

A neuroscientist sees the brain in action

Peter A. Bandettini, Ph.D.

Section on Functional Imaging Methods
Laboratory of Brain and Cognition

<http://fim.nimh.nih.gov>

&

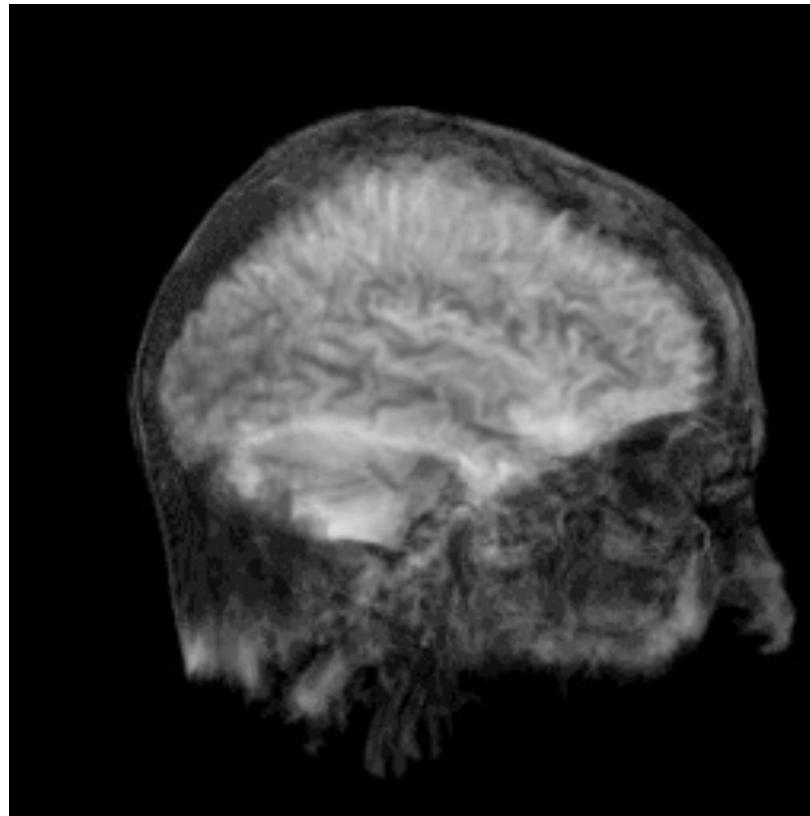
Functional MRI Facility

<http://fmrif.nimh.nih.gov>



Two Types of Neuroimaging

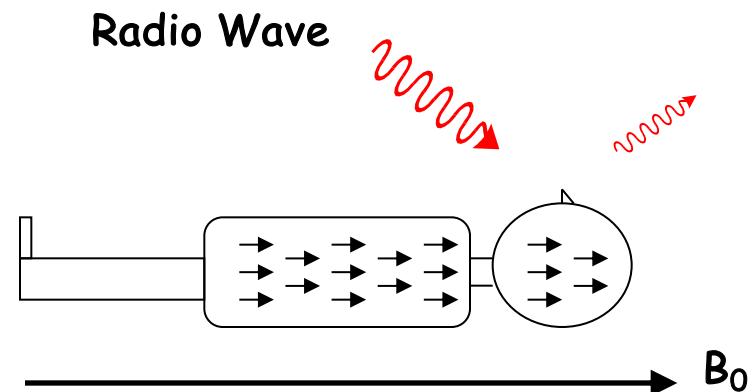
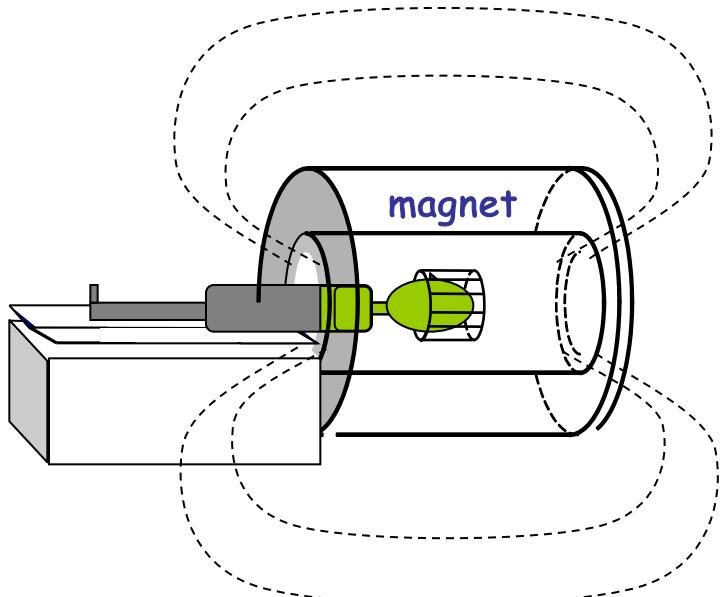
- Structural/Anatomical Imaging
- Functional Imaging



Magnetic Resonance Imaging



Magnetic Resonance Imaging (MRI)



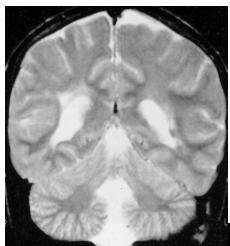
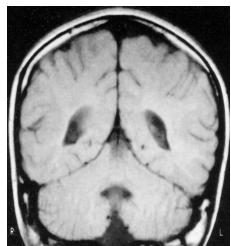
Sensitive to:

- # of protons (H_2O)
- Magnetic environment
 - Tissue structure

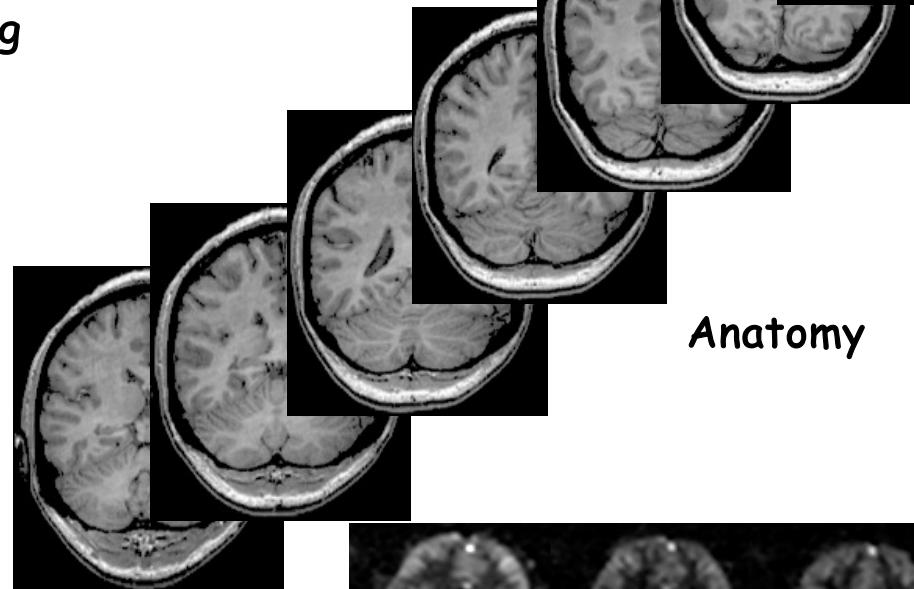
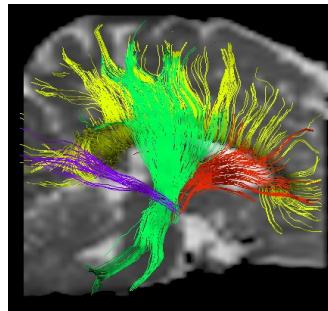
Venography



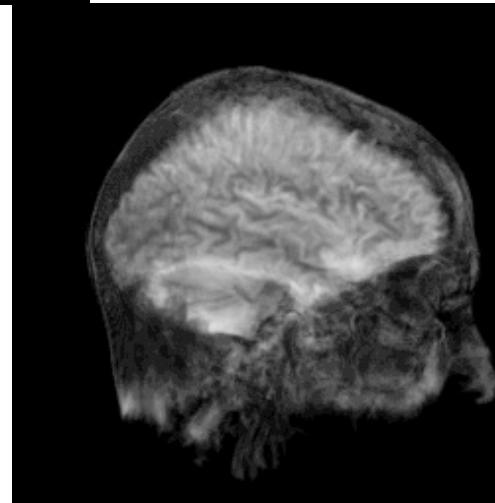
T1 weighted T2 weighted



Fiber Track Imaging



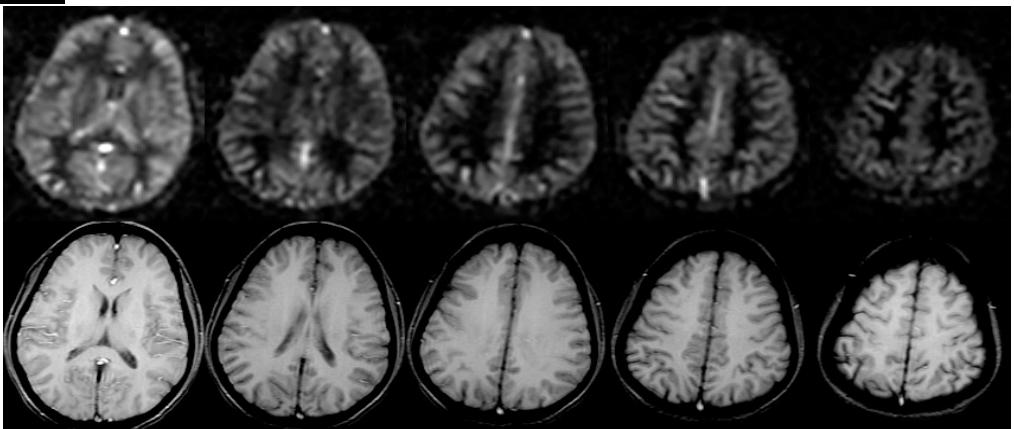
Anatomy



Angiography

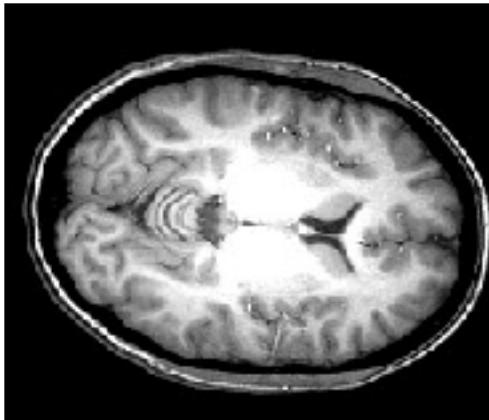


Perfusion



MRI vs. fMRI

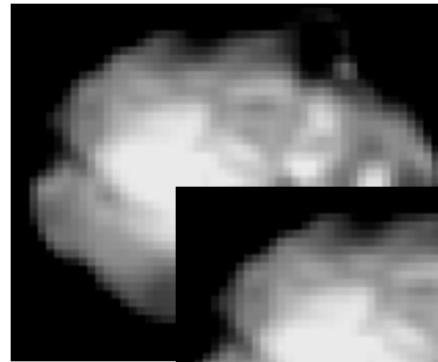
MRI



one image

high resolution
(1 mm or less)

fMRI

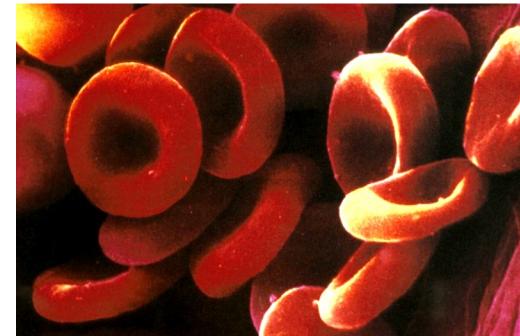
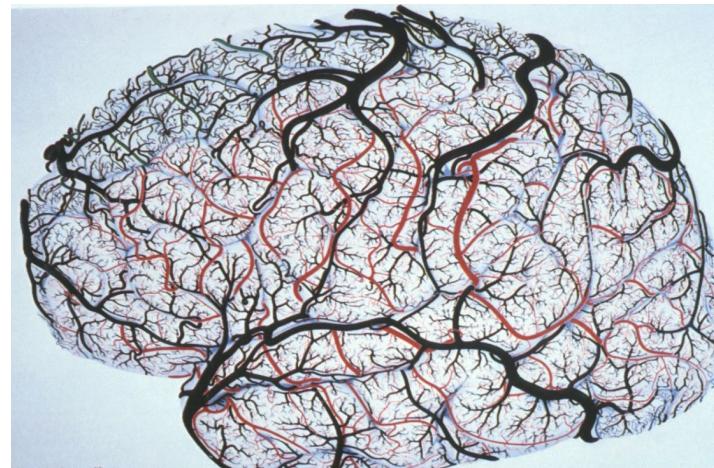
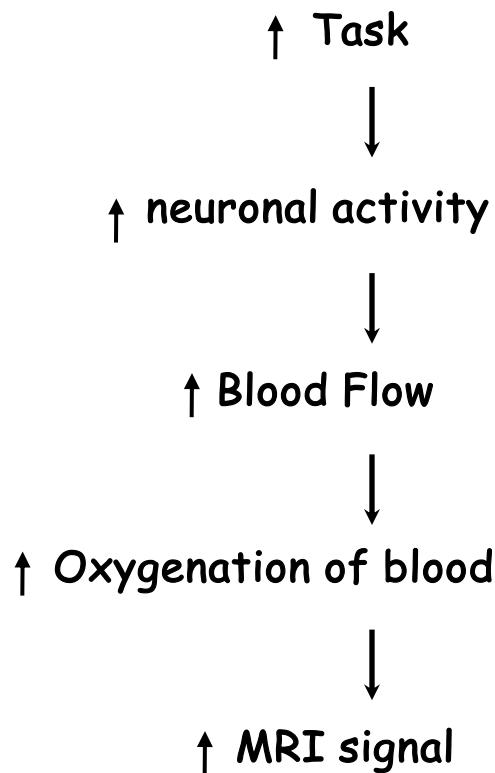


Time

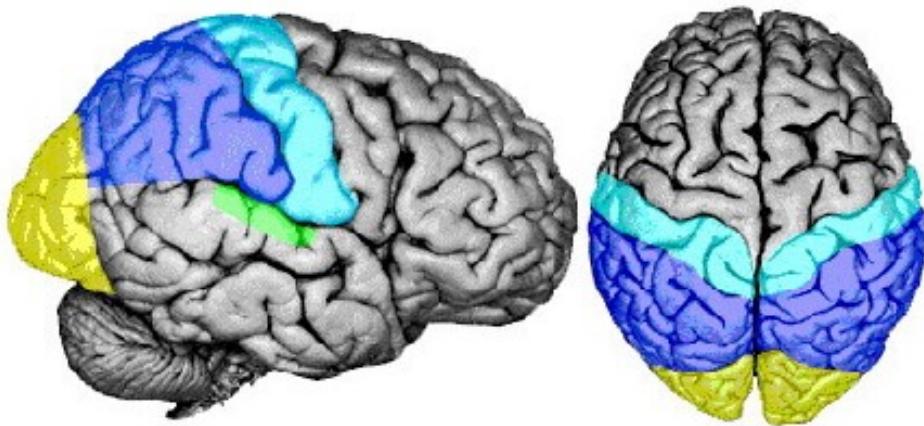
many images
(e.g., every 2 sec for 5
mins)

low resolution
(1.5 to 4 mm)

Measuring Brain function with MRI

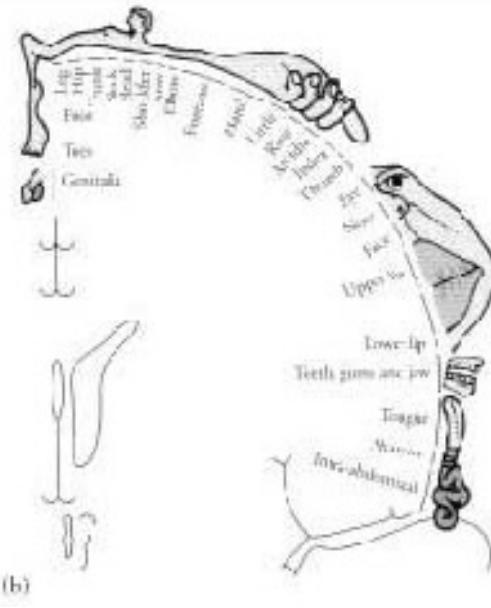
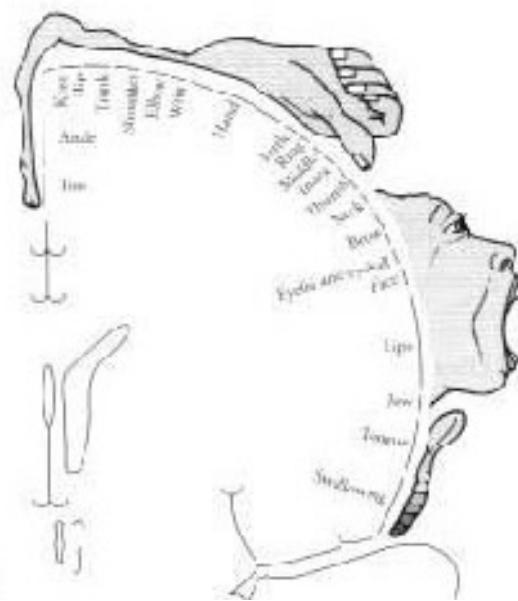


Red Blood Cells



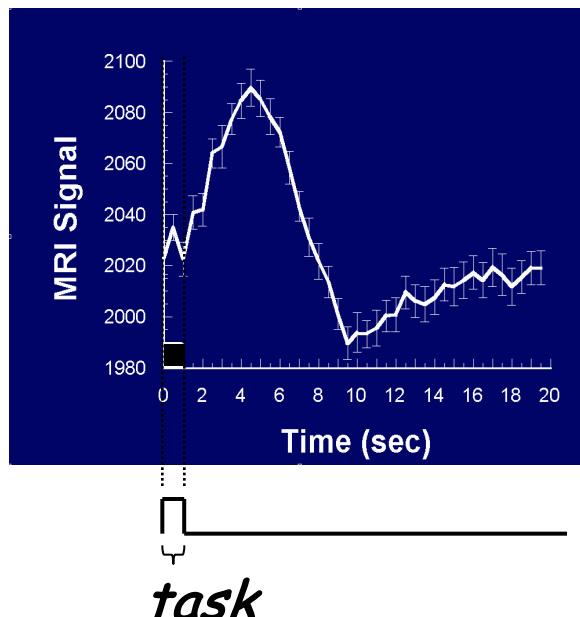
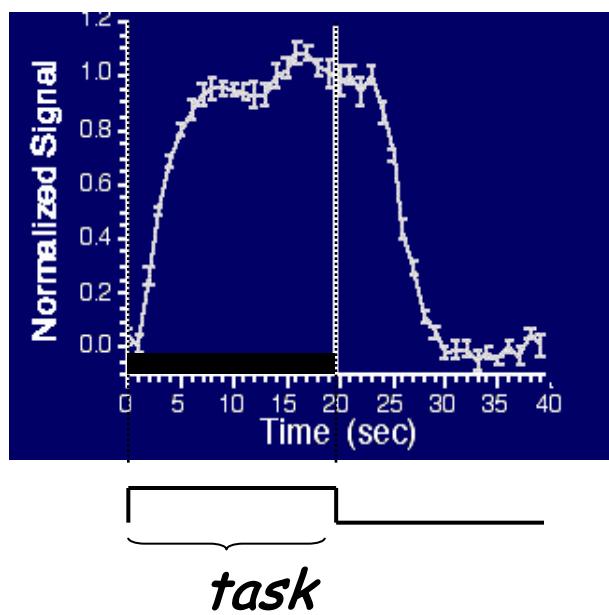
**Parietal/
Somatosensory**
**Parietal/
Association Area**

Occipital/Vision
Auditory



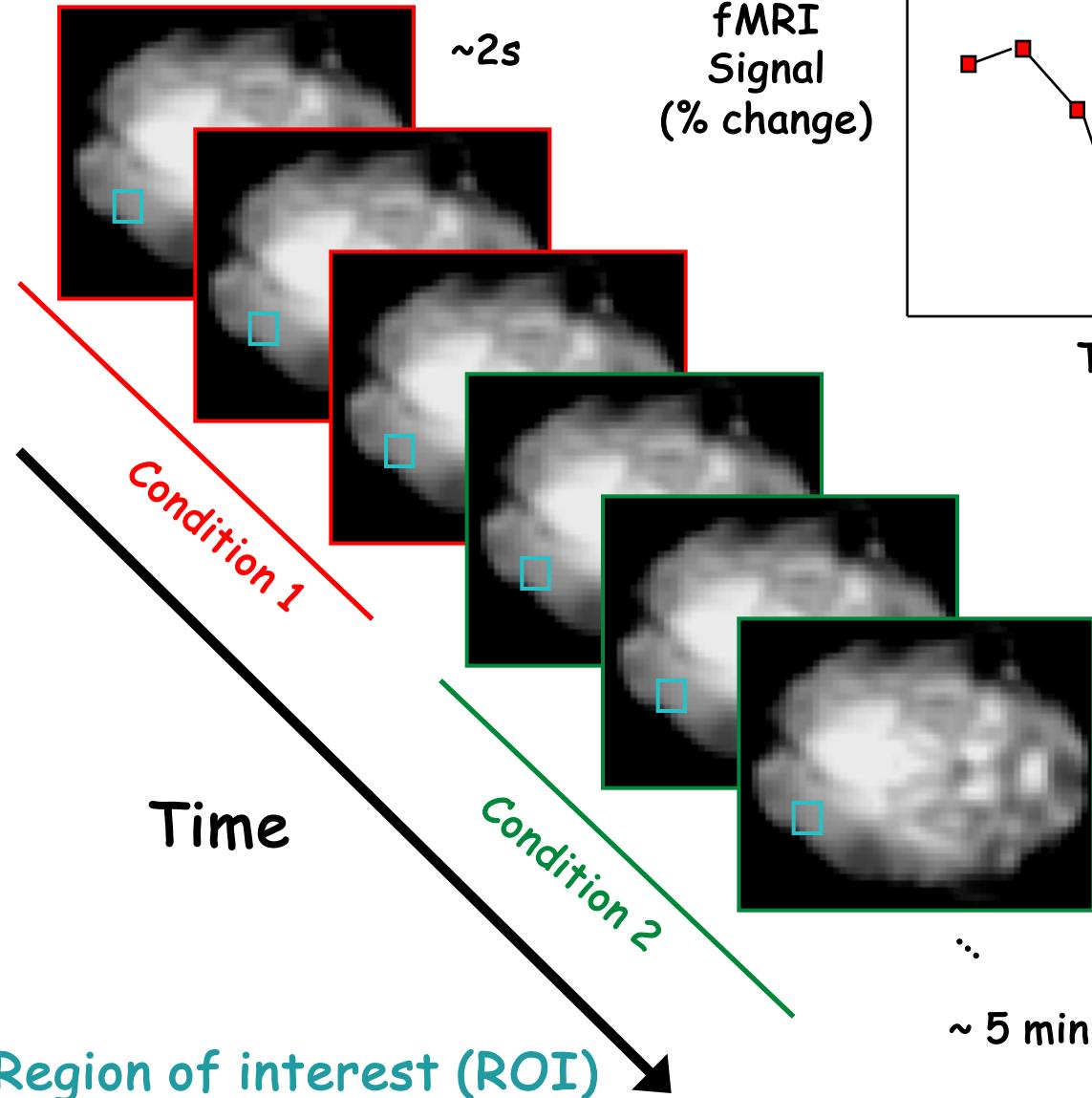


BOLD Contrast Imaging

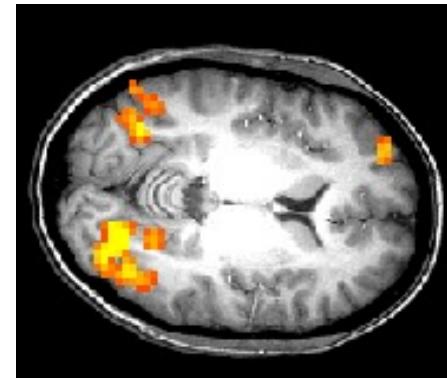


Activation Statistics

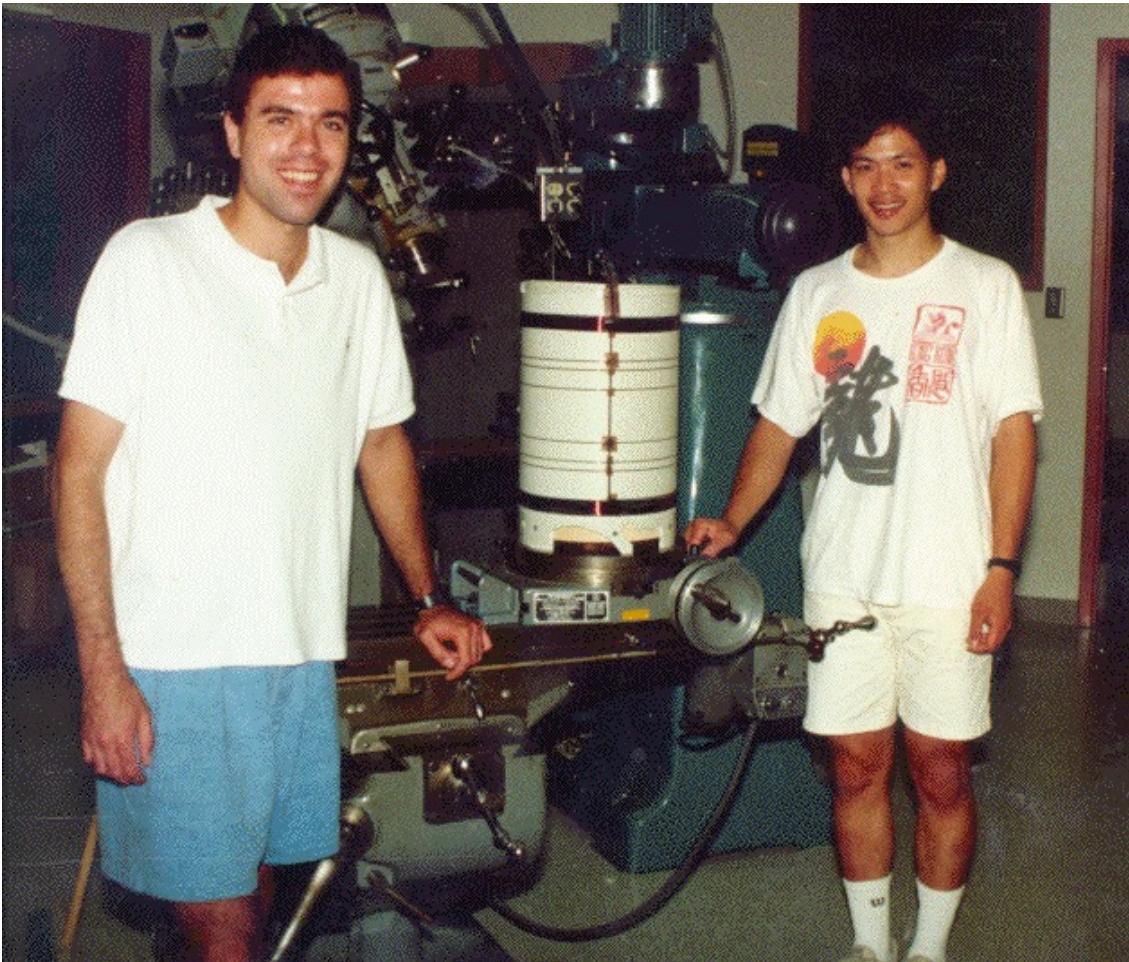
Functional images



Statistical Map
superimposed on
anatomical MRI image







August, 1991

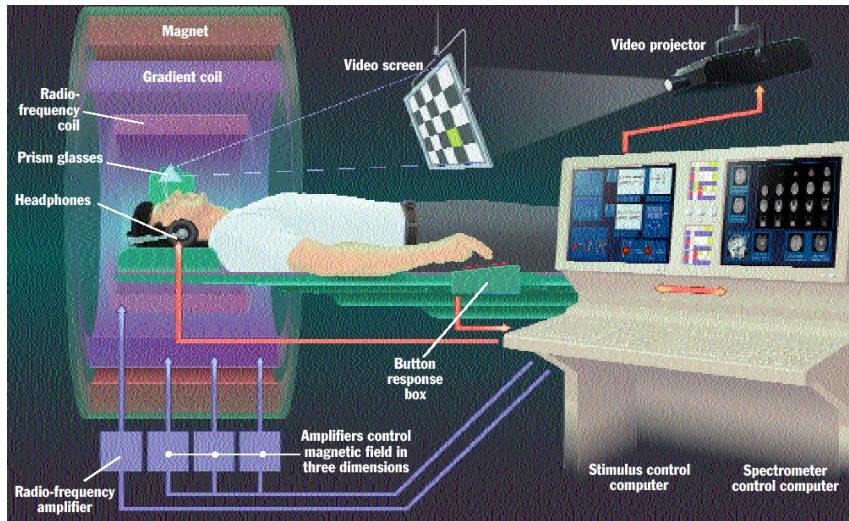
1991-1992



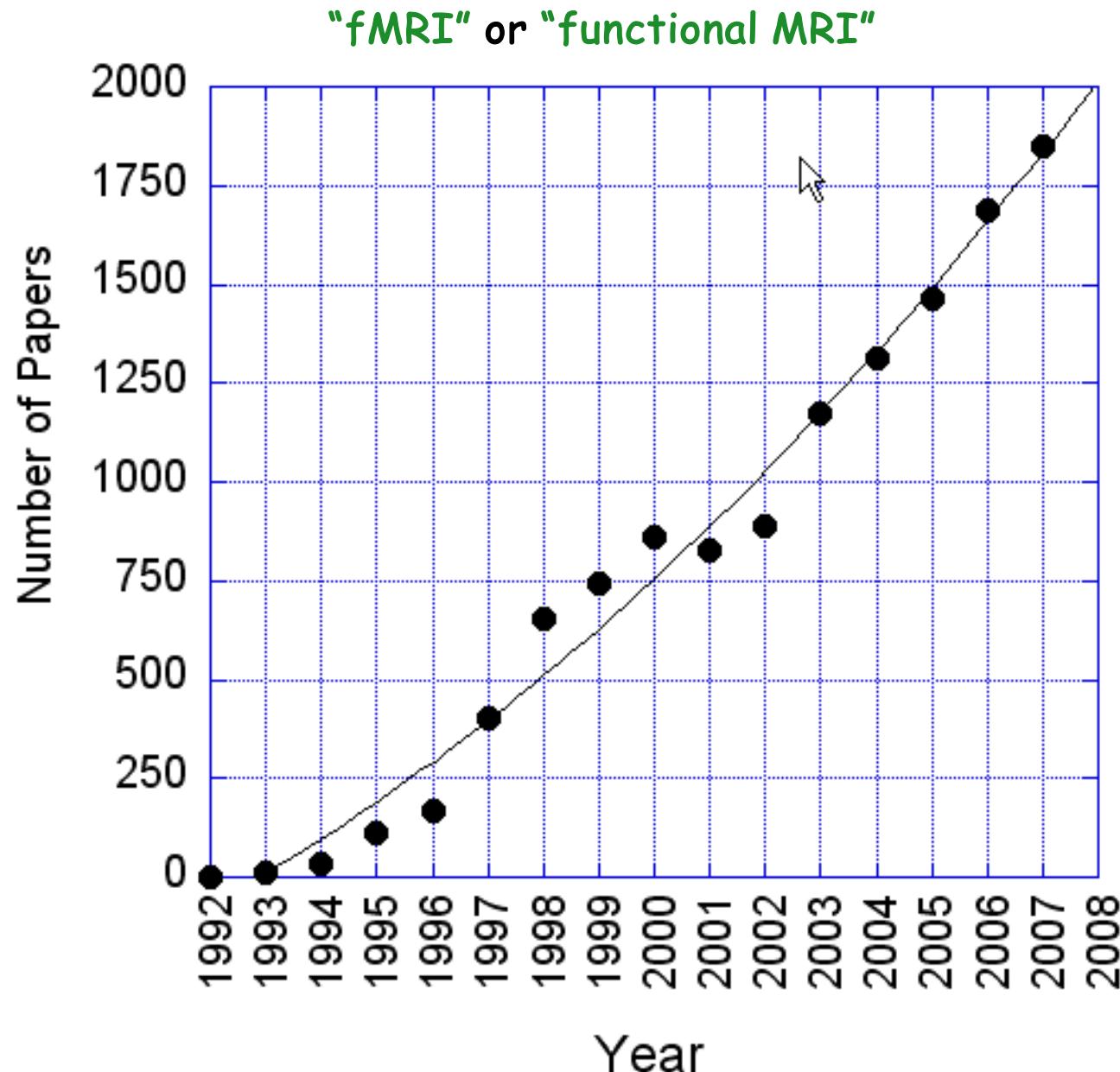
1992-1999



fMRI Setup

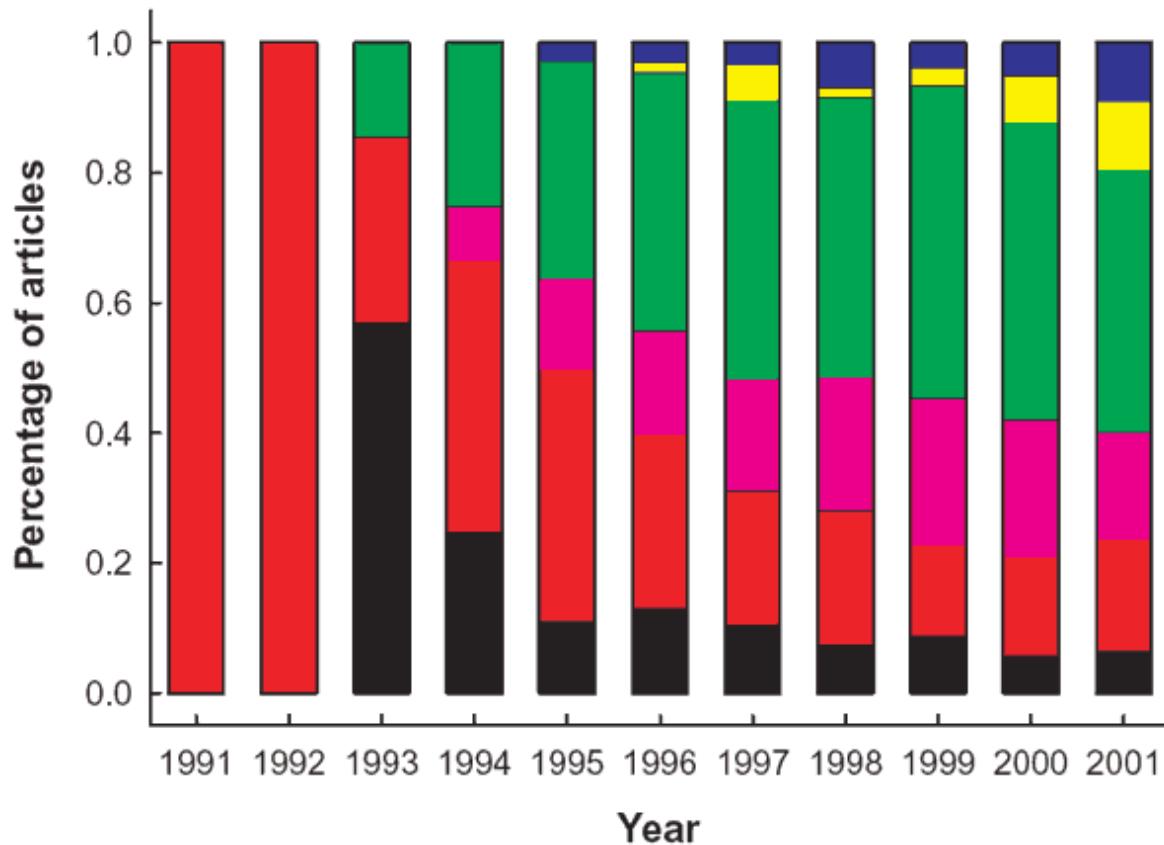


Scopus: Articles or Reviews Published per Year

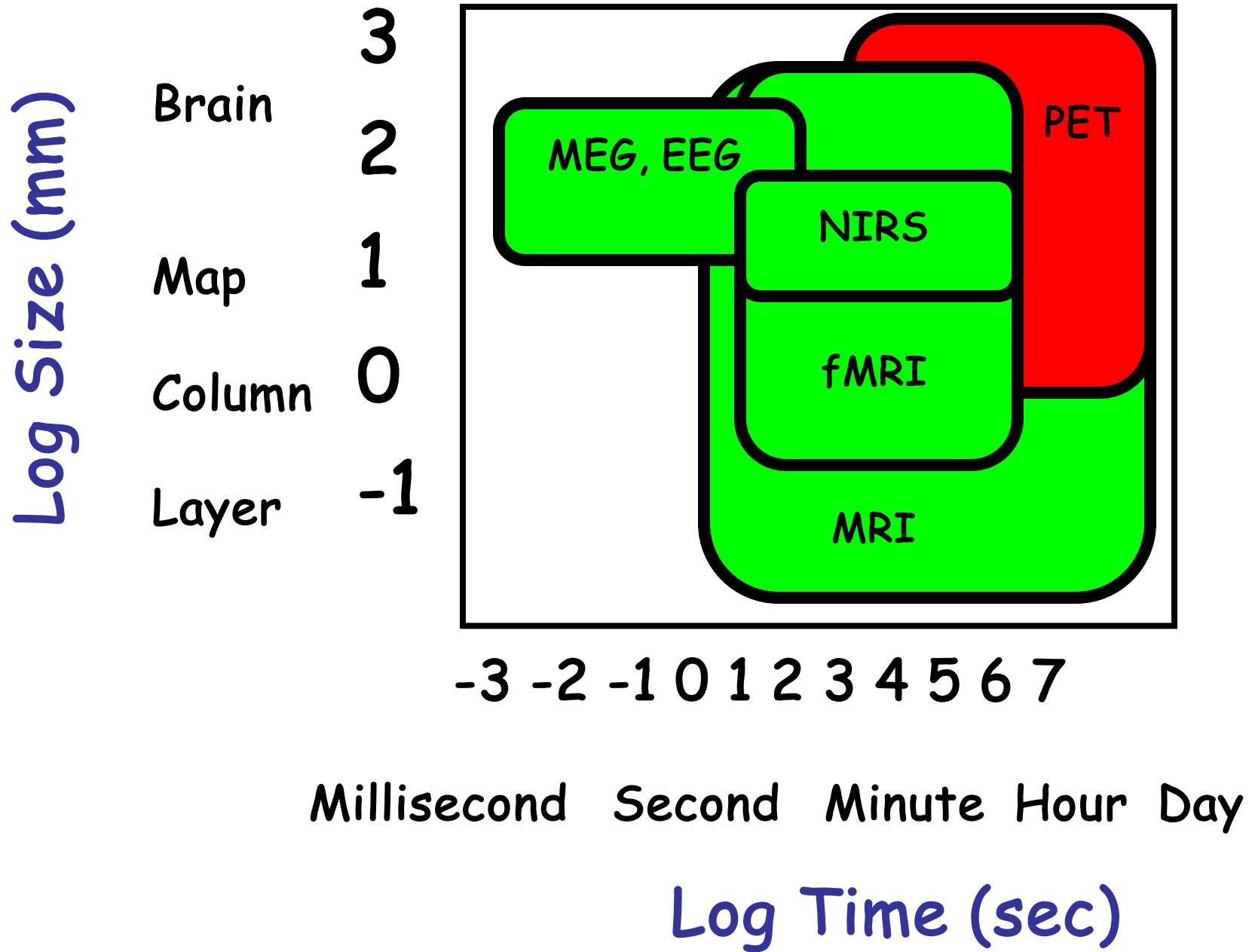


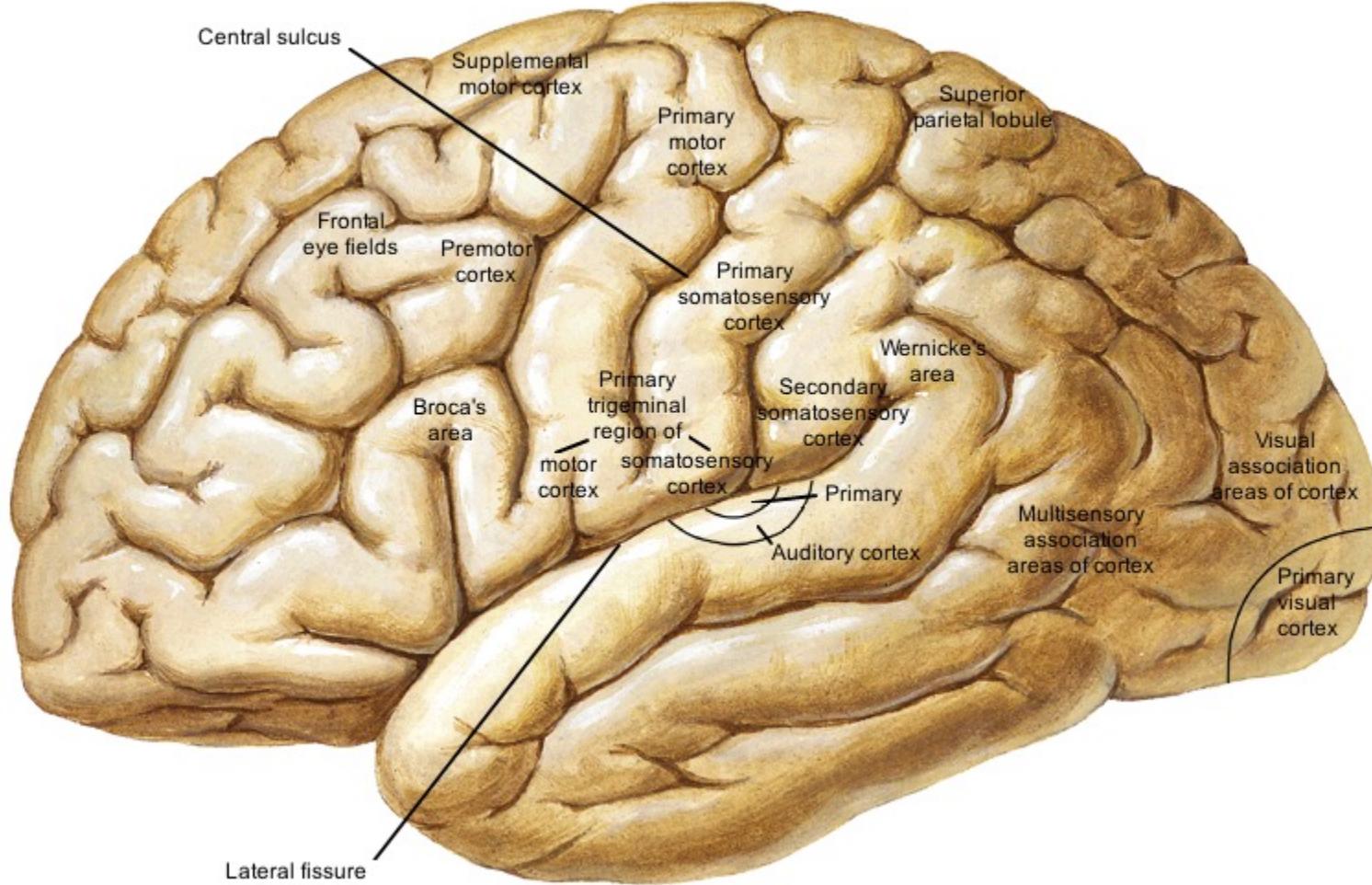
Type of fMRI research performed

Motor
Primary Sensory
Integrative Sensory
Basic Cognition
High-Order Cognition
Emotion

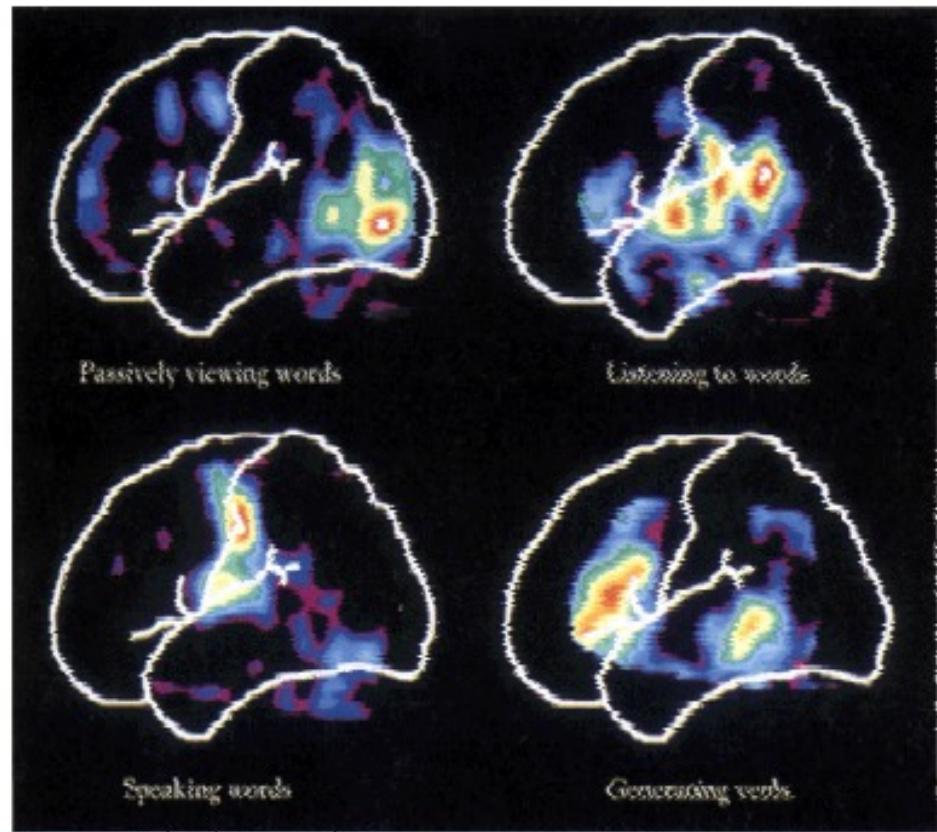


J. Illes, M. P. Kirsch, J. D. E. Gabrielli,
Nature Neuroscience, 6 (3) p.205, 2001





Positron Emission Tomography (PET)



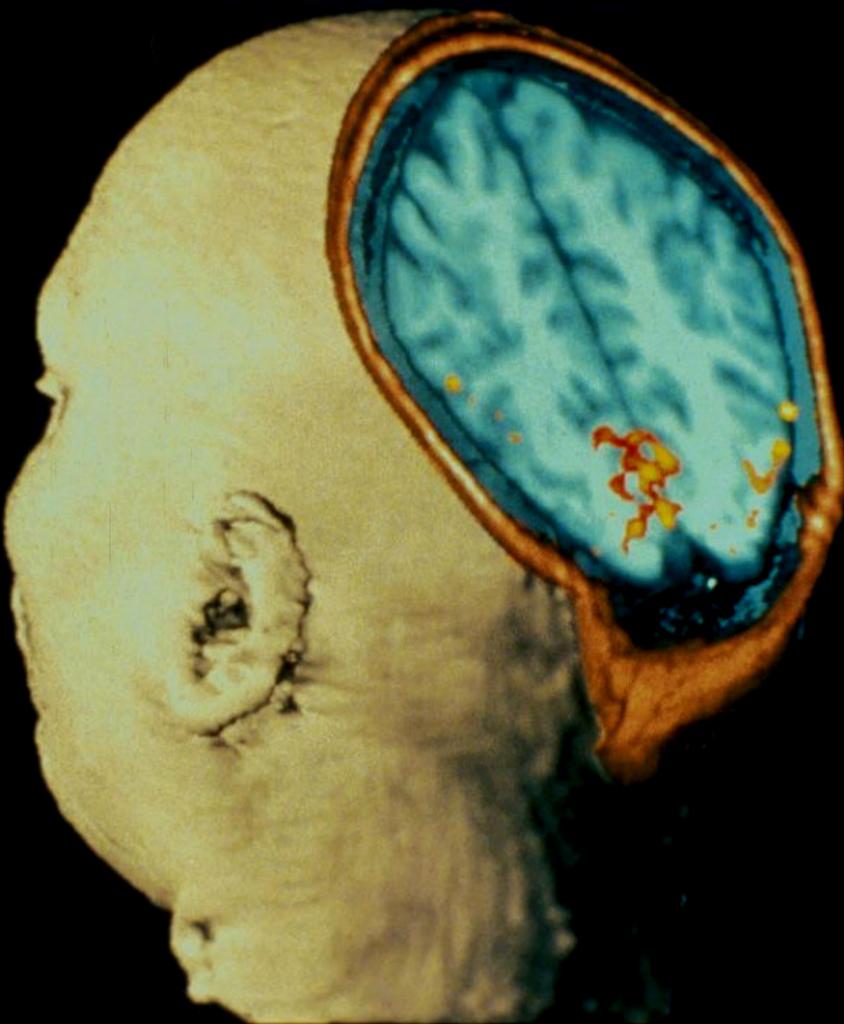
The first fMRI paper

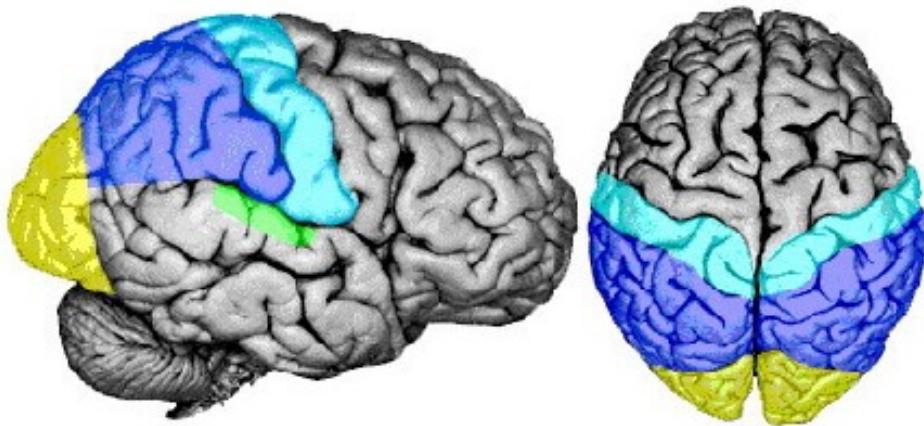
**Photic
Stimulation**

**MRI Image showing
activation of the
Visual Cortex**

**From Belliveau, et al.
Science Nov 1991**

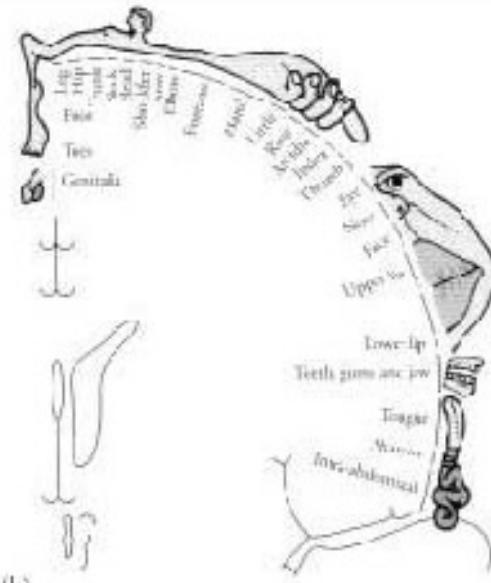
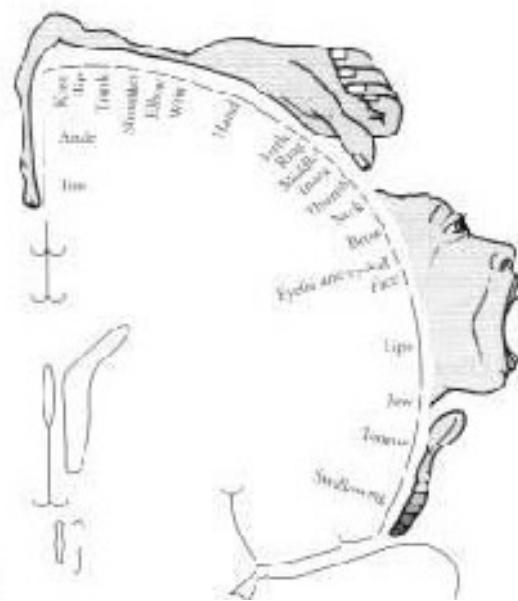
MSC - perfusion





**Parietal/
Somatosensory**
**Parietal/
Association Area**

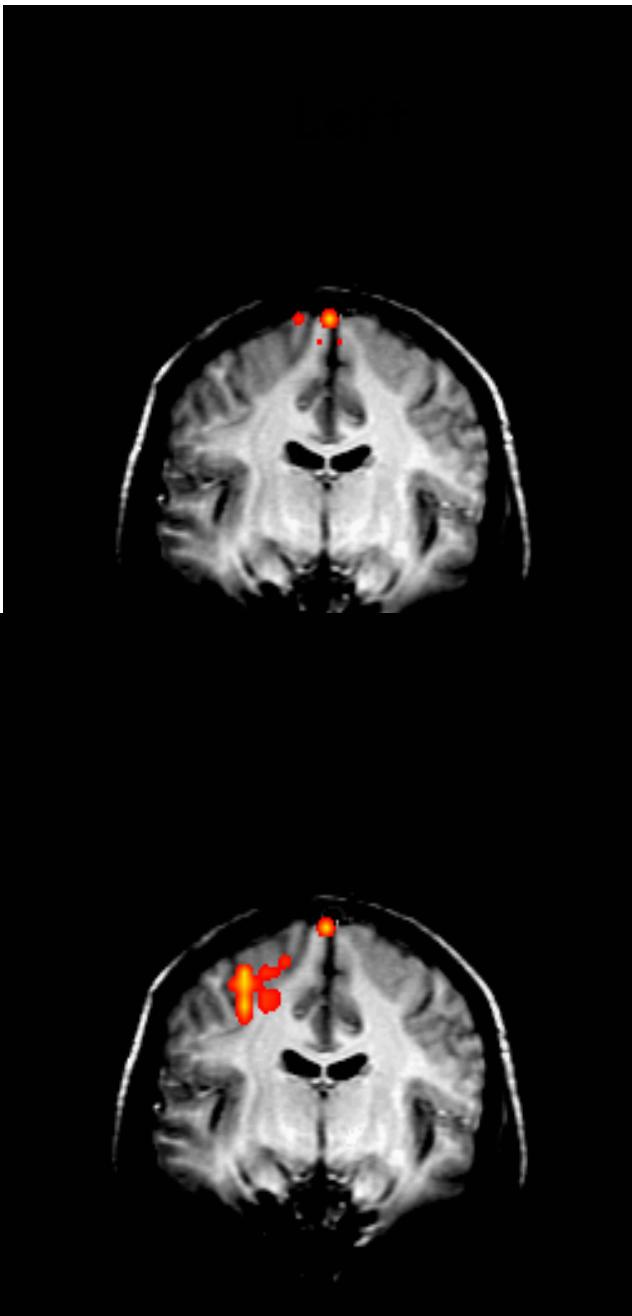
Occipital/Vision
Auditory



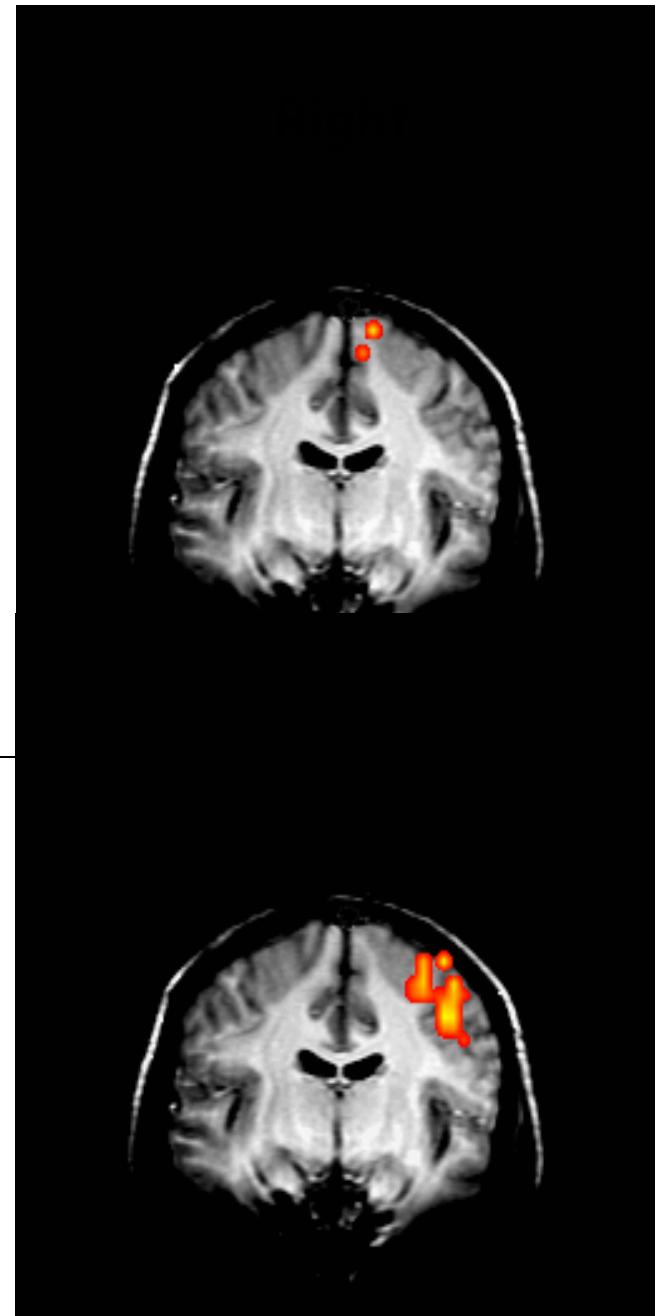
(b)

(c)

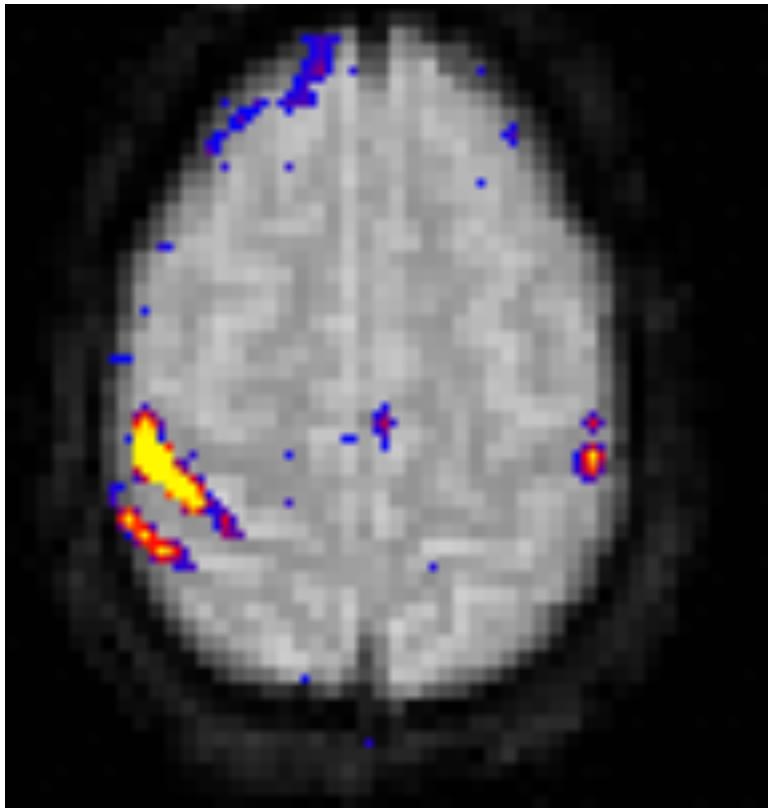
Toe movement



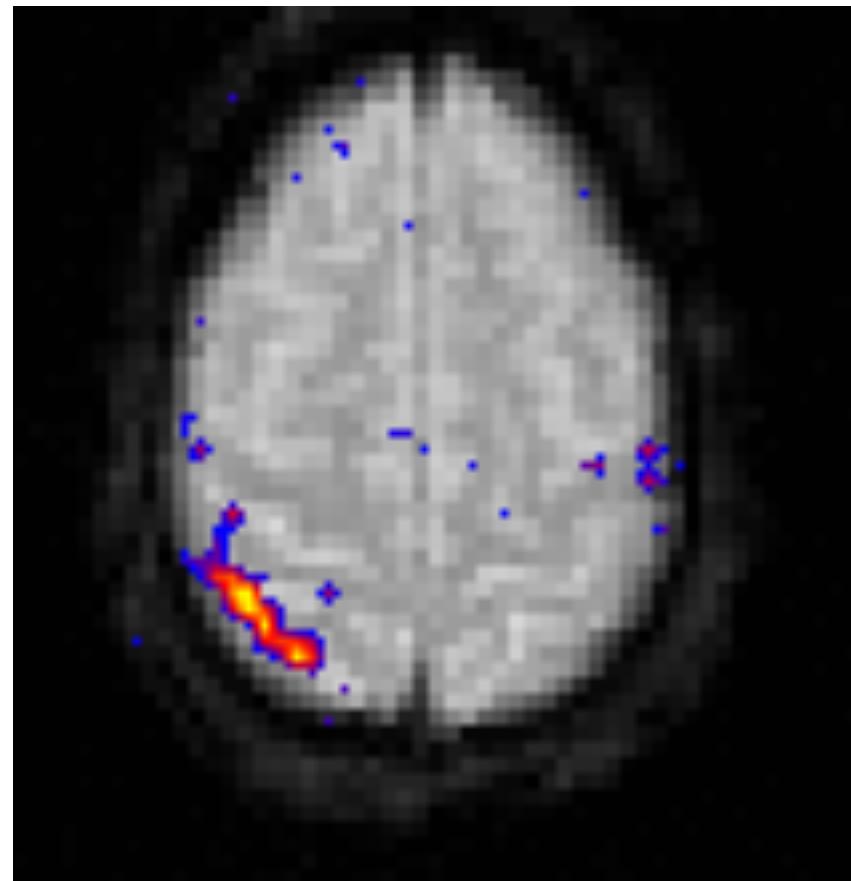
Finger movement



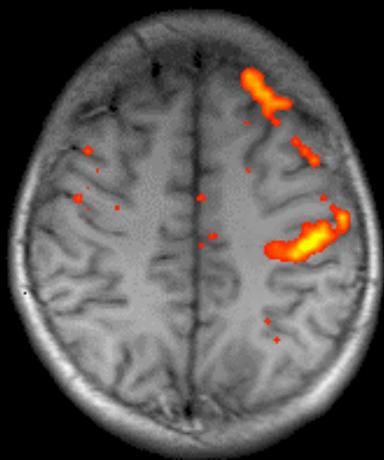
Finger Movement



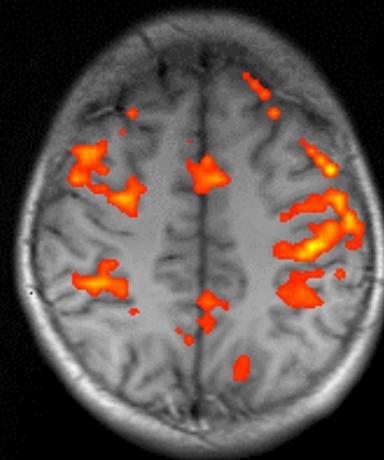
Tactile Stimulation



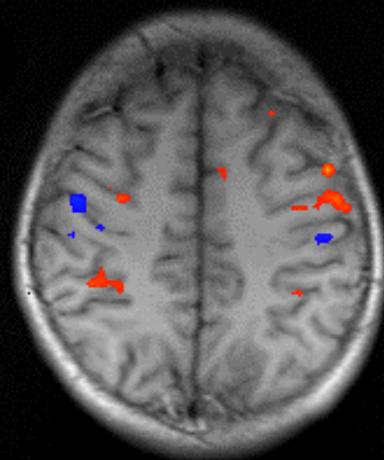
Simple Right



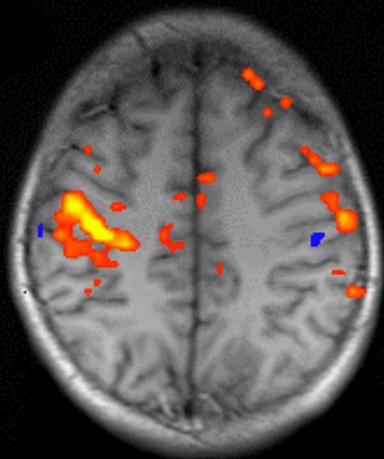
Complex Right



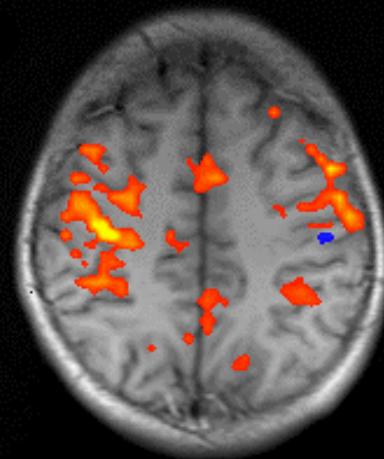
Complex Right



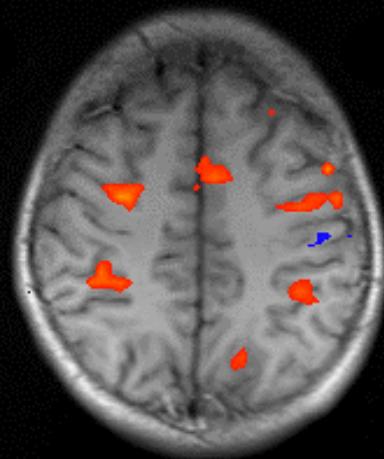
Simple Left



Complex Left

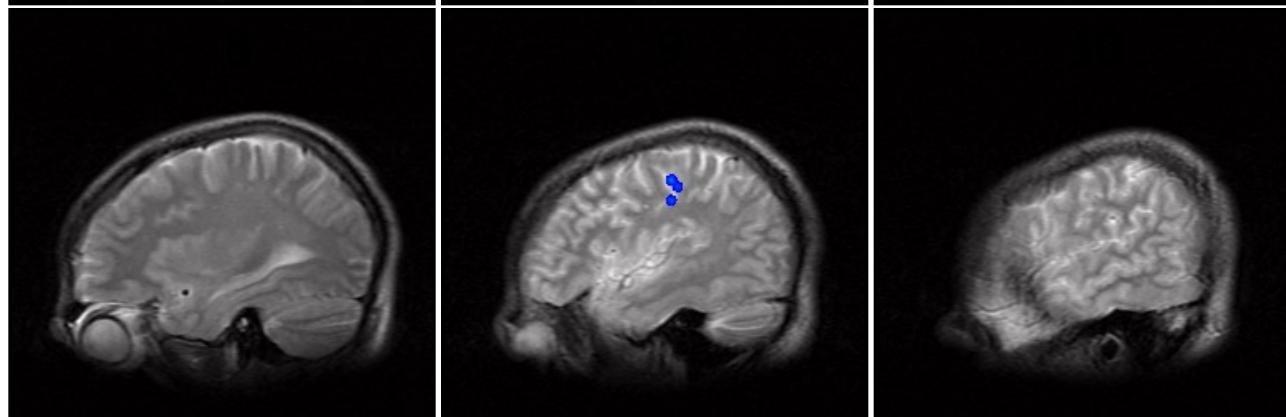
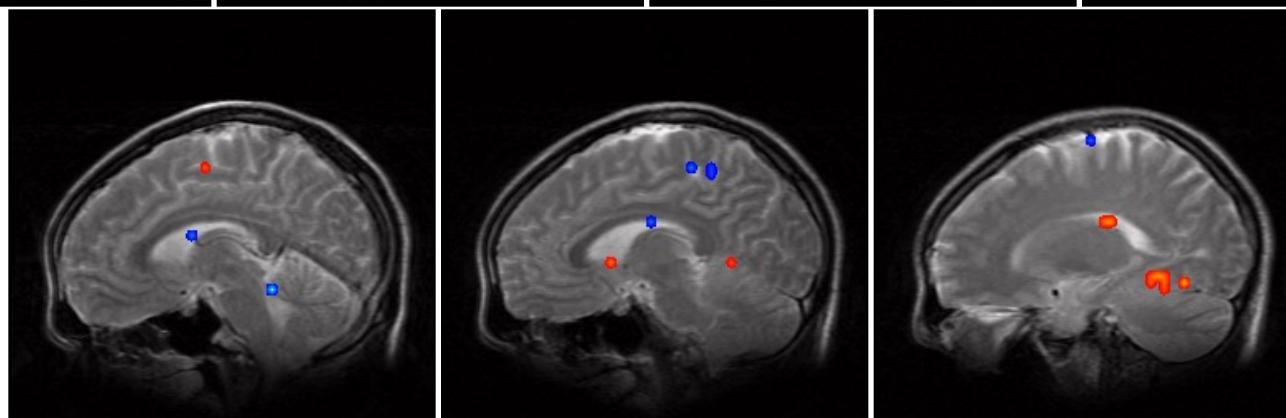
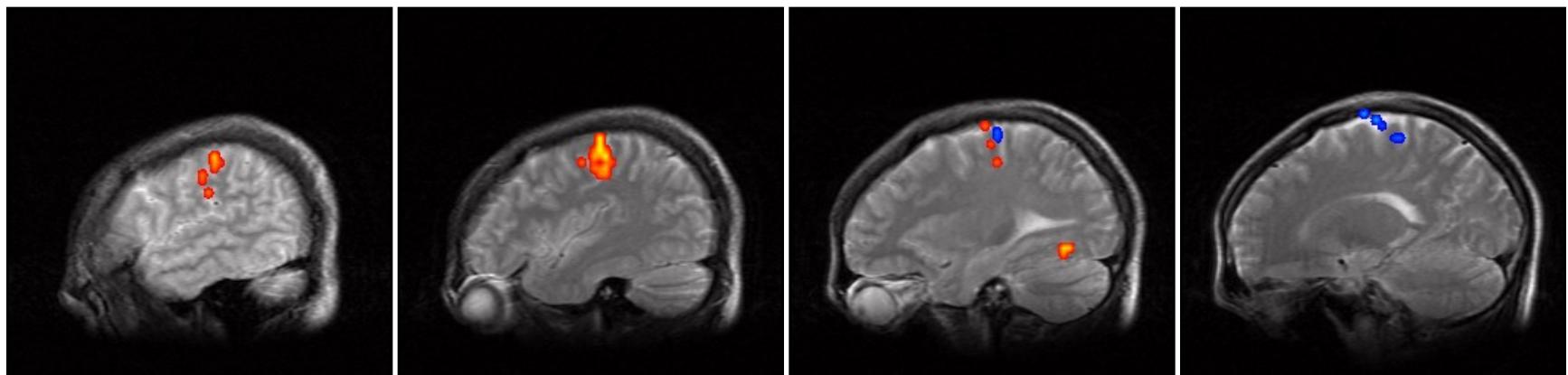


Imagined
Complex Left



Left

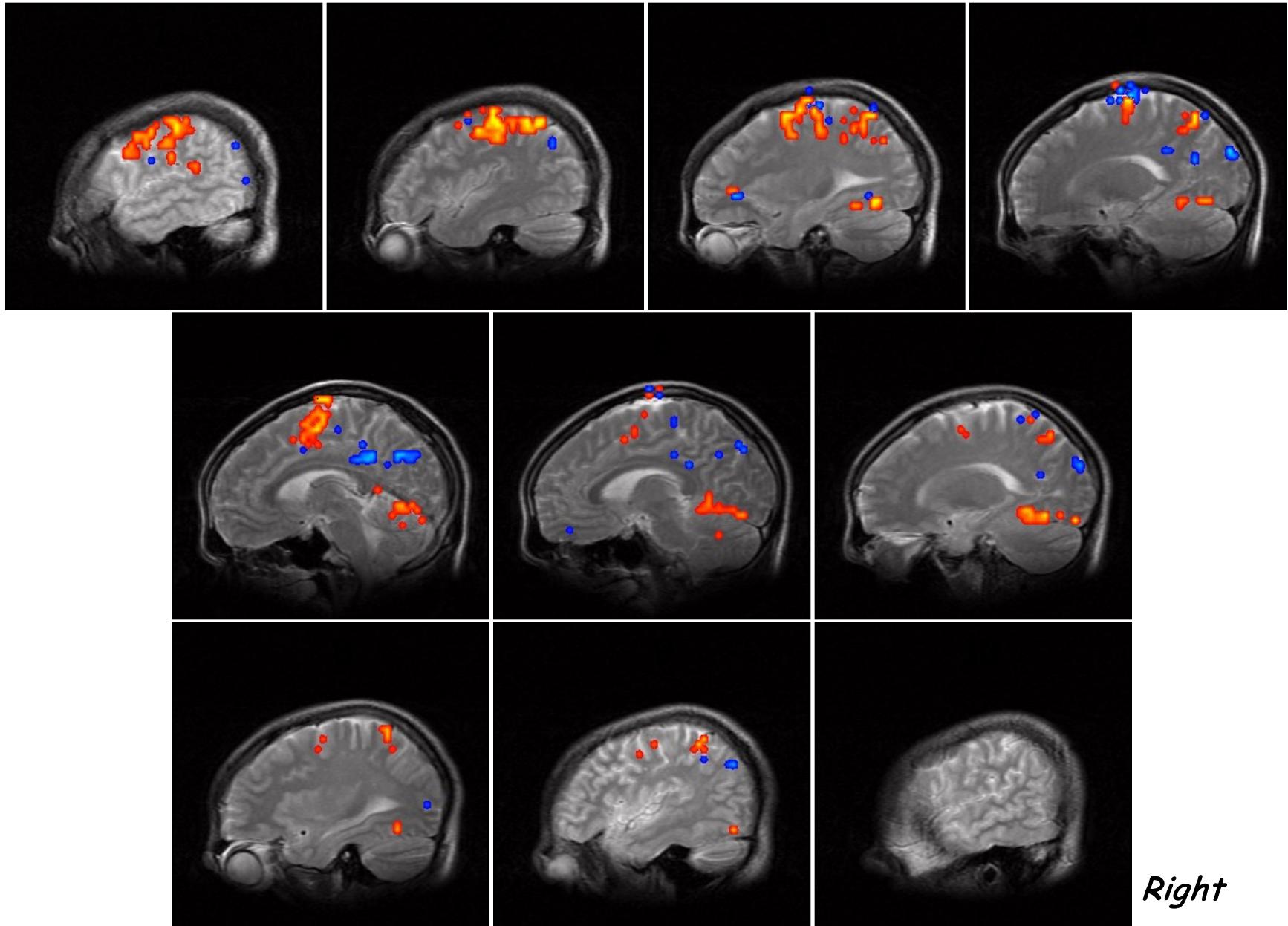
Simple Finger Movement on the Right Hand



Right

Left

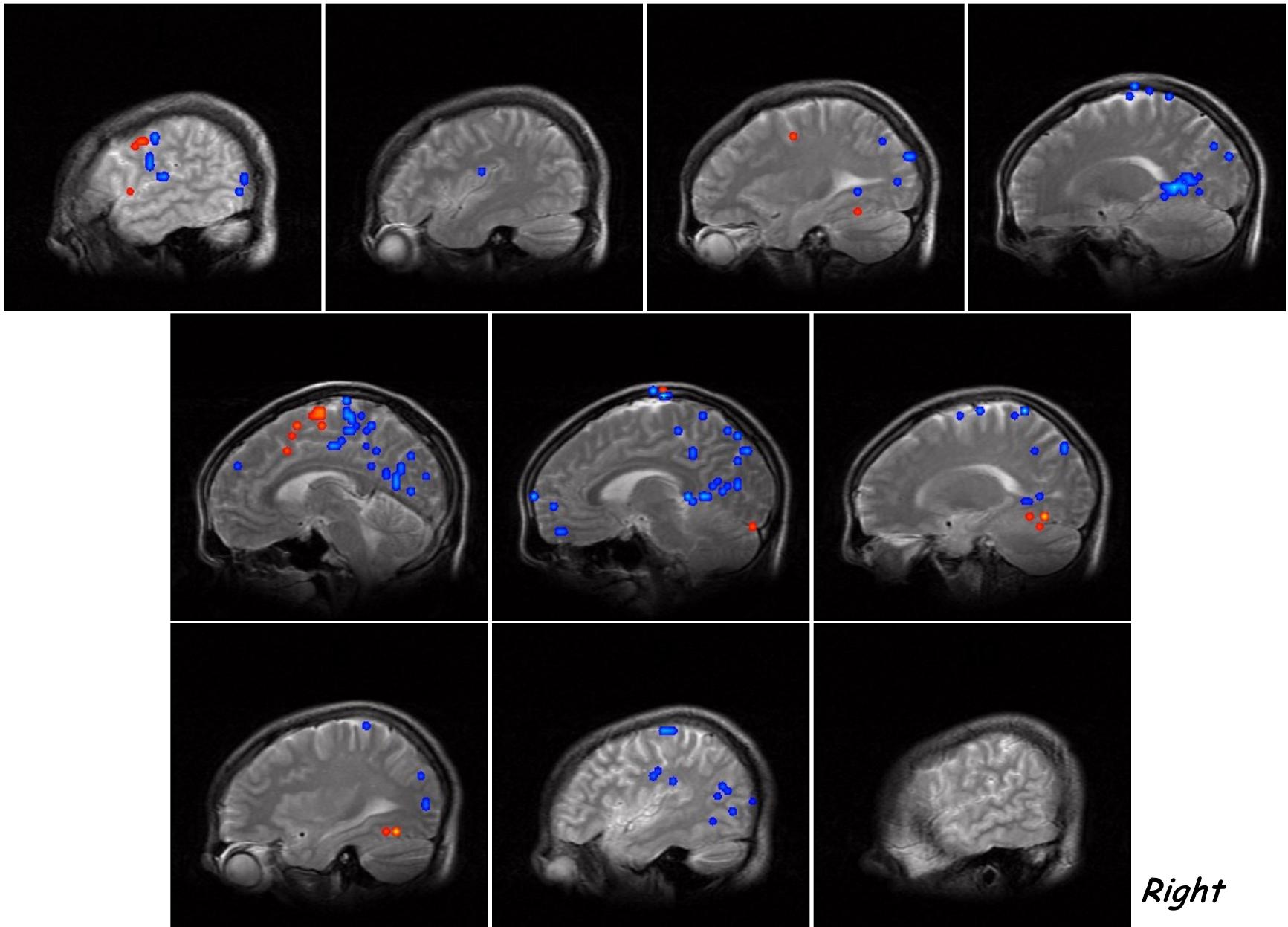
Complex Finger Movement on the Right Hand



Right

Left

Imagined Complex Finger Movement on the Right Hand



Right

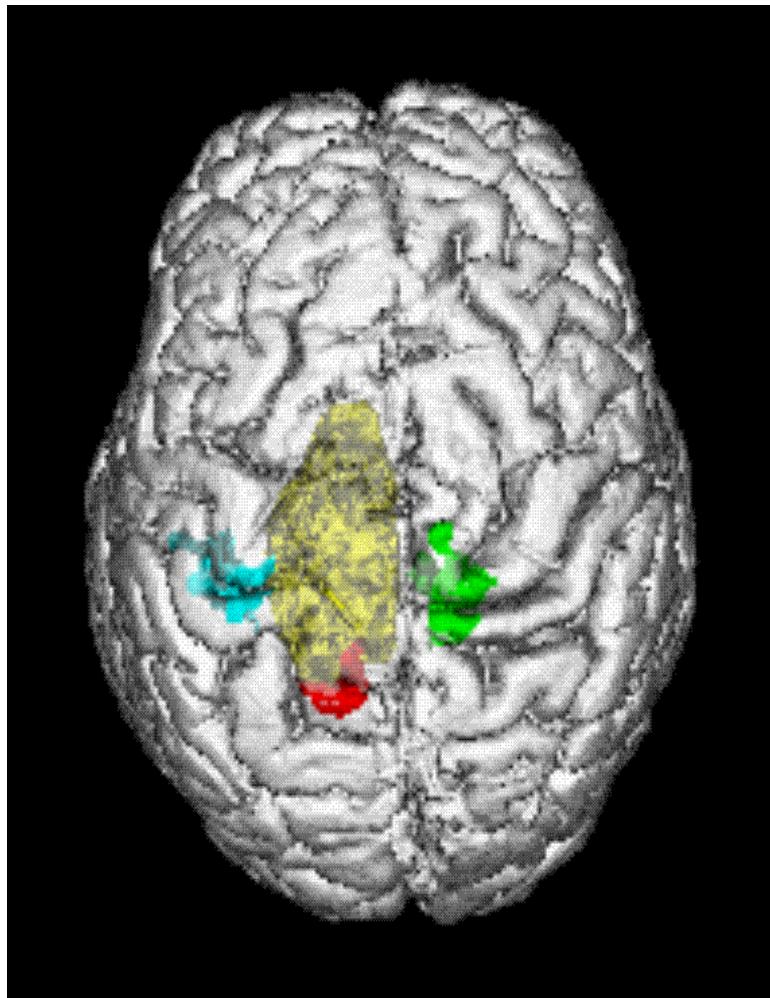
Presurgical Mapping

Left Foot

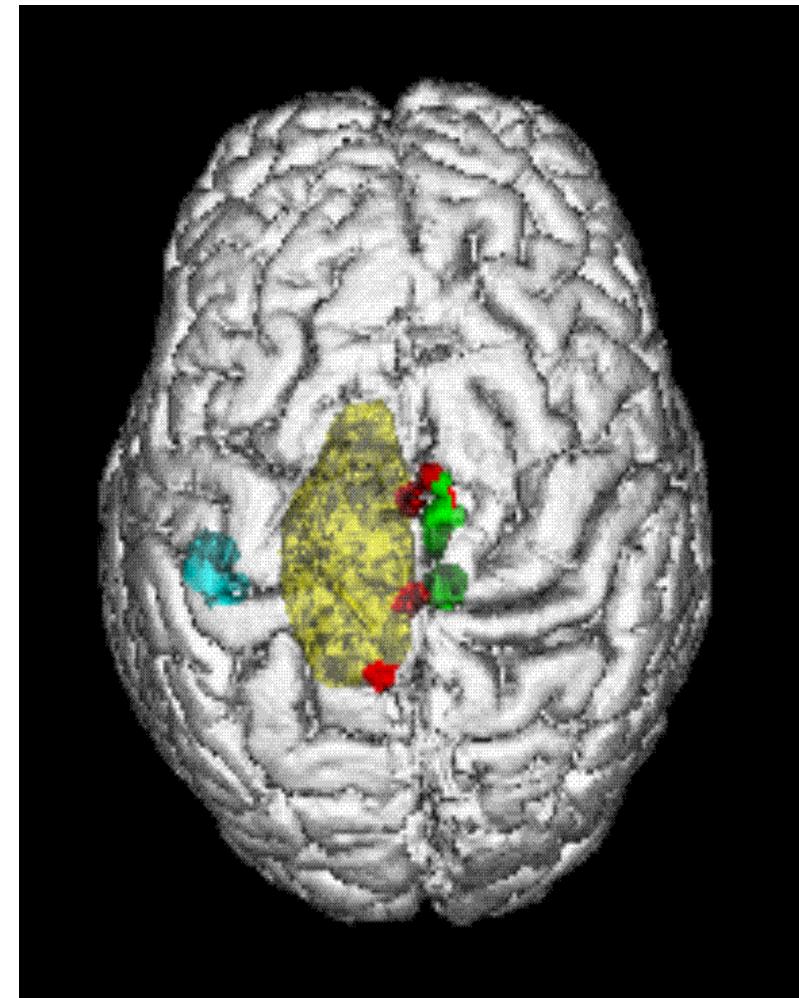
Tumor

Right Foot

Right Hand

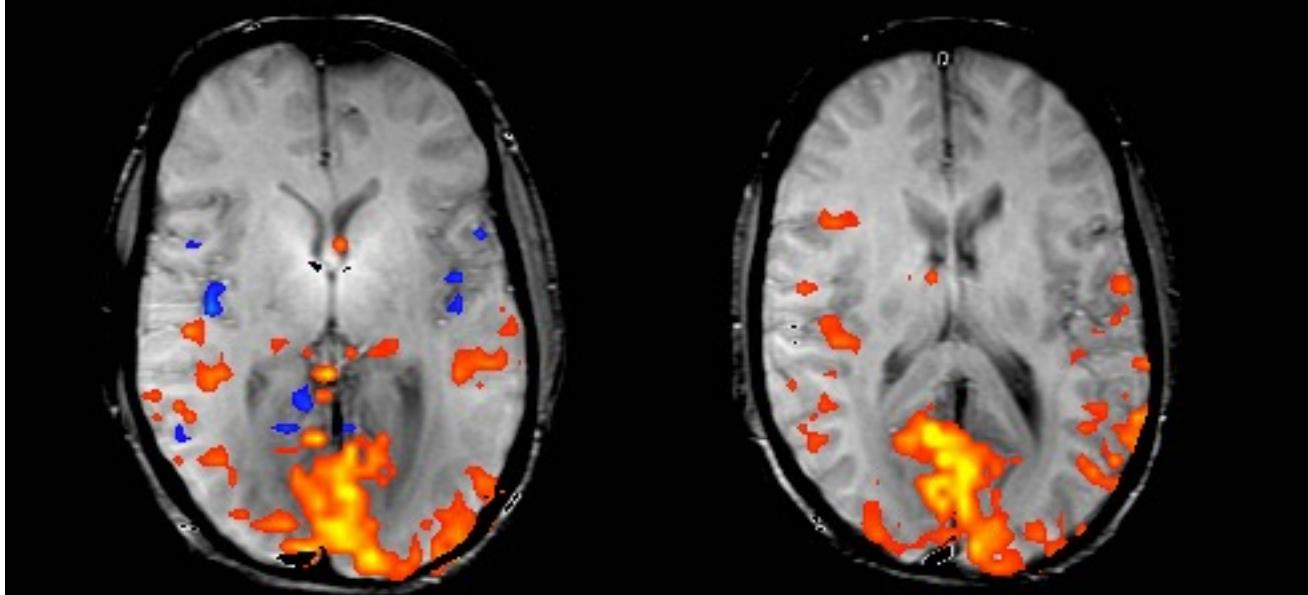


fMRI

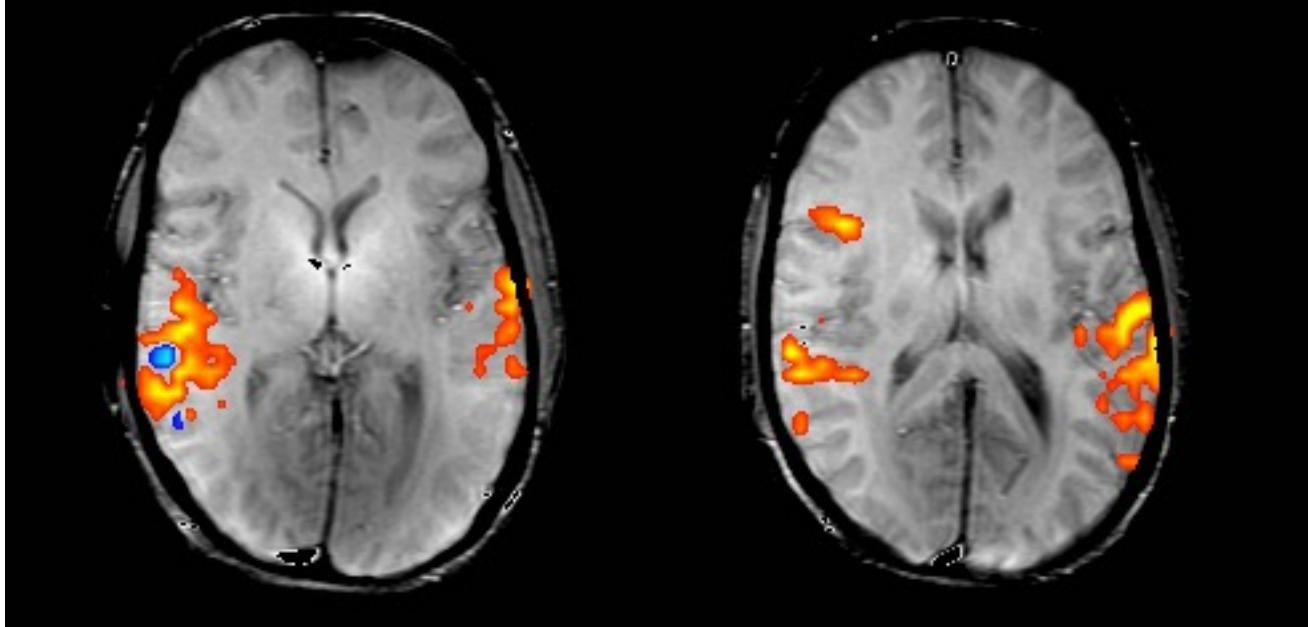


O-15 PET

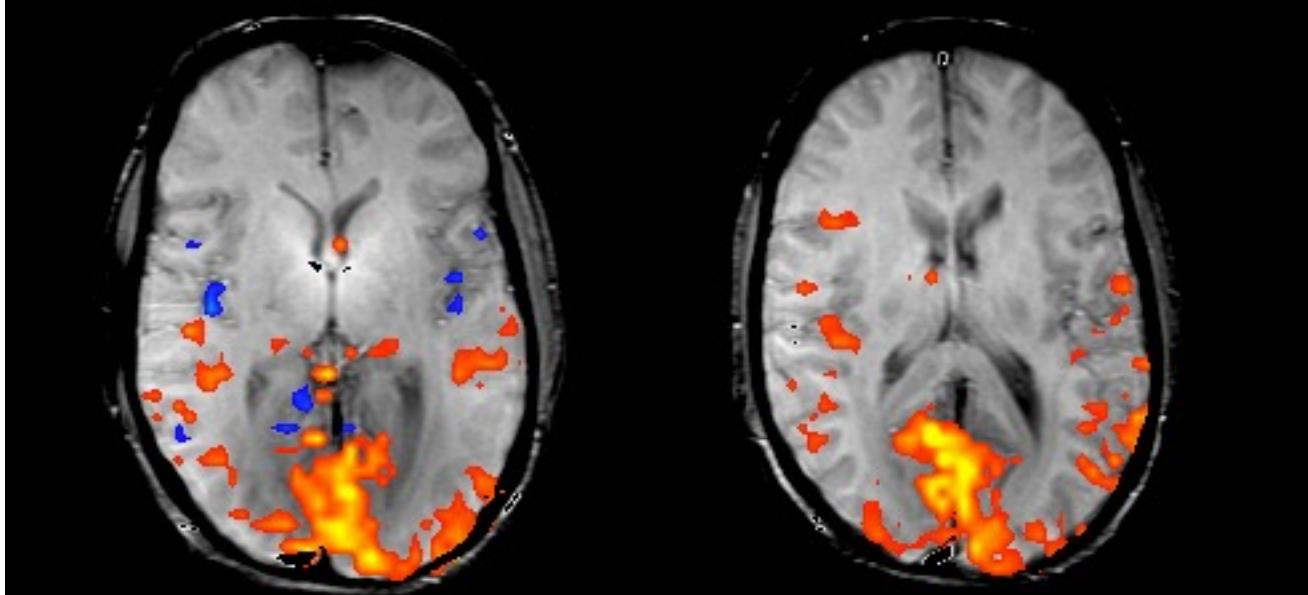
Reading



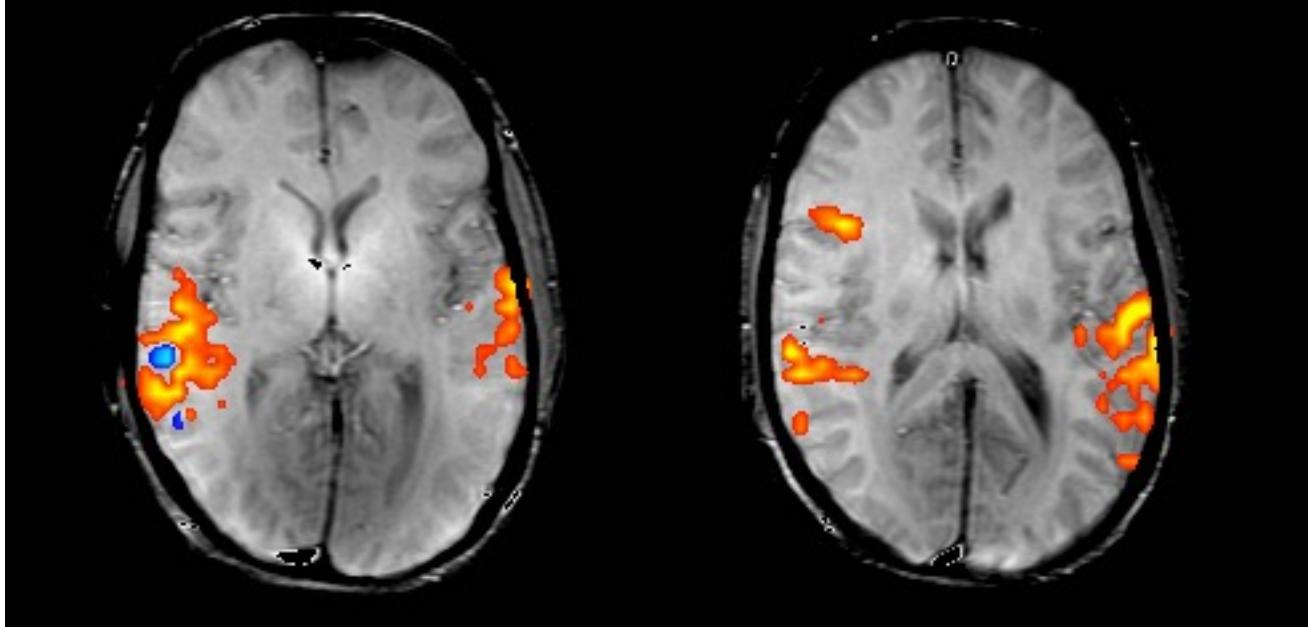
Listening



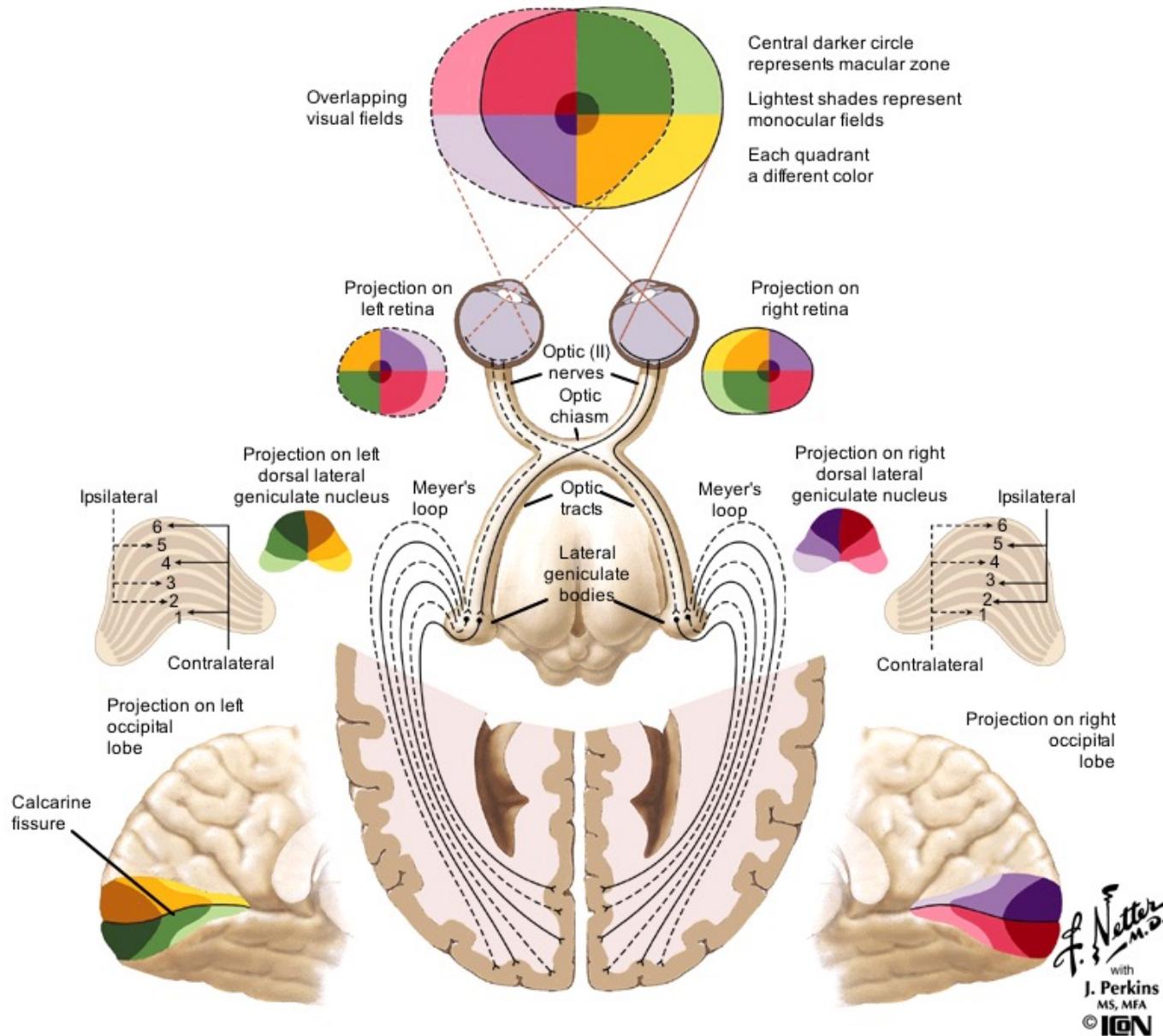
Reading

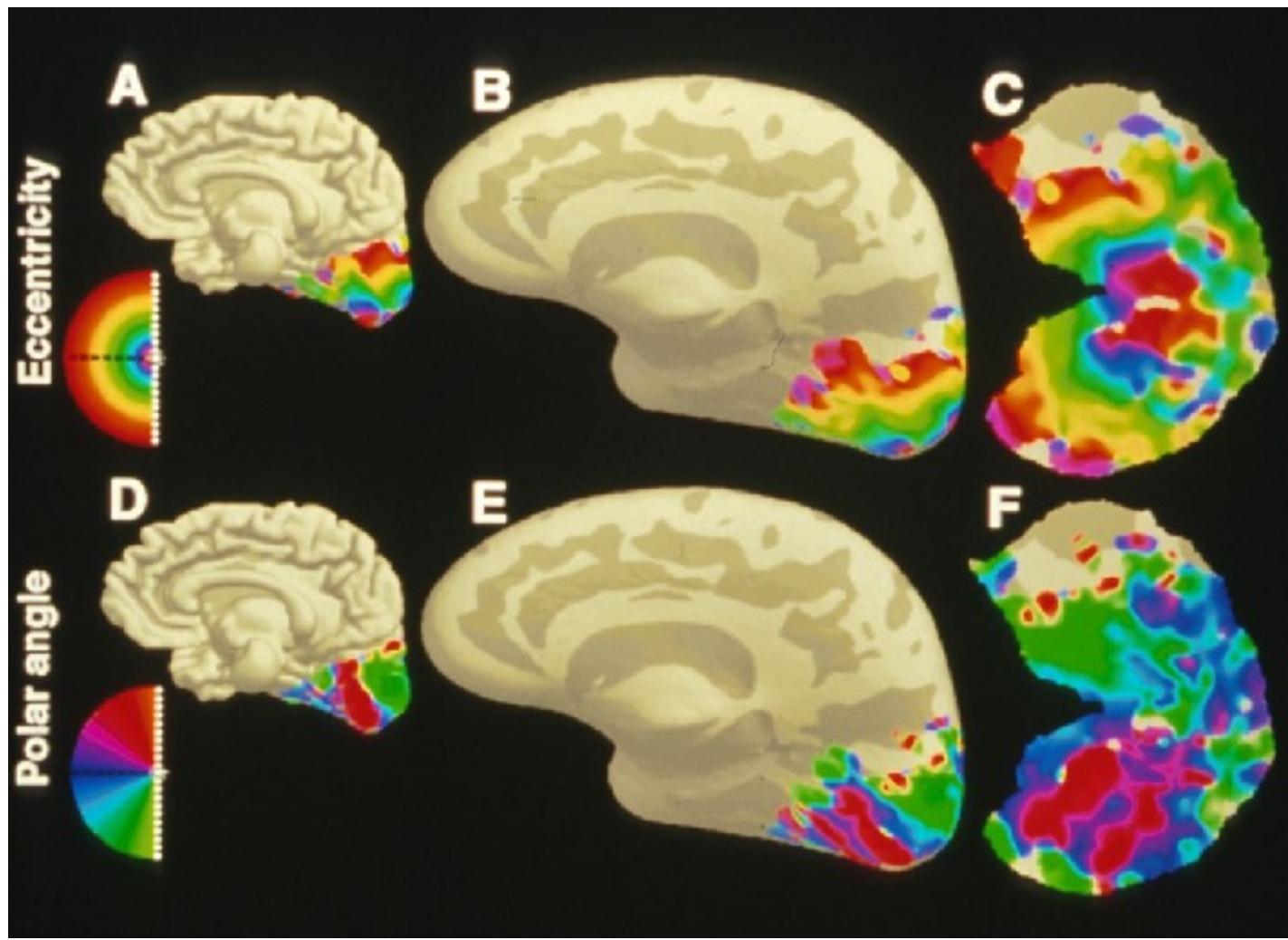


Listening

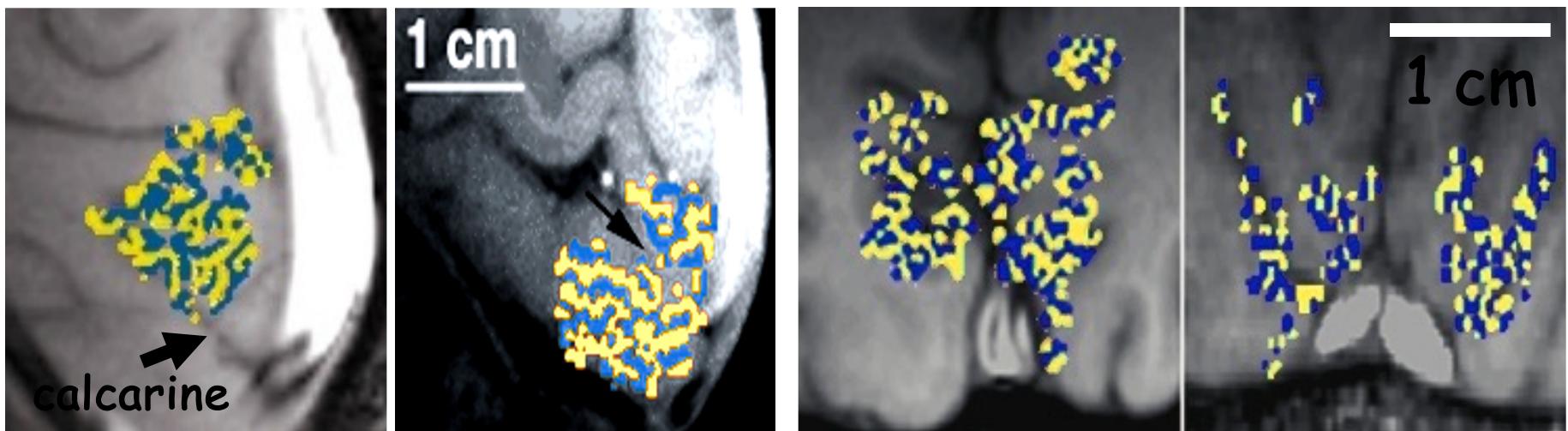


Visual Pathways: The Retino-Geniculo-Calcarine Pathway





ODC Maps using fMRI



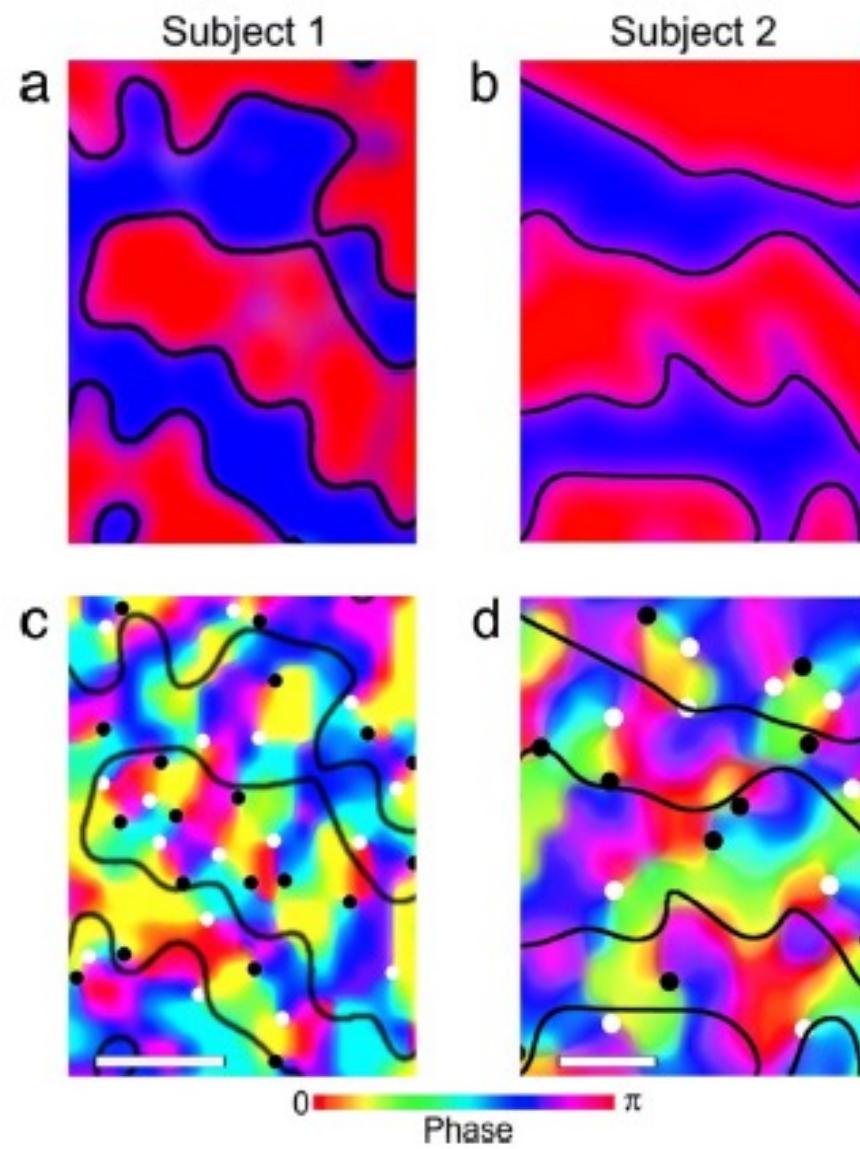
- Identical in size, orientation, and appearance to those obtained by optical imaging¹ and histology^{3,4}.

Menon et al.

¹Malonek D, Grinvald A. *Science* 272, 551-4 (1996).

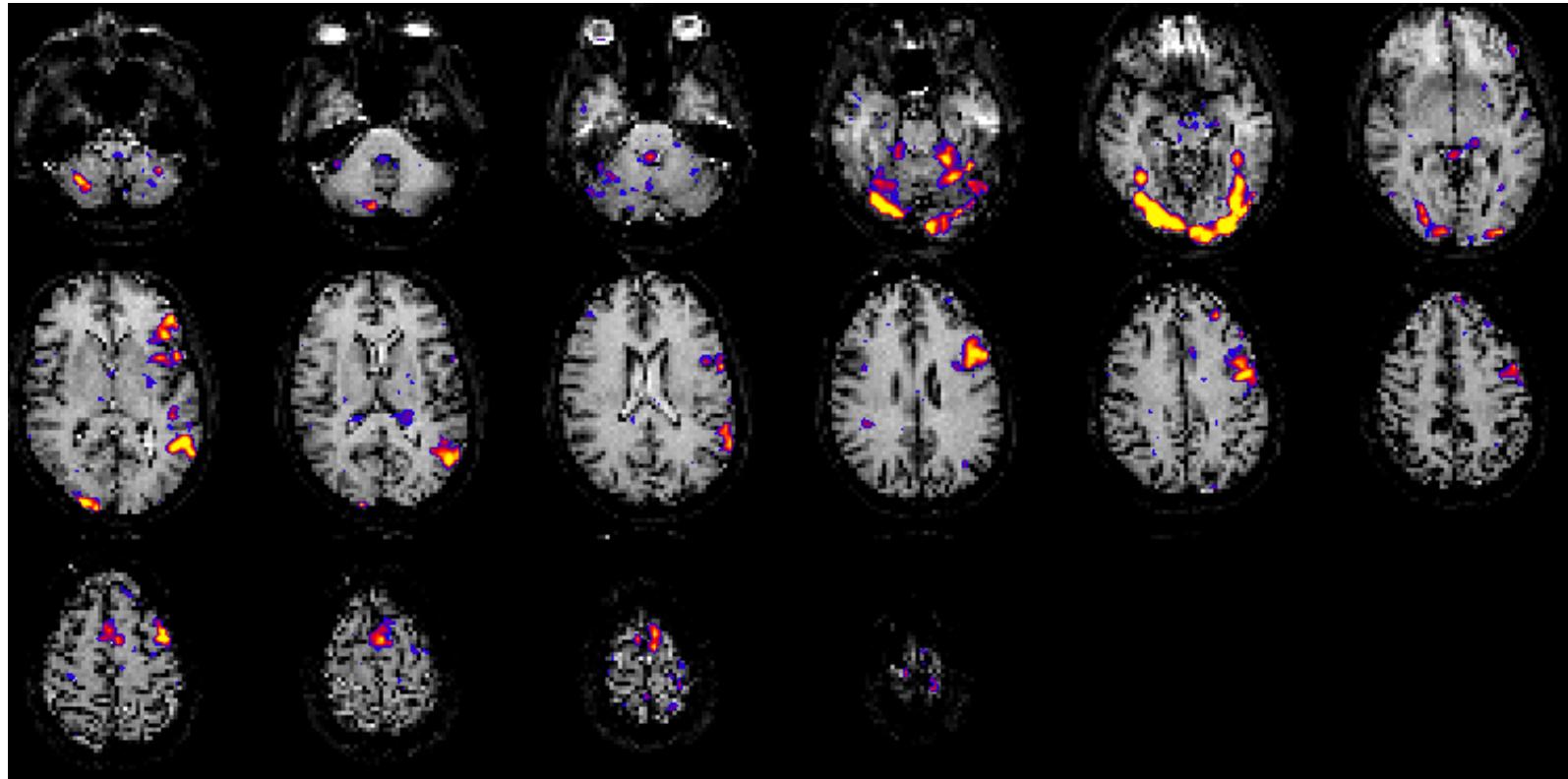
³Horton JC, Hocking DR. *J Neurosci* 16, 7228-39 (1996).

⁴Horton JC, et al. *Arch Ophthalmol* 108, 1025-31 (1990).



Yacoub et al. PNAS 2008

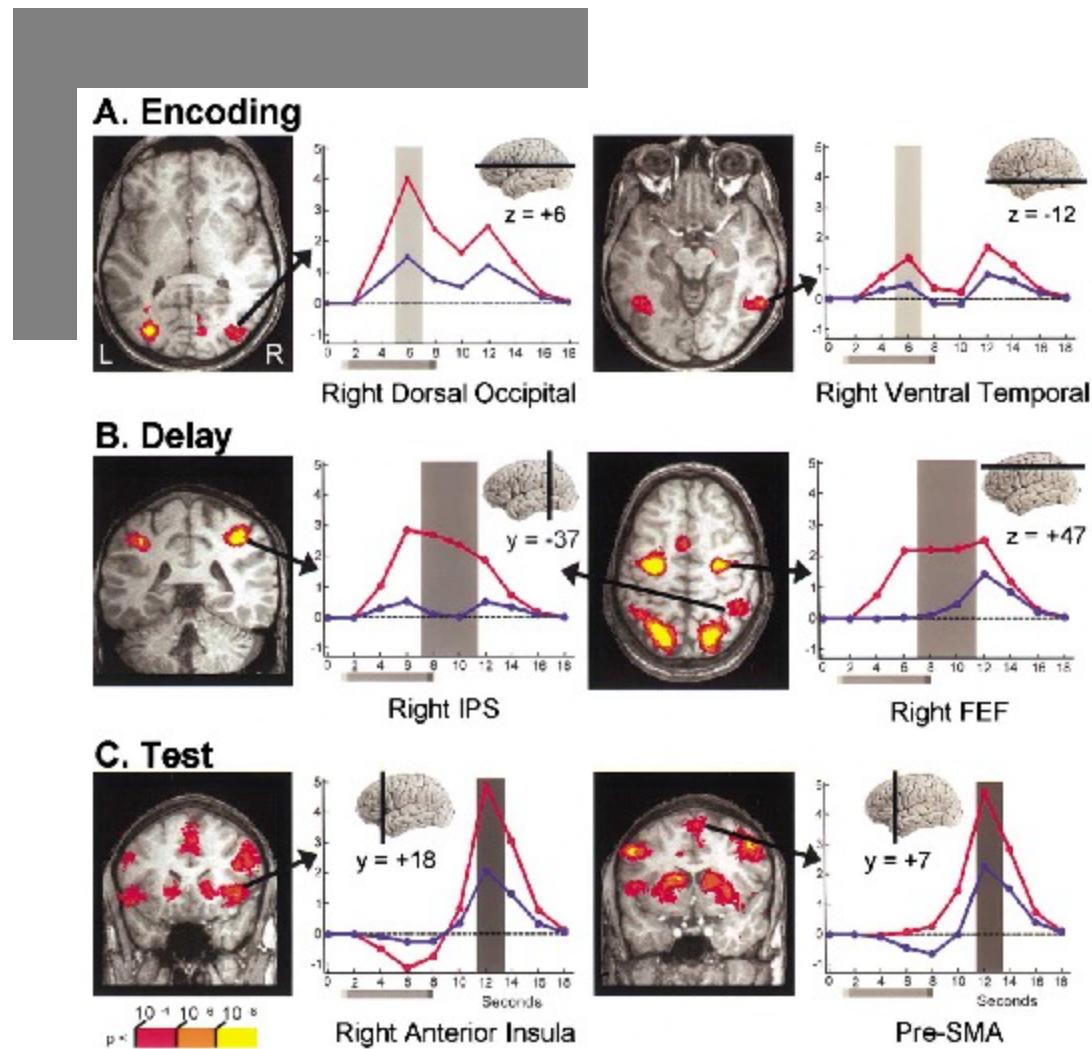
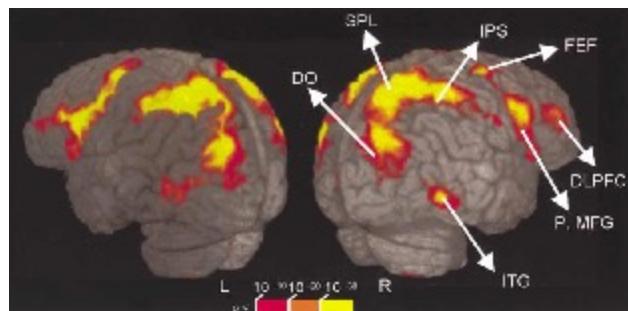
Word stem completion





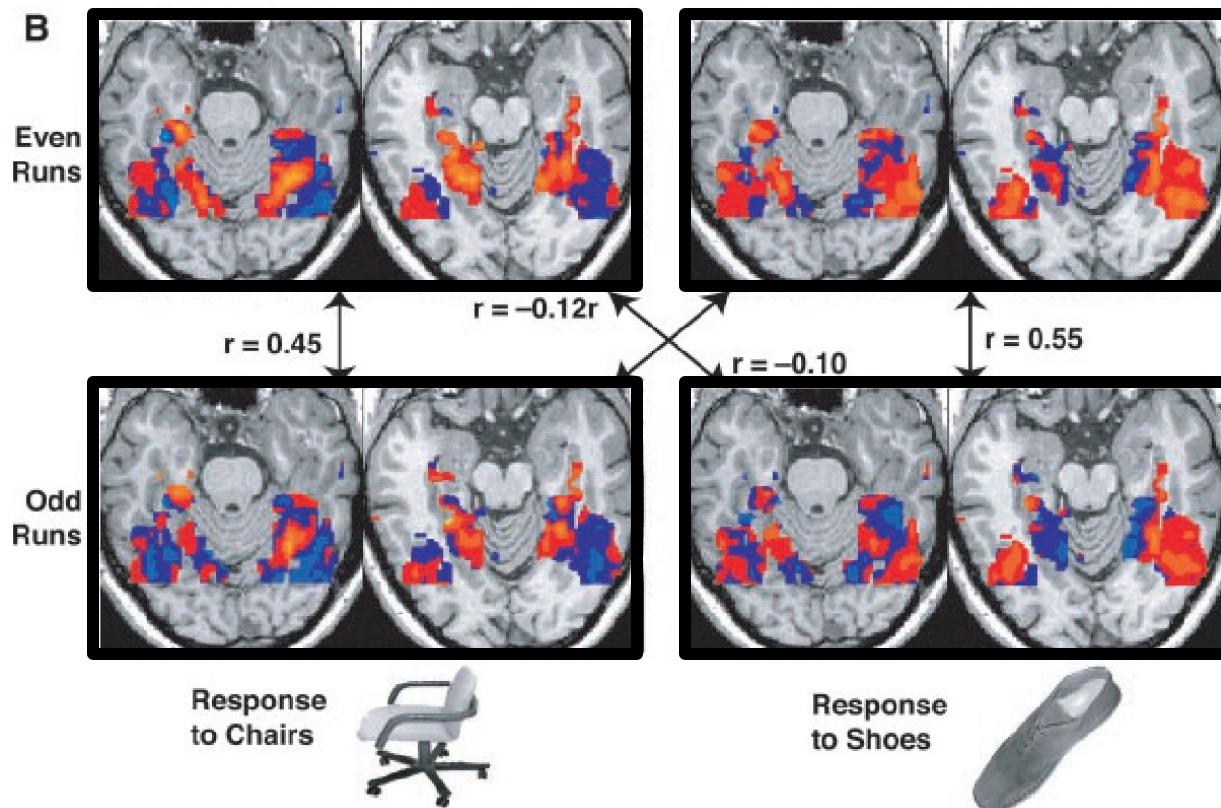
Neural Correlates of Visual Working Memory: fMRI Amplitude Predicts Task Performance

Luiz Pessoa,¹ Eva Gutierrez, Peter A. Bandettini,
and Leslie G. Ungerleider
Laboratory of Brain and Cognition
National Institute of Mental Health
National Institutes of Health
Bethesda, Maryland 20892



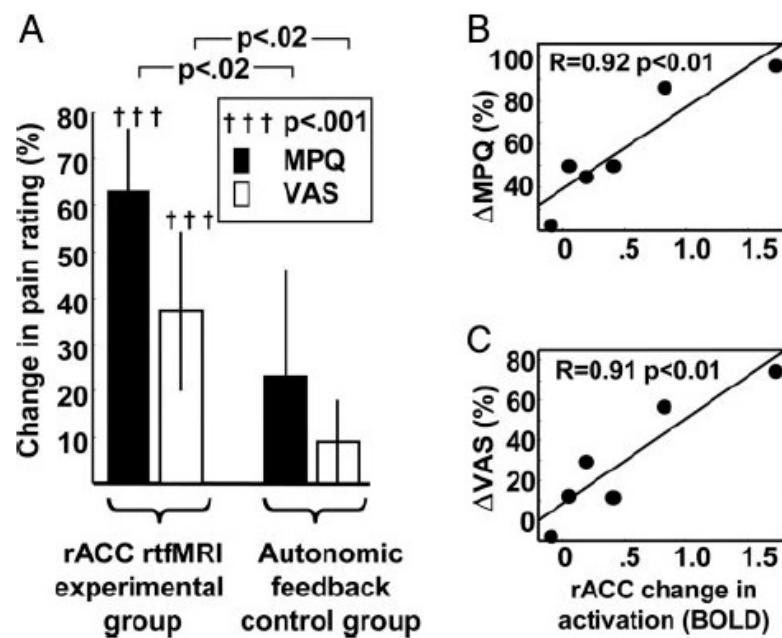
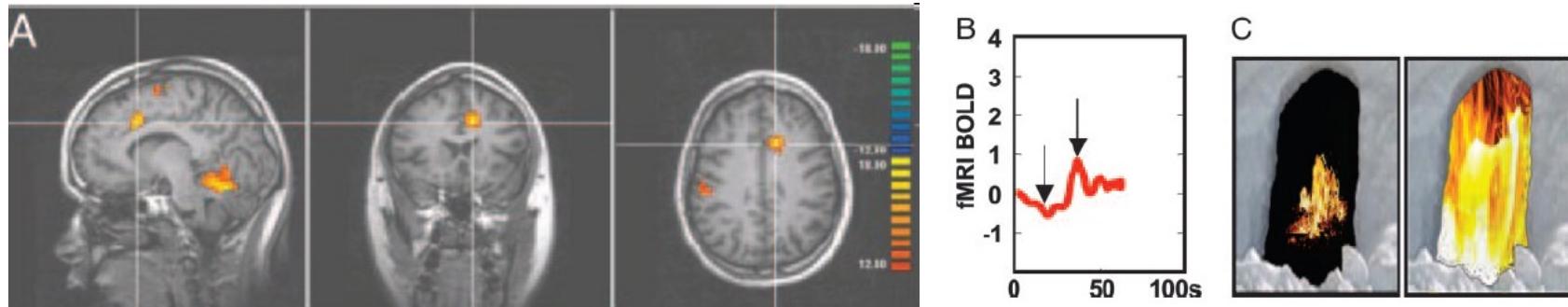
Ventral temporal category representations

Object categories are associated with distributed representations in ventral temporal cortex



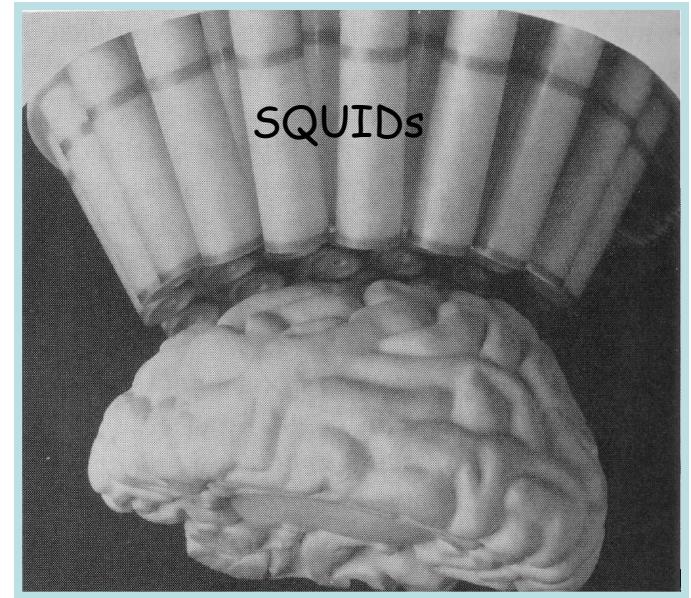
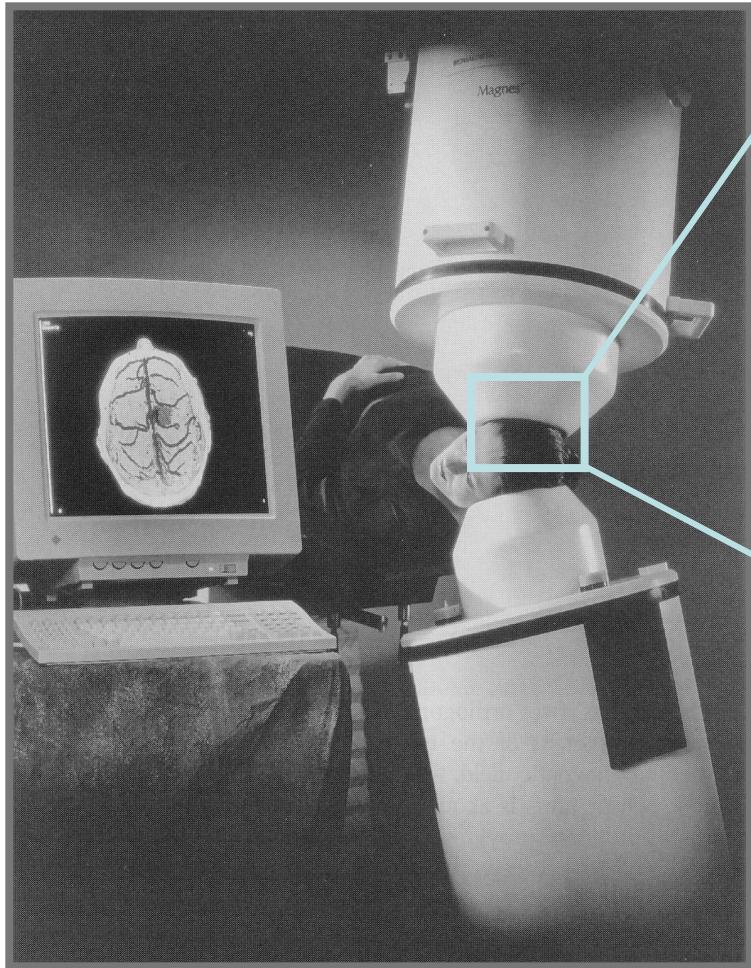
Haxby et al. 2001

Real time fMRI feedback to reduce chronic pain



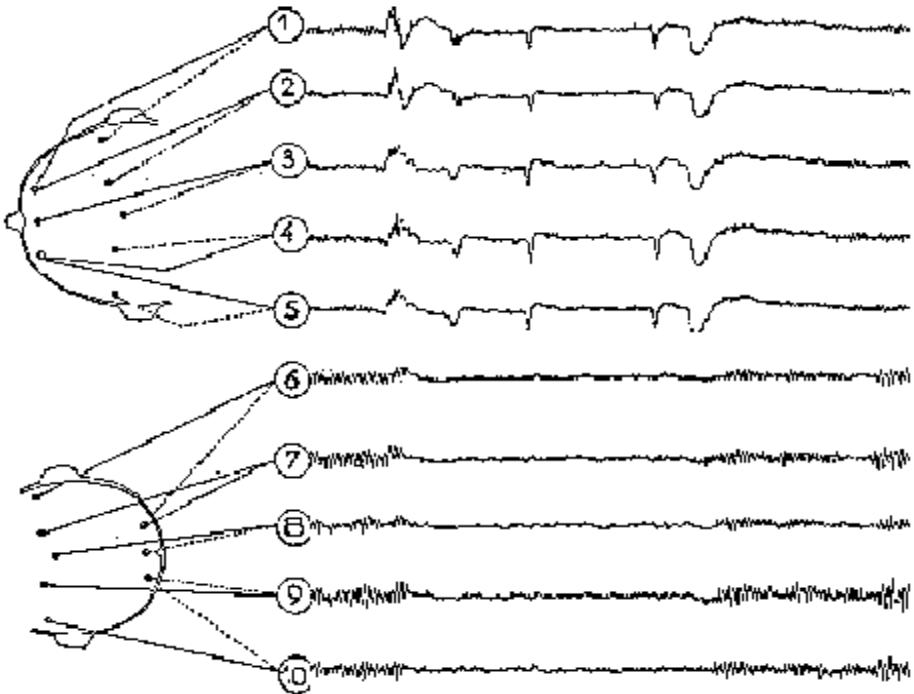
Control over brain activation and pain learned by using real-time functional MRI,
R. C. deCharms, et al. PNAS, 102: 18626-18631 (2005)

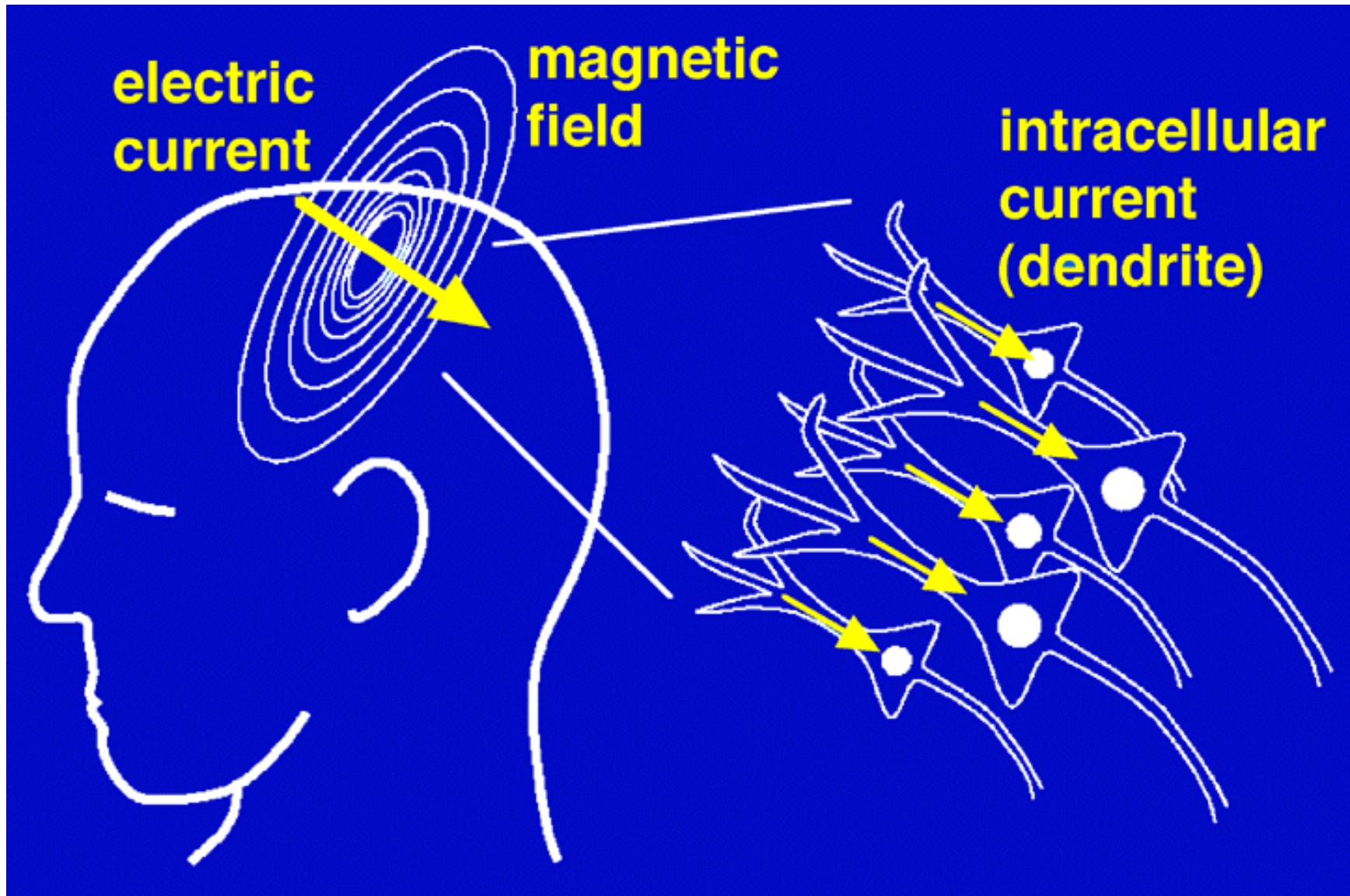
Magnetoencephalography (MEG)

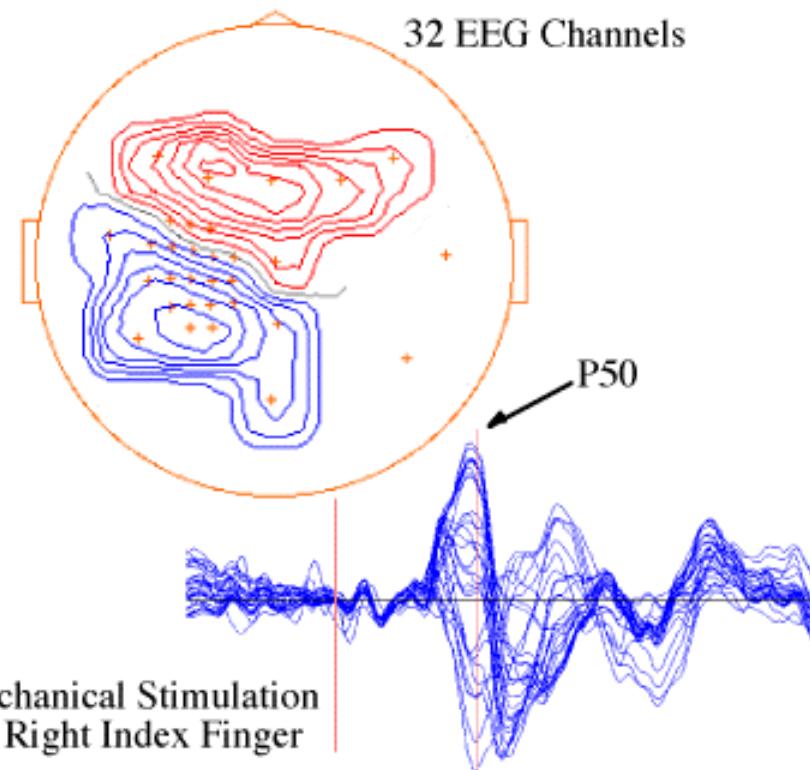
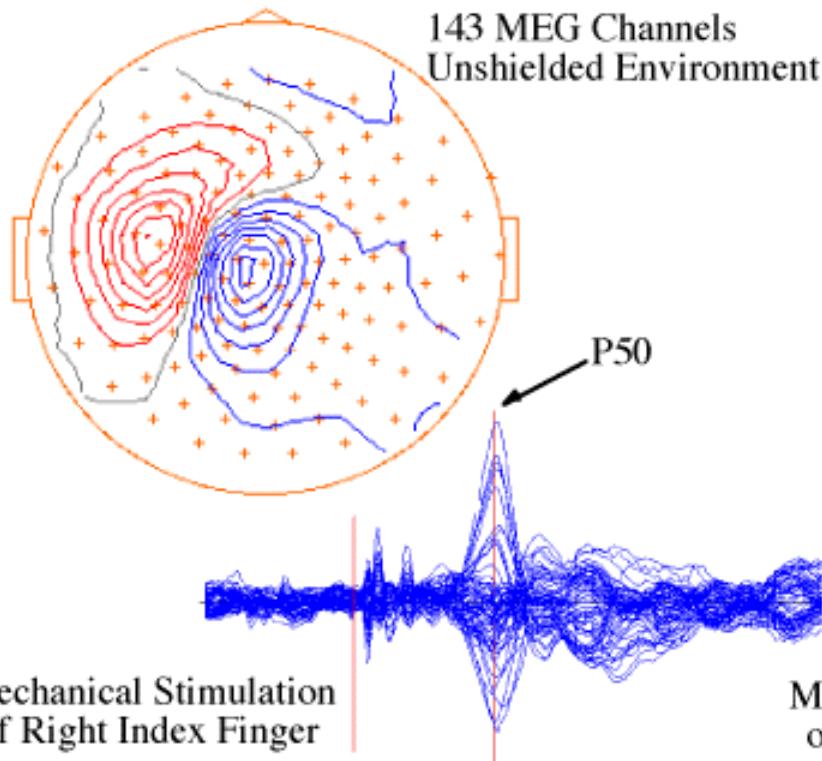


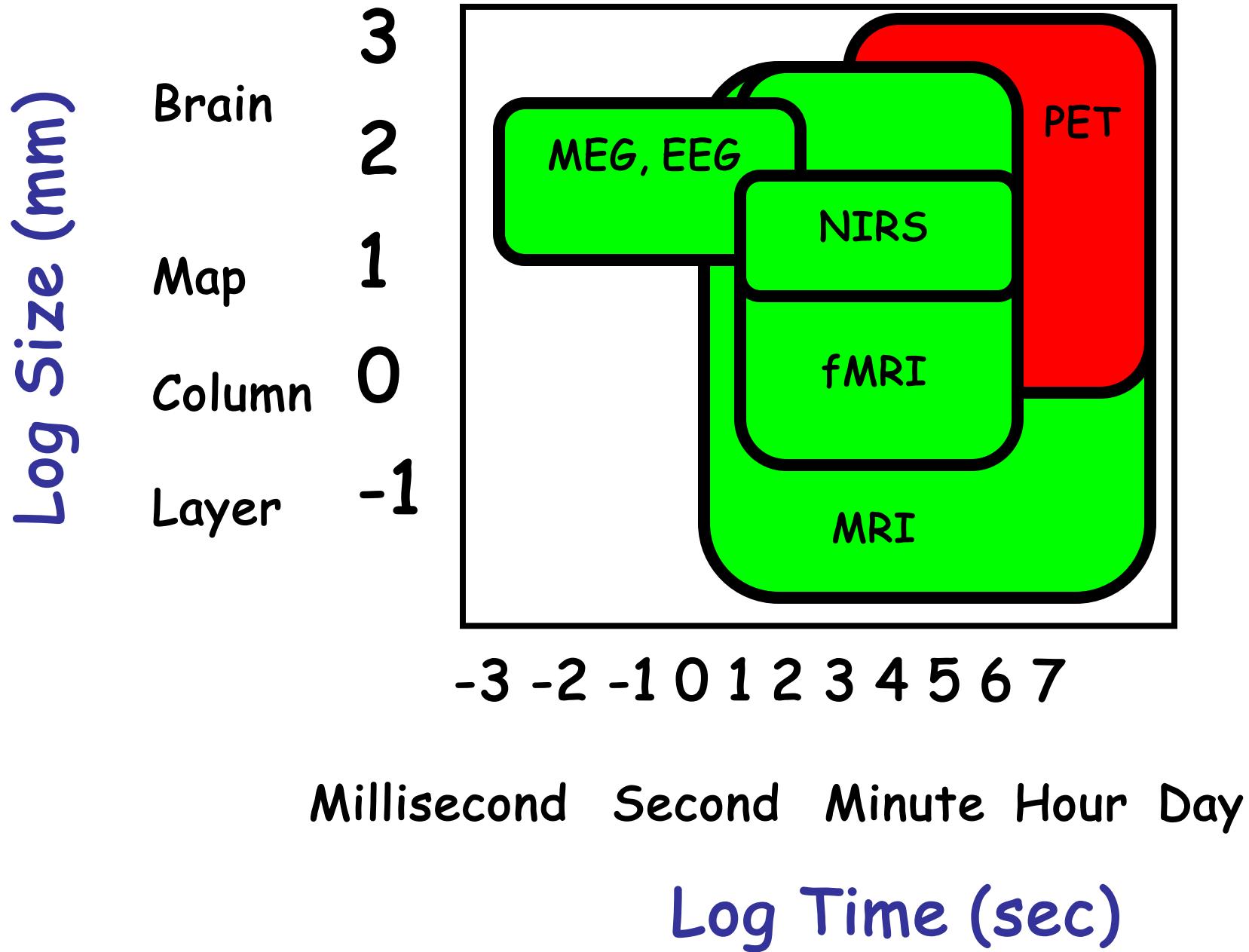
SQUID:
Superconducting Quantum
Interference Device

Electroencephalography (EEG)

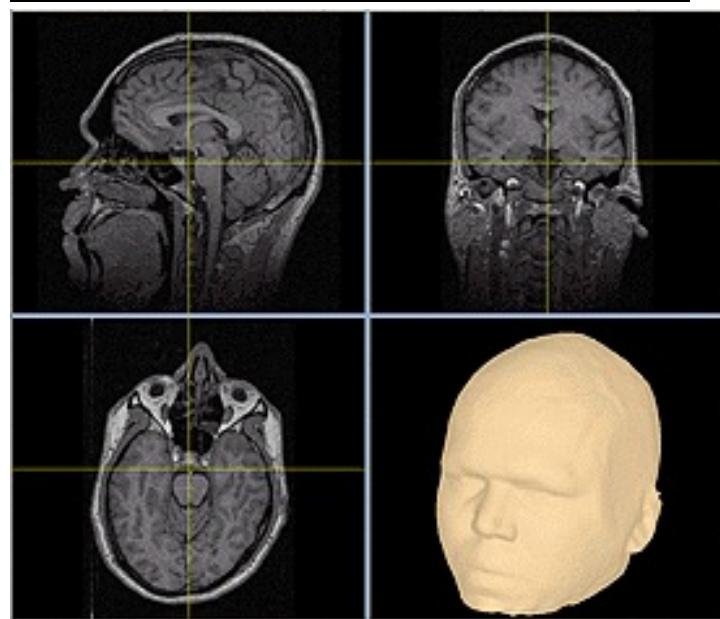
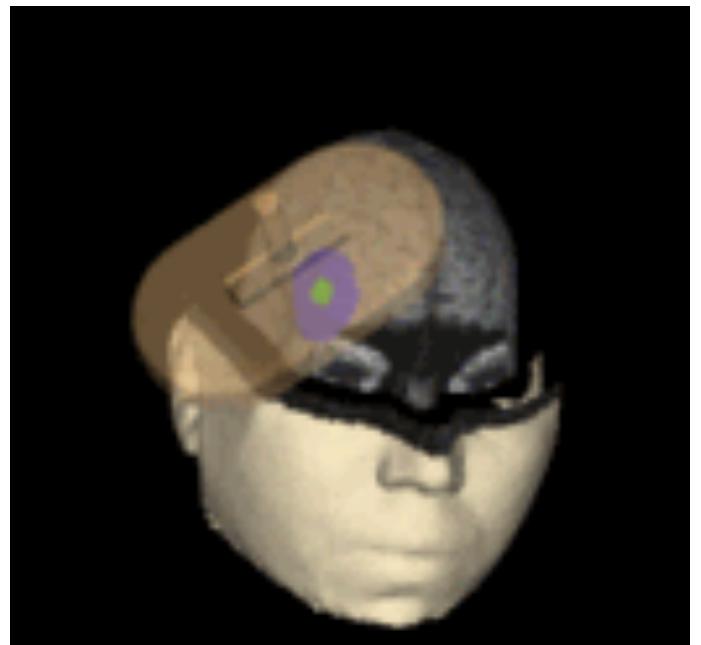




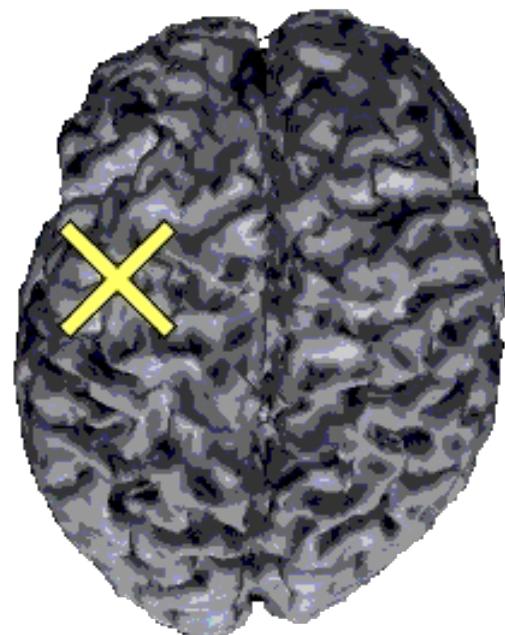




Transcranial Magnetic Stimulation



Transcranial Magnetic Stimulation (TMS)





Section on Functional Imaging Methods & FMRI Facility

