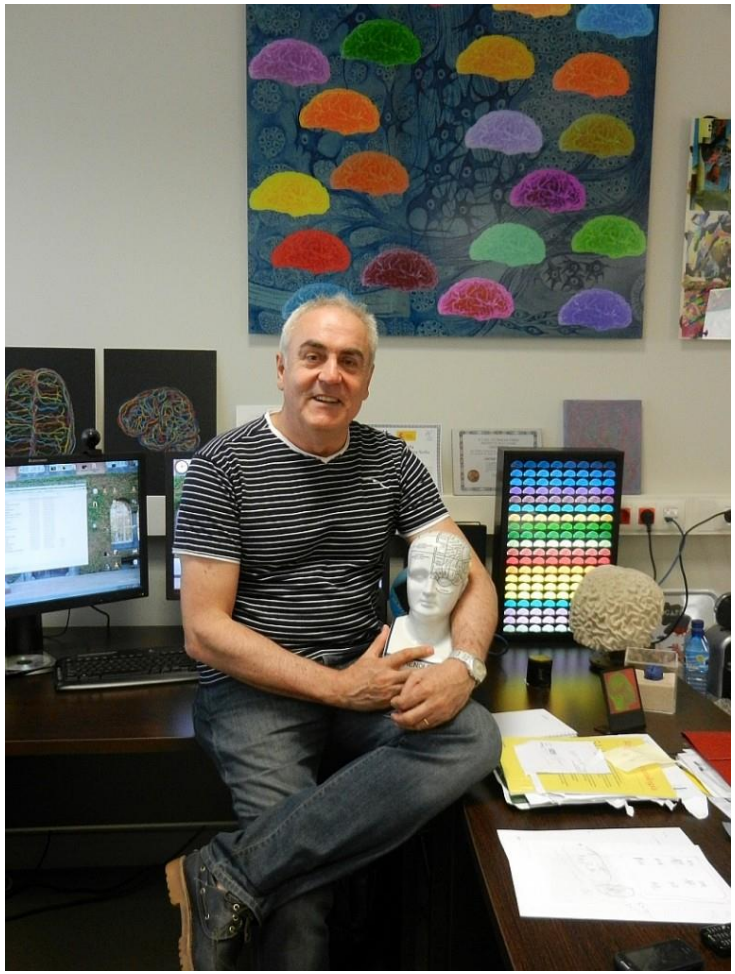
- **An initial aesthetic network: *sensu stricto***. General appraisal of the aesthetic qualities, visual stimulus “beautiful” or “not beautiful,” is performed very quickly
- **A delayed aesthetic network:** *sensu lato*. Detailed aspects of beauty, interesting or original, how to rate it, reasons, are performed later

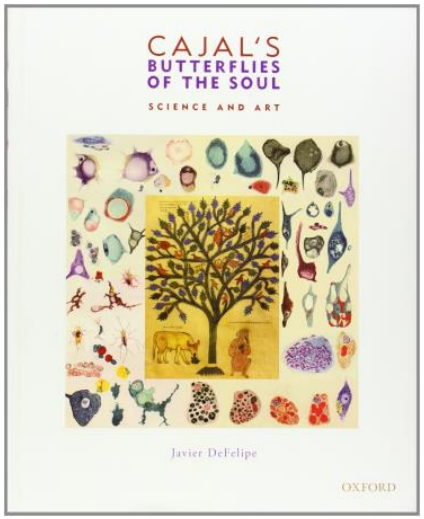


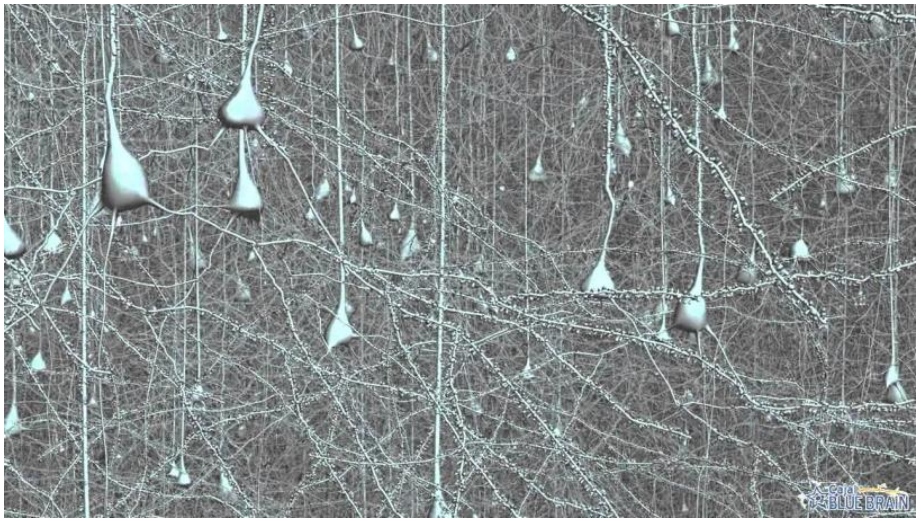


(Cela-Conde at al. PNAS, 2013)

Javier de Felipe





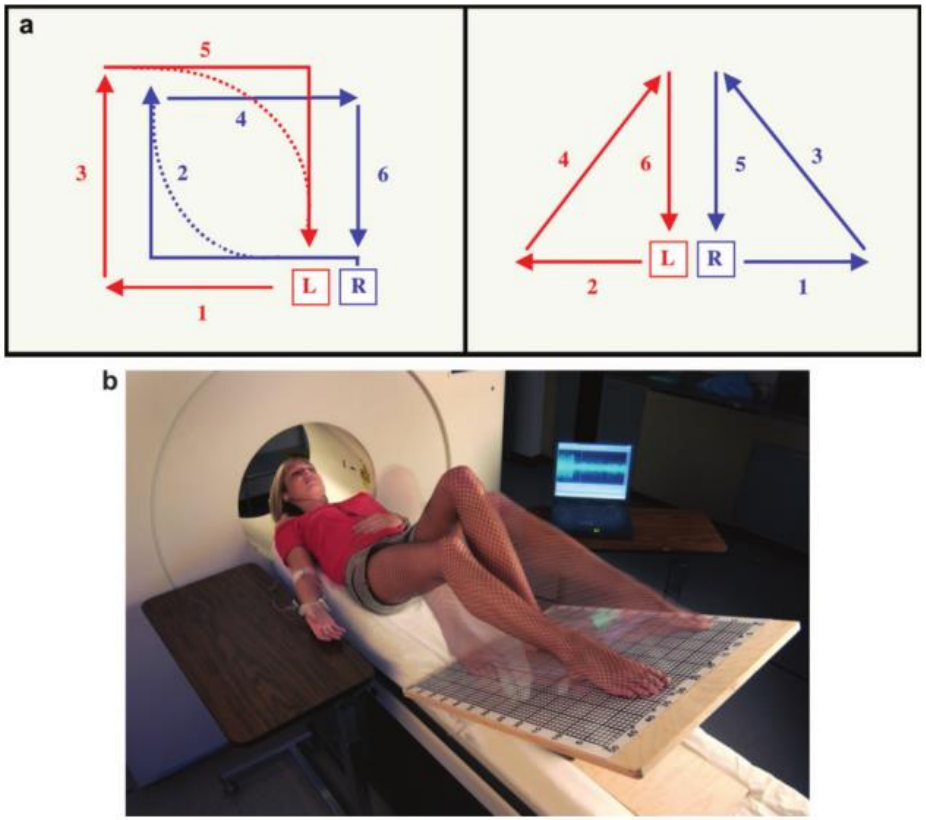


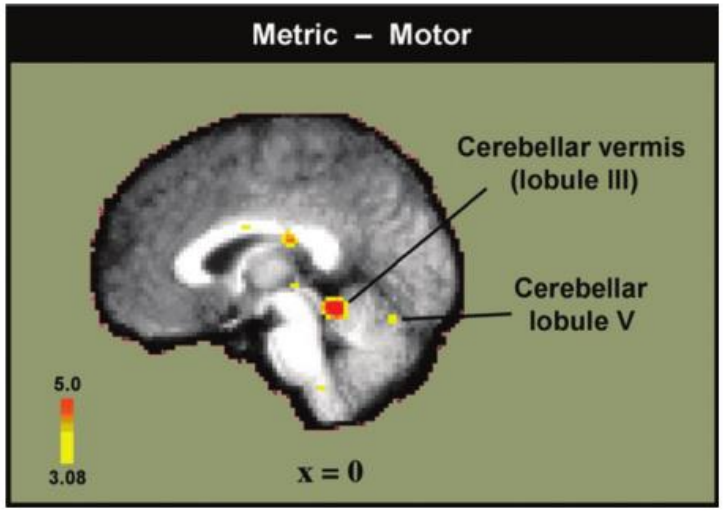
Neuronal Forest
Human Brain Project
Cajal Blue Brain

Dancing

Dancing

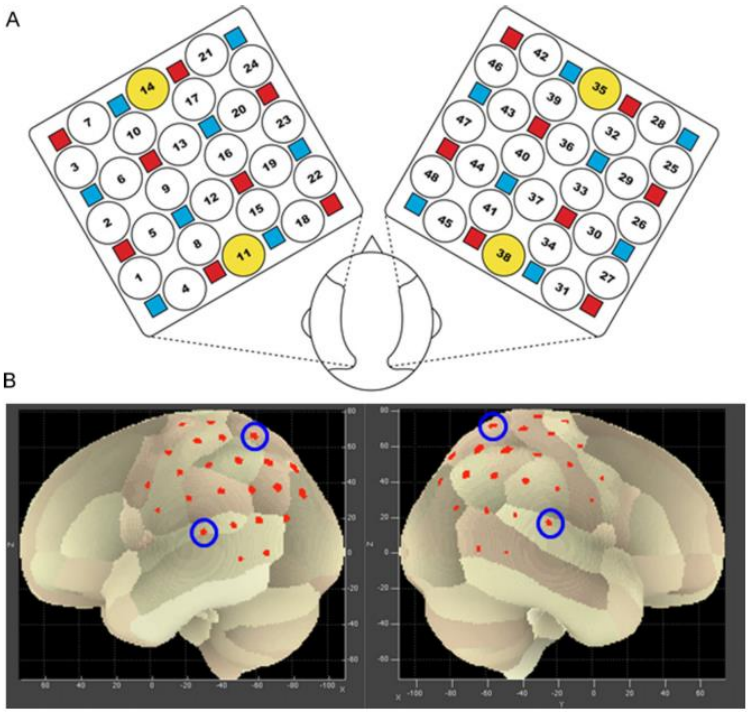
PET: Perform tango steps (involving legs only) (Brown et al. Cerebral Cortex, 2006)

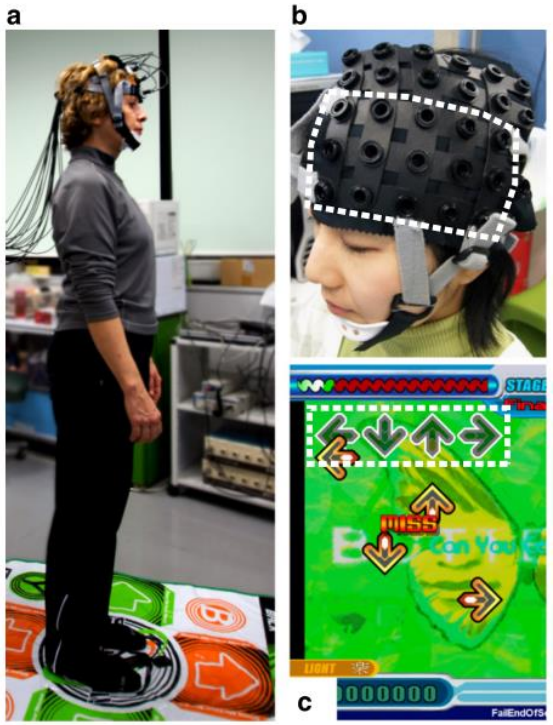


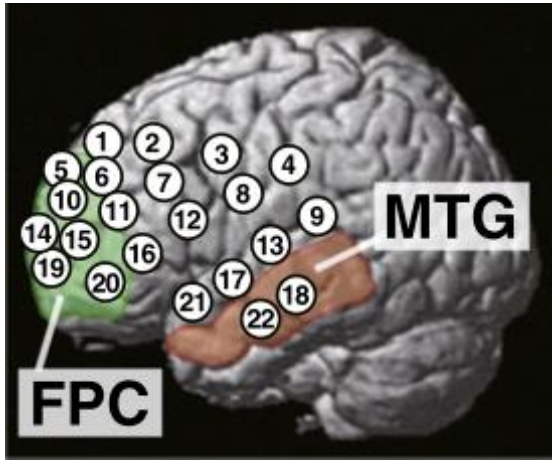


Dancing

functional near-infrared spectroscopy (fNIRS): non-dancers while they performed a dance video game (Tachibana et al. 2011) (Ono et al. 2014)





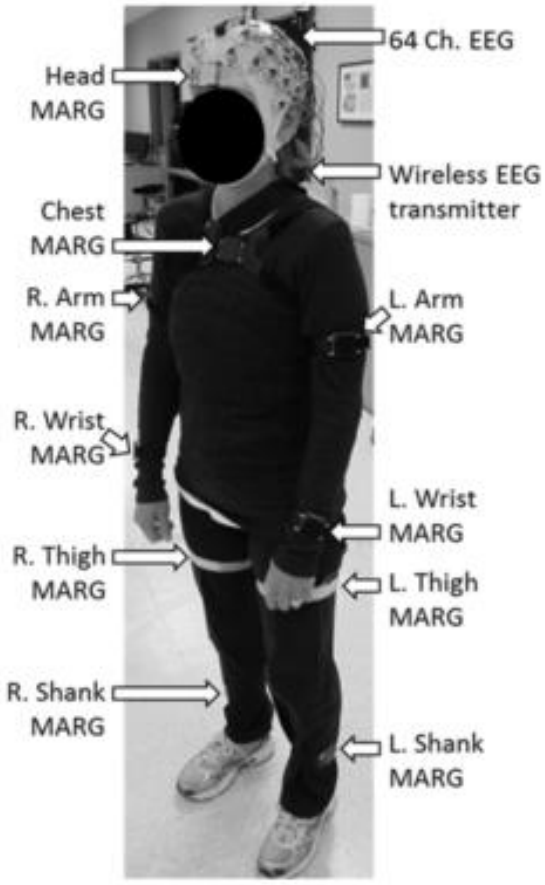


Dancing

EEG: dancers who performed movements in three conditions. (Cruz-Garza et al.2014)

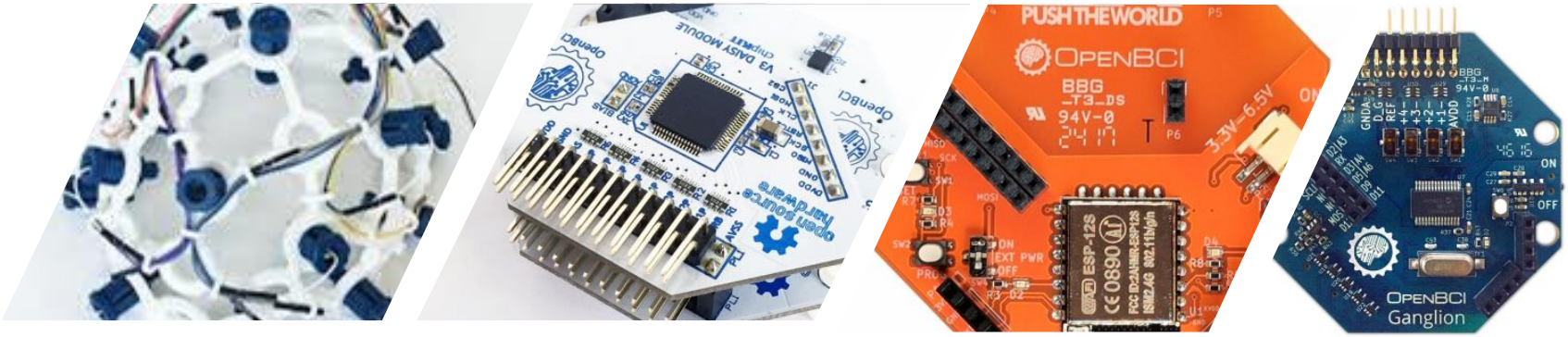
Machine learning algorithm that classified movements based on the thought or performed expression.

Activation was found in **premotor, motor, and parietal regions**, and the classification was not limited by motion artifacts.



Wireless EEG

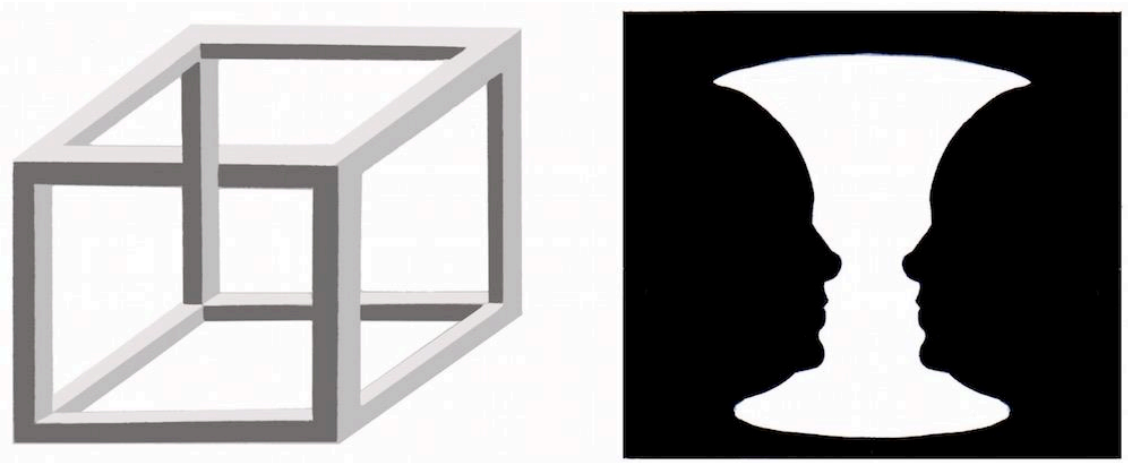
New **wireless EEG** systems that allow **mobility**

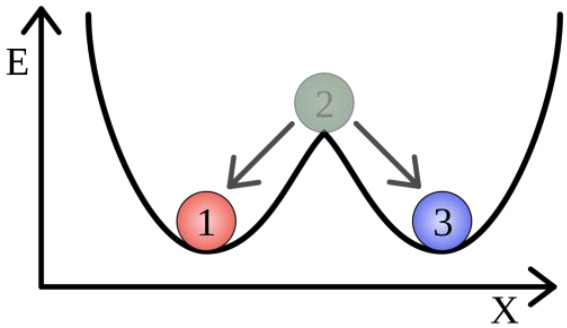


Optical Illusions

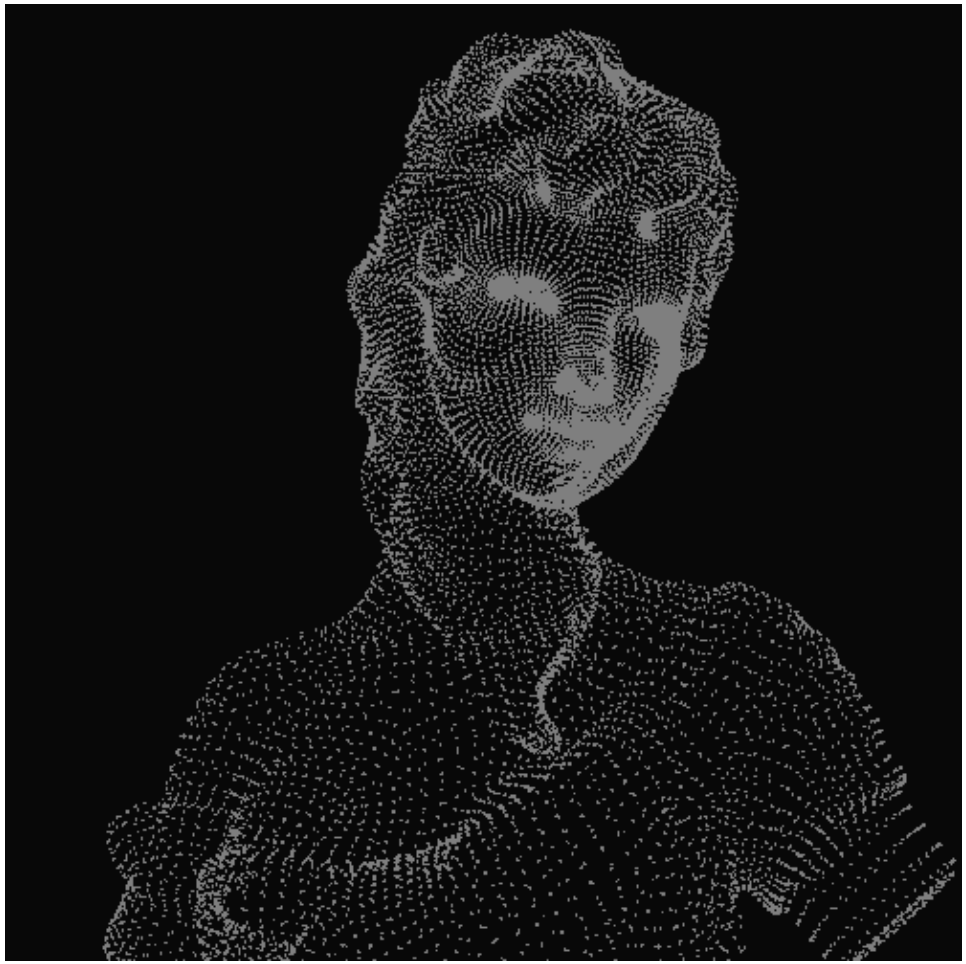
MULTISTABILITY

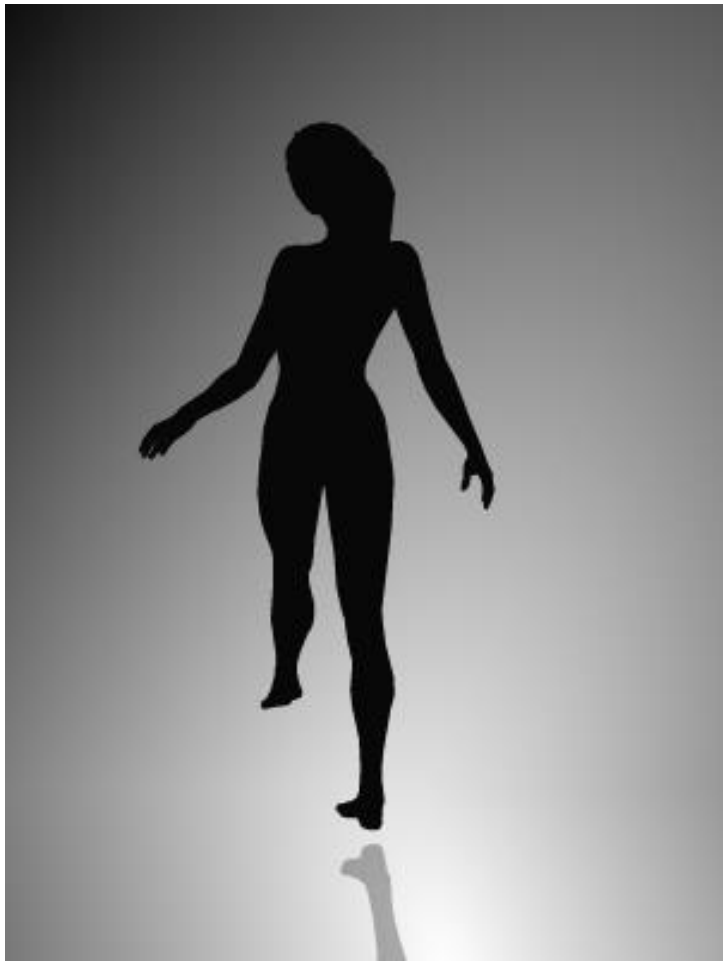
The Necker cube and the Rubin vase





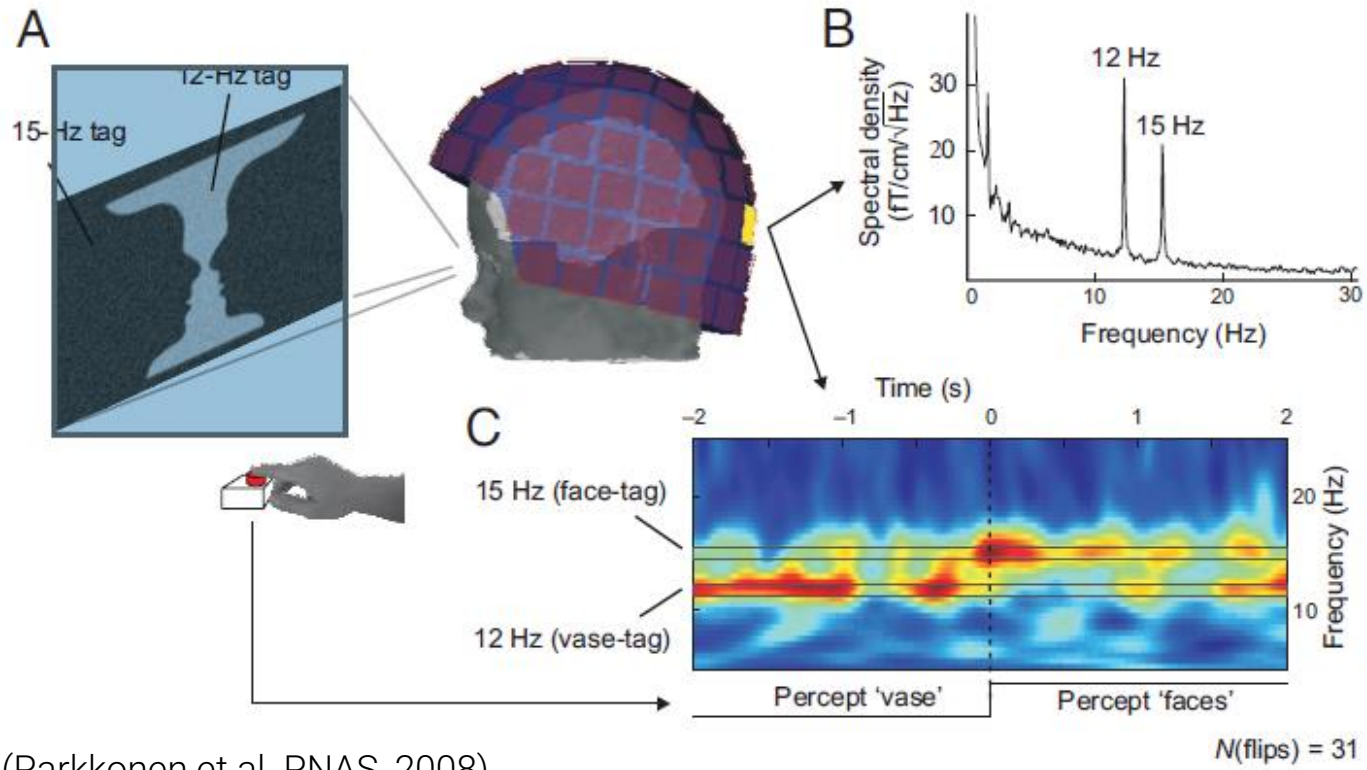
Optical Illusions





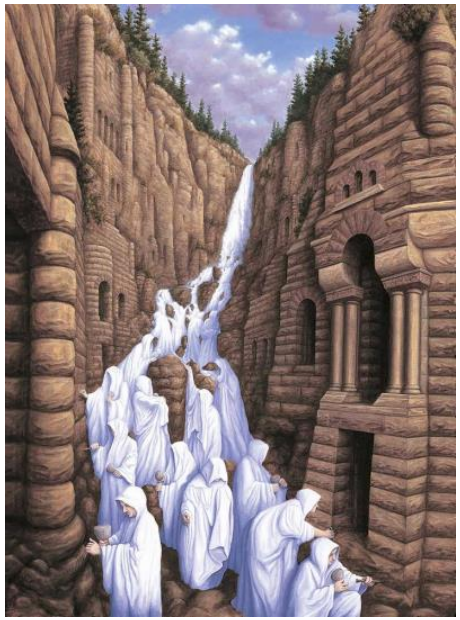
Optical Illusions

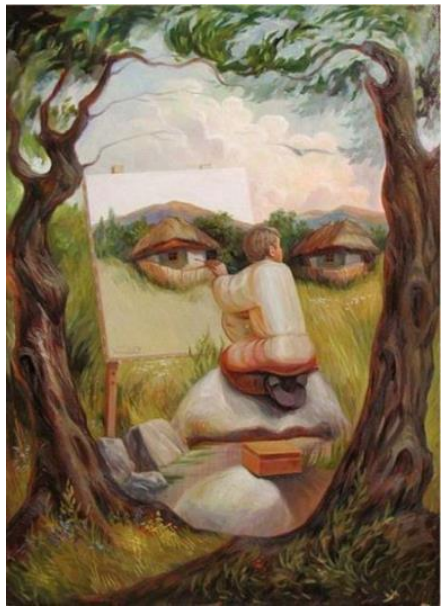
Bistable images

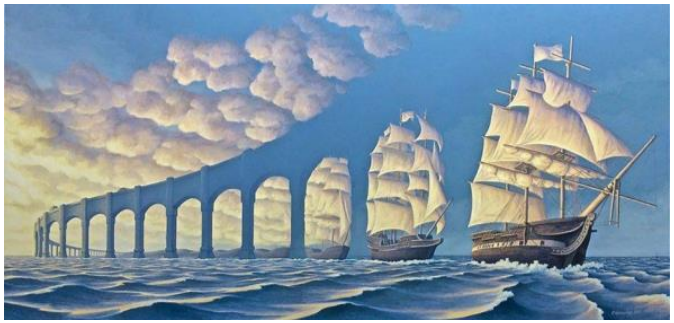


(Parkkonen et al. PNAS, 2008)

Optical Illusions







¡MUCHAS GRACIAS!

guiomar.niso@ctb.upm.es

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