HST.583 Functional Magnetic Resonance Imaging: Data Acquisition and Analysis
Fall 2008

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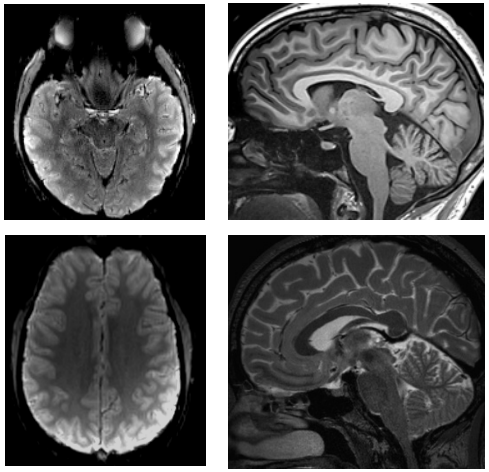
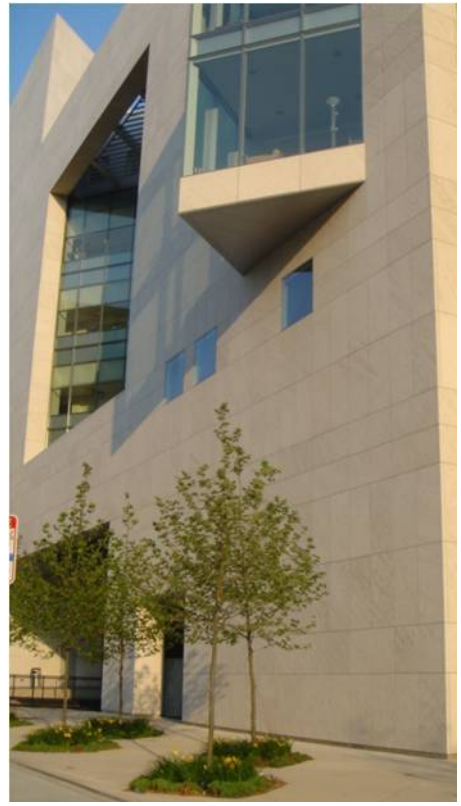
@ McGOVERN INSTITUTE
FOR BRAIN RESEARCH AT MIT

HST:583

fMRI Acquisition Lab1

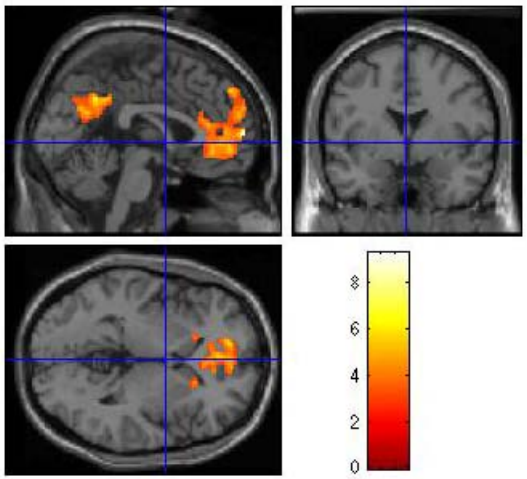


Susan Whitfield-Gabrieli
Christina Triantafyllou
Steven Shannon
Sheeba Arnold



web.mit.edu/mitmri/

Self Reference



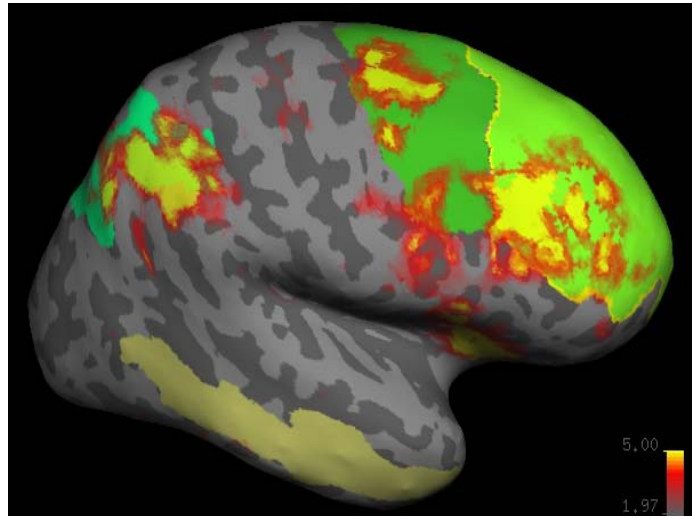
TASKS:

Self Reference

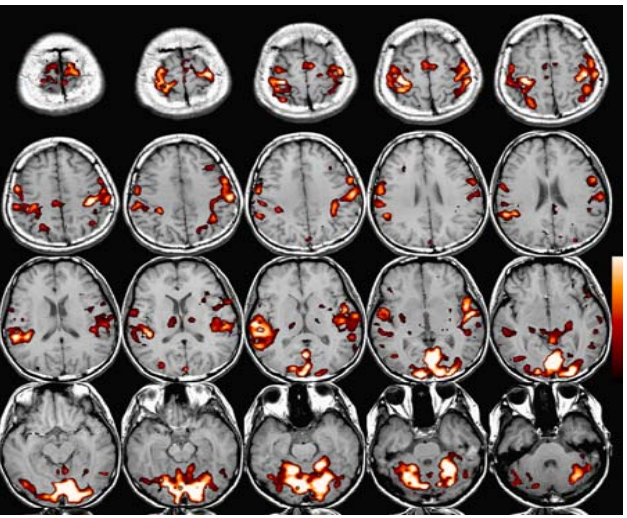
Sternberg (WM)

Sensorimotor with Neuro3D

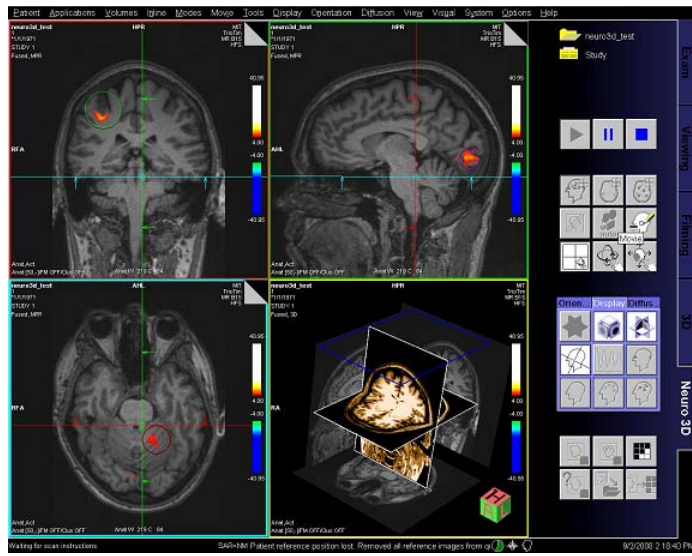
Sternberg (WM)



Sensorimotor



Neuro3D



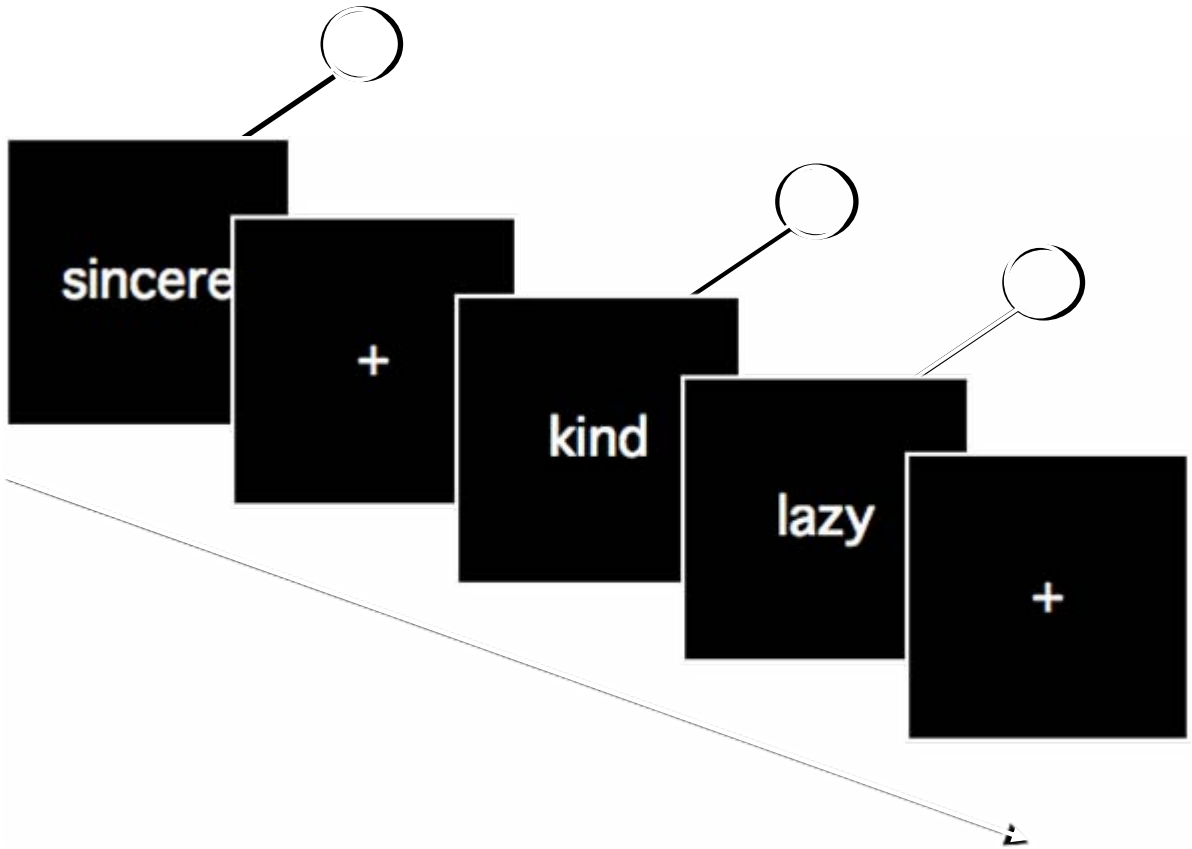
Self

- **representation of knowledge about one's thoughts, feelings**

Self-Related Cognition

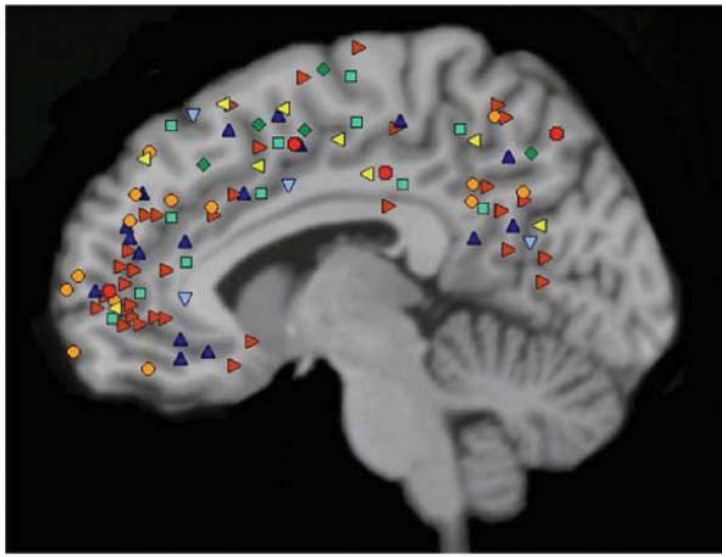
- **Self-referential processing with trait adjectives**

Cartoon removed due to copyright restrictions. Person thinking “I used to be indecisive…now I’m not sure.”



Moran et al., 2006, JoCN

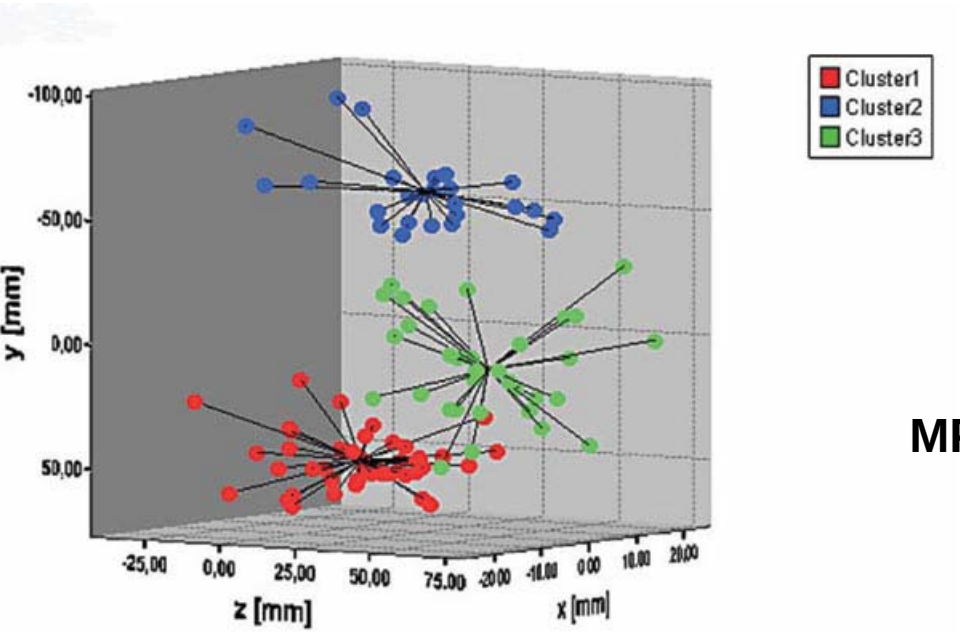
Activation in CMS observed in imaging studies during self related tasks in different domains.

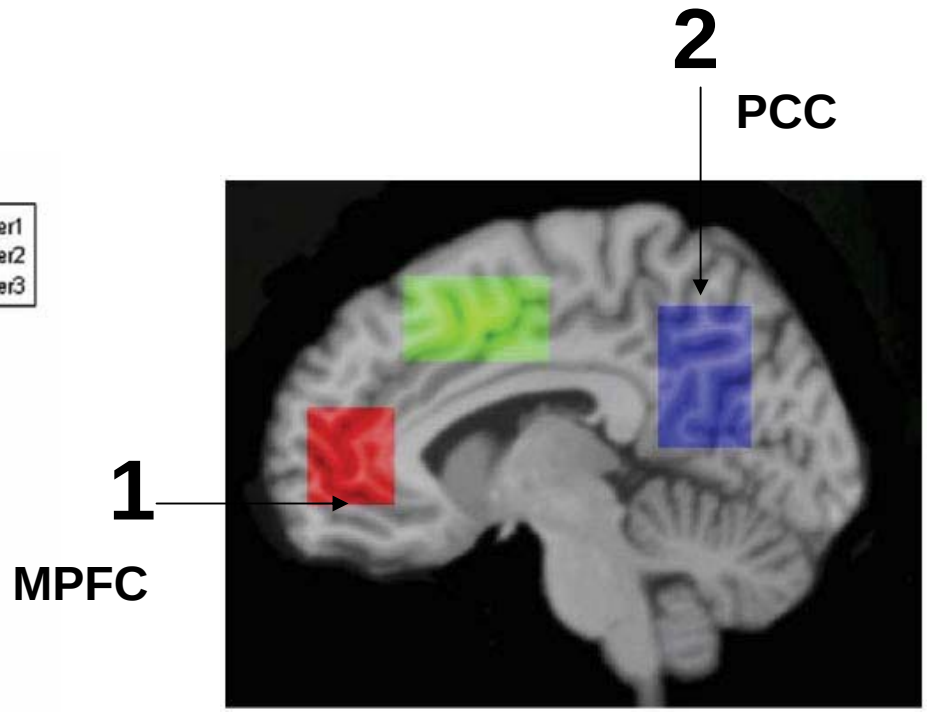


▲ emotional domain: self > non-self
▽ facial domain: self > non-self
□ memory domain: self > non-self
◆ motor domain: self > non-self
◁ social domain: self ∩ other
○ social domain: self > other
✚ spatial domain: self > non-self
▷ verbal domain: self > non-self

Northoff Neuroimage 2006

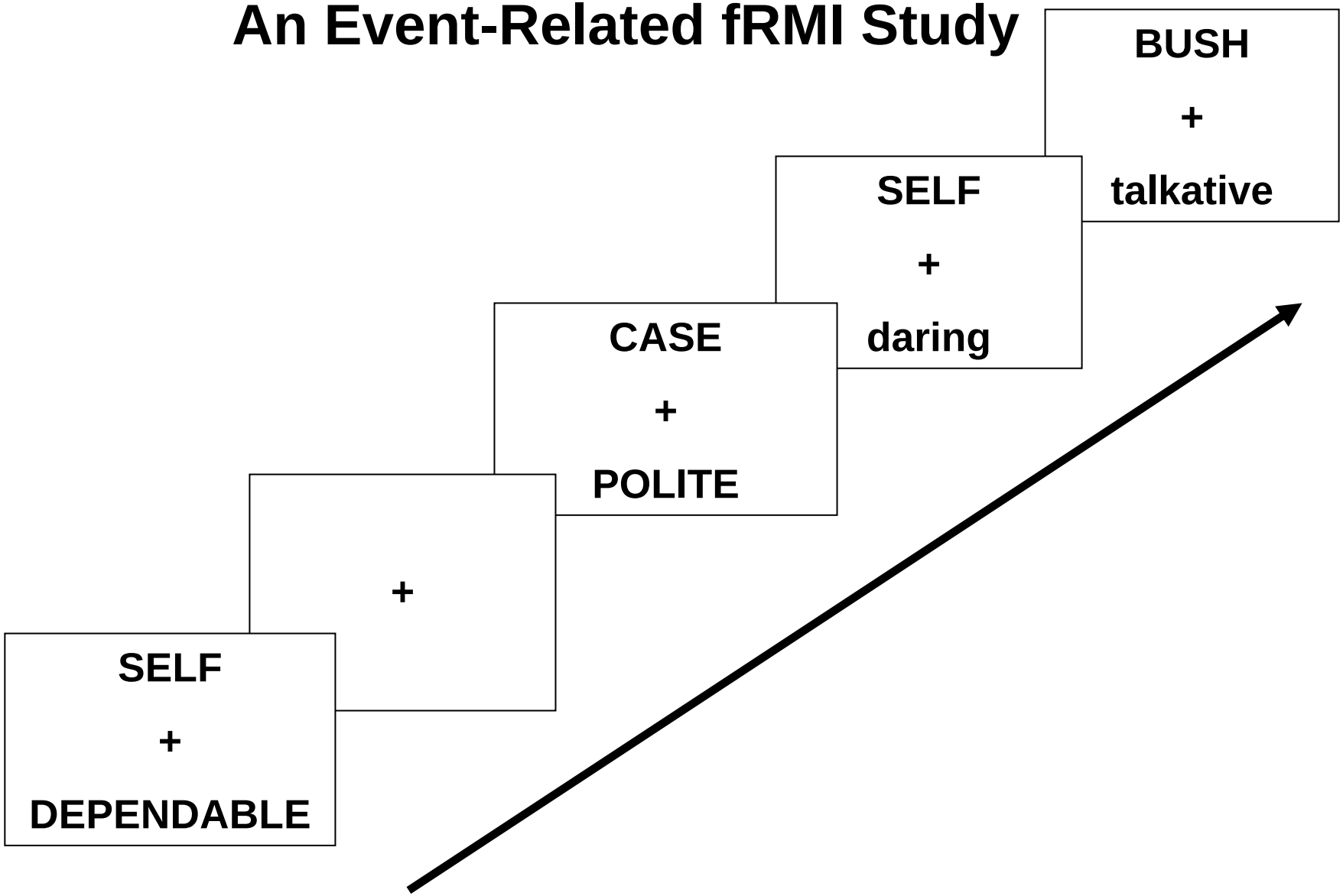
Graphic representation of localizations of clusters





Northoff Neuroimage 2006

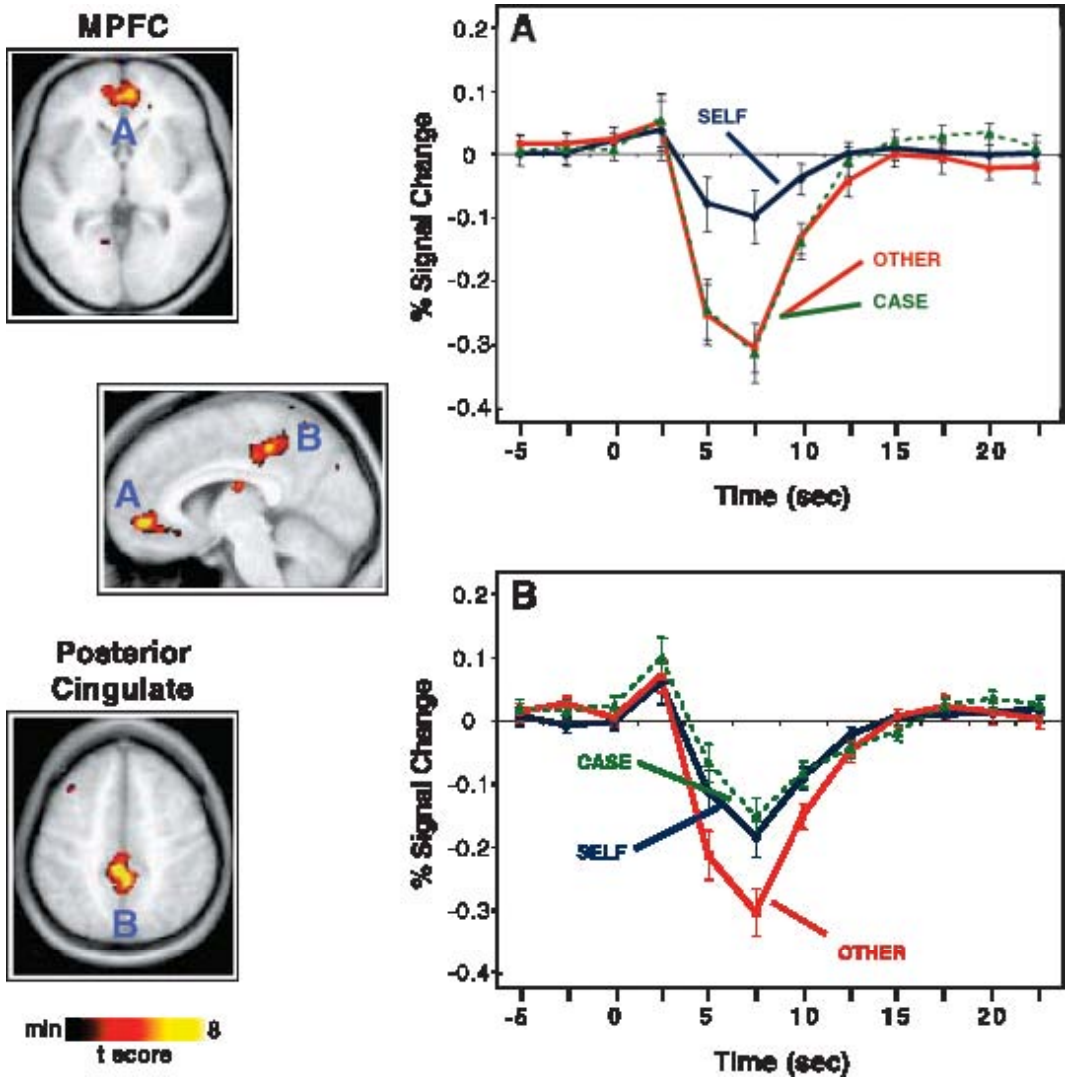
Finding the Self?
An Event-Related fRMI Study



2.5 s

Kelley et al., 2002, *J Cogn Neurosci*

ACTIVATION FOR SELF-REFERENCE

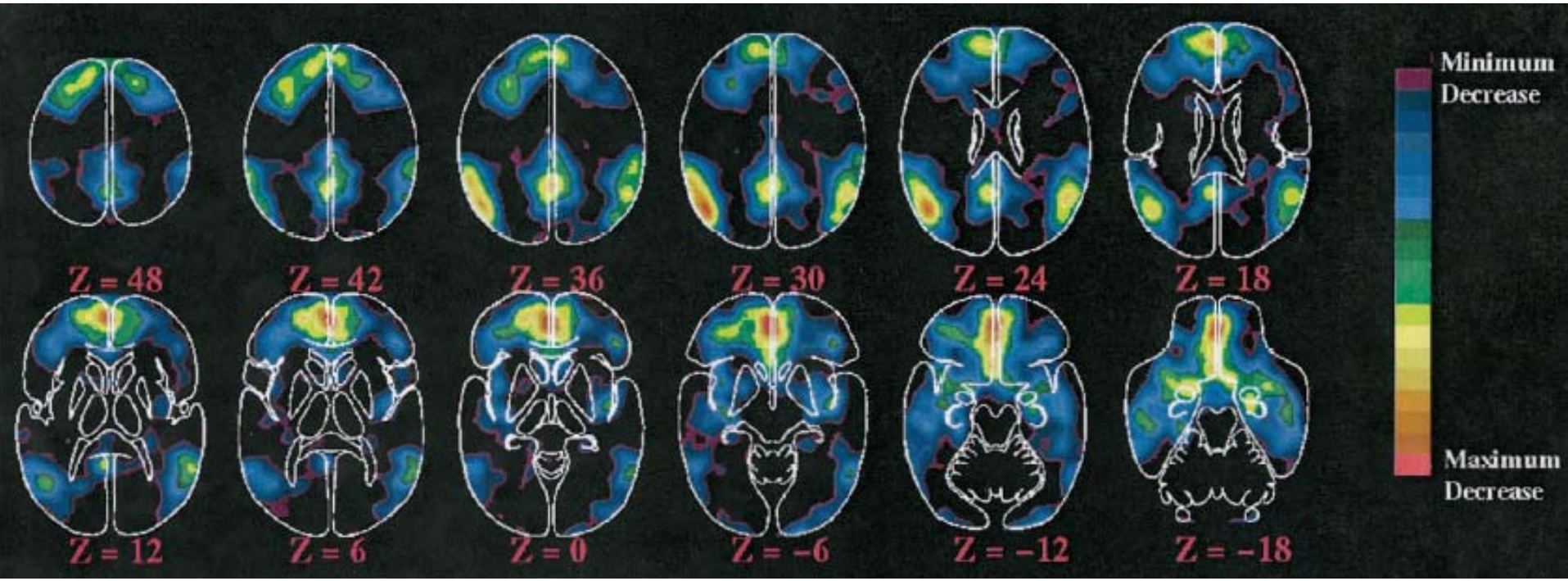


Kelley et al., 2002, *J Cogn Neurosci*

Default Network

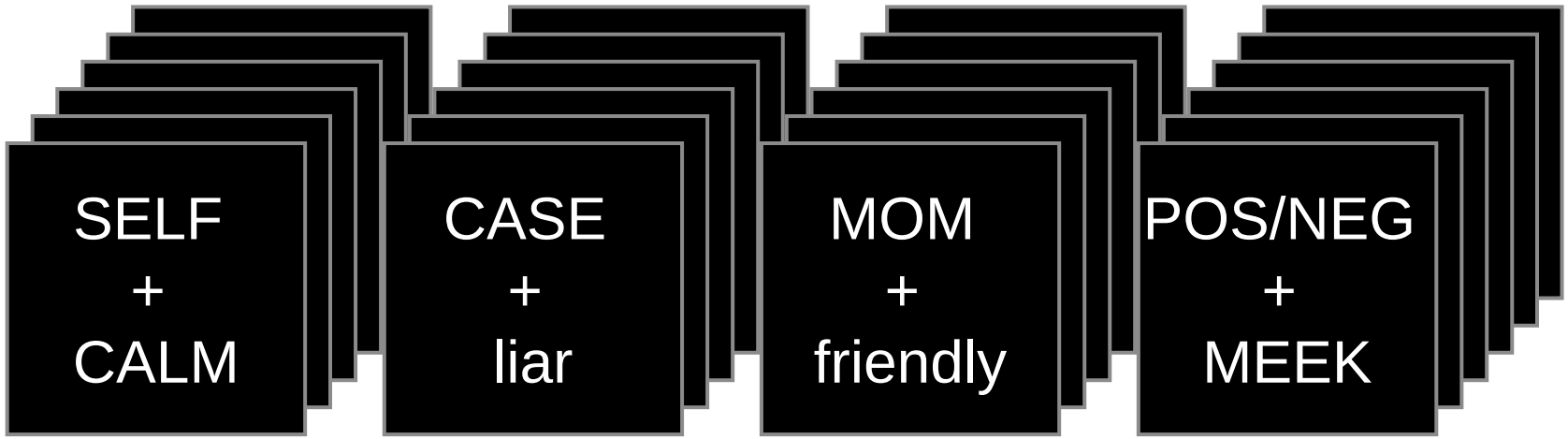
- more active during rest than most attention demanding tasks
- stimulus-independent, task-independent
- also supported by
  - medial prefrontal cortex (MPFC)
  - posterior cingulate/precuneus (PCC)

Default Network



Raichle et al, PNAS, 2001

Self Reference Task Design



Stimuli: trait adjective words

Words were drawn from Anderson's (1968) list of normed trait adjectives. The lists were counterbalanced for word valence, length and number of syllables.

Presentation:

- TR=3s / 6 items per condition / blocked design

SELF – "Does this word describe you?"

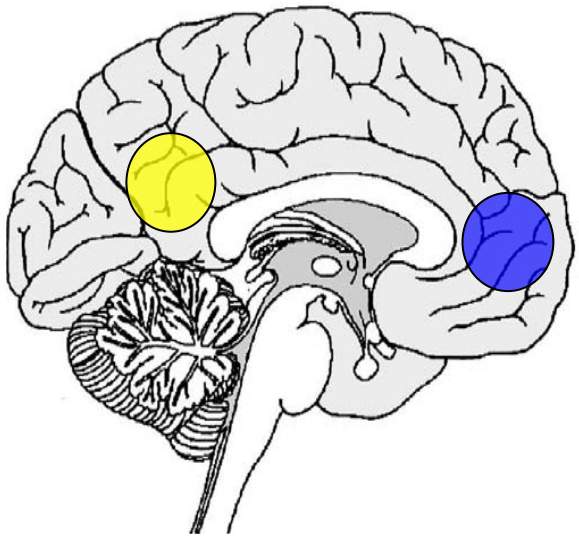
MOM – "Does this word describe your mother?"

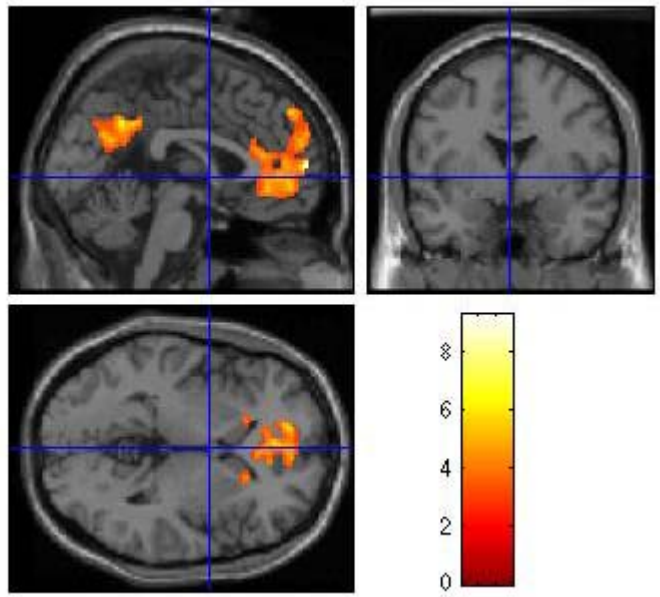
SEM – "Is this word positive or negative?"

CASE – "Is this word presented in upper- or lowercase letters?"

- 72 measurements per session

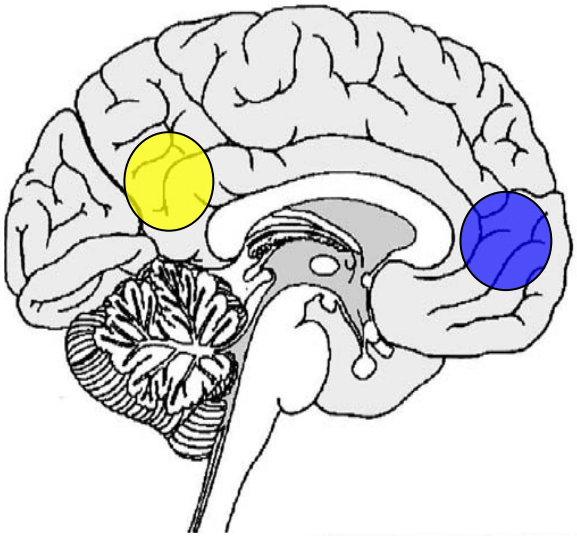
Self reference
SELF > SEM Group Analysis

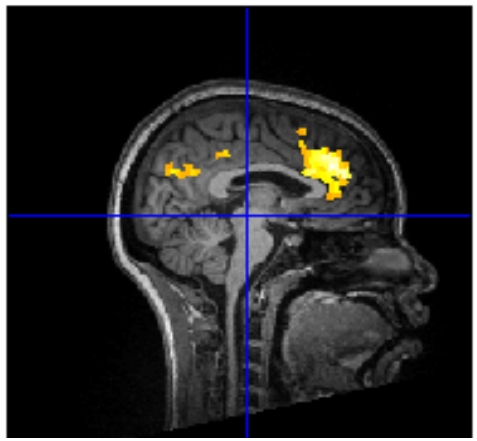


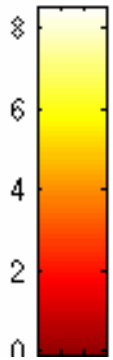


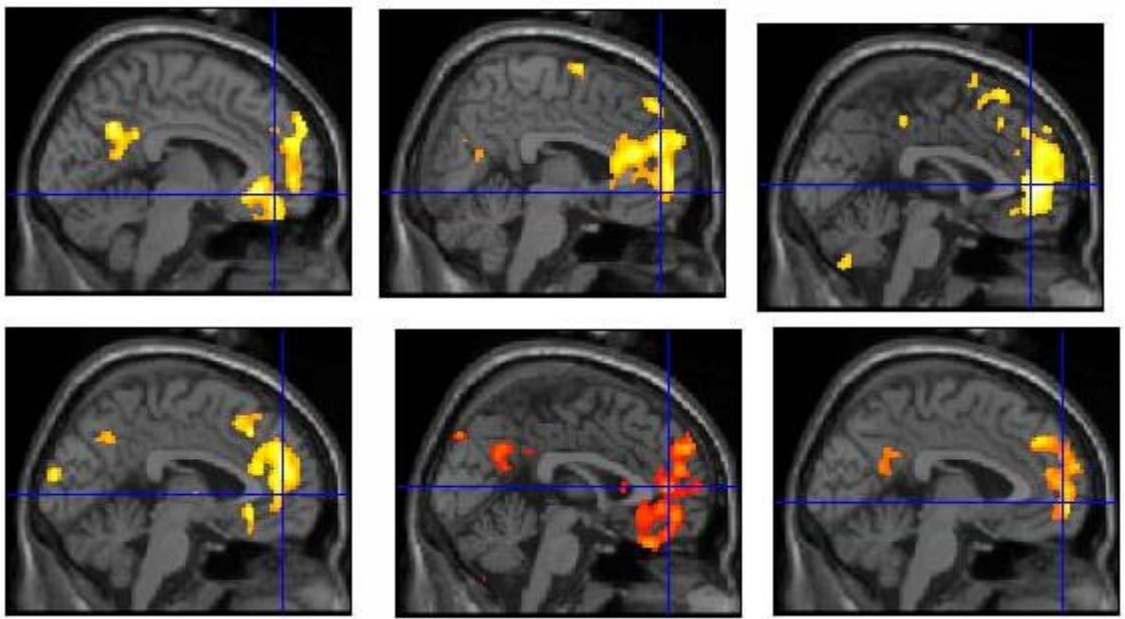
Self Reference, Single Subject

(self-semantic)

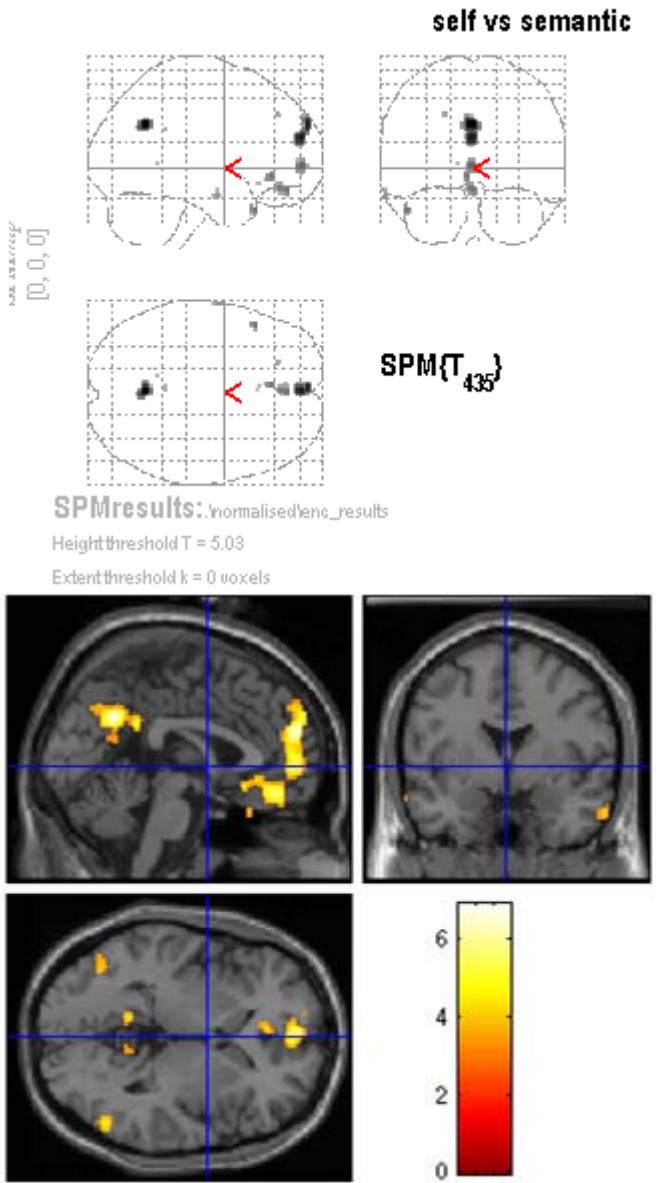


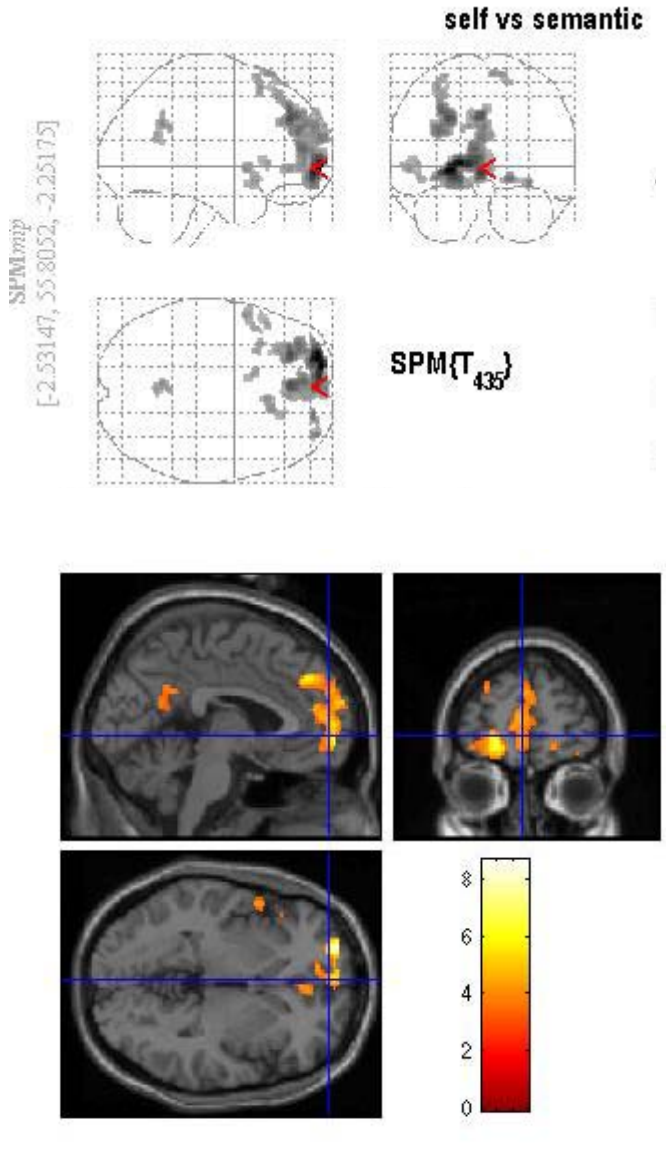






Frontal regions are prone to susceptibility artifact



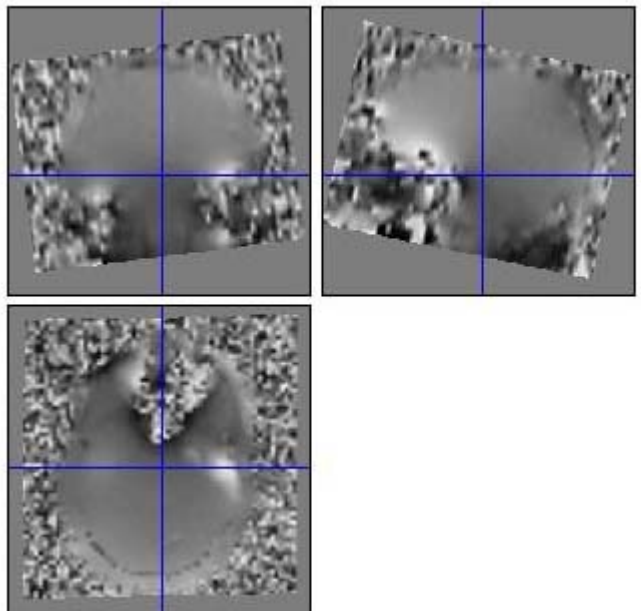


Field Maps:

The field map is a 2D gradient echo sequence which acquires an image at 2 different echo times. This sequence generates 2 types of images, a magnitude image and a phase map.

The phase map represents the phase differences of the spins which ultimately represent the **local field inhomogeneities**. You can display this map to see which regions are prone to **susceptibility artifacts.**

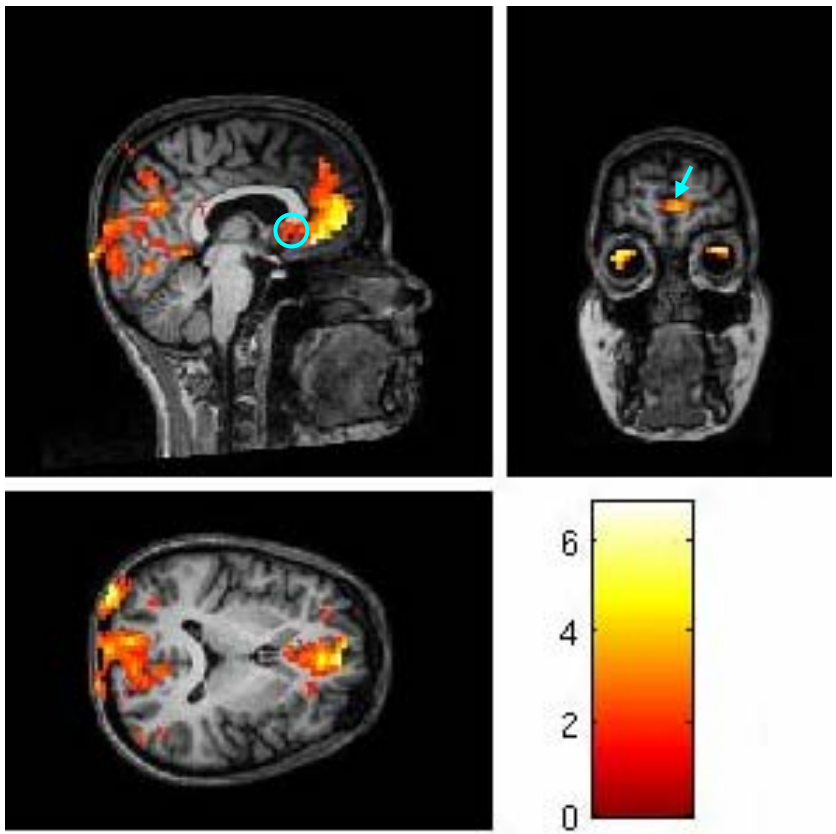
PHASE MAP

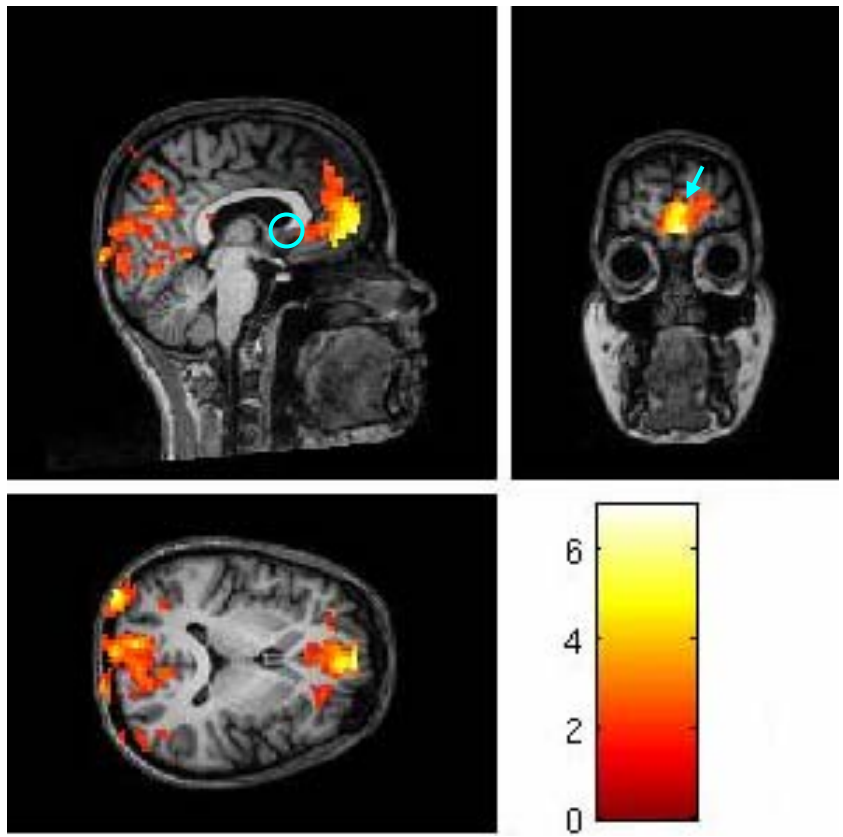


Field Map Correction

Base>Sem
(Before Correction)

Base>Sem
(After Correction)





p-value = 0.05 (unc)
Extend threshold=5

WORKING MEMORY WM

- **a system for temporarily storing and manipulating information required to carry out complex cognitive tasks.**

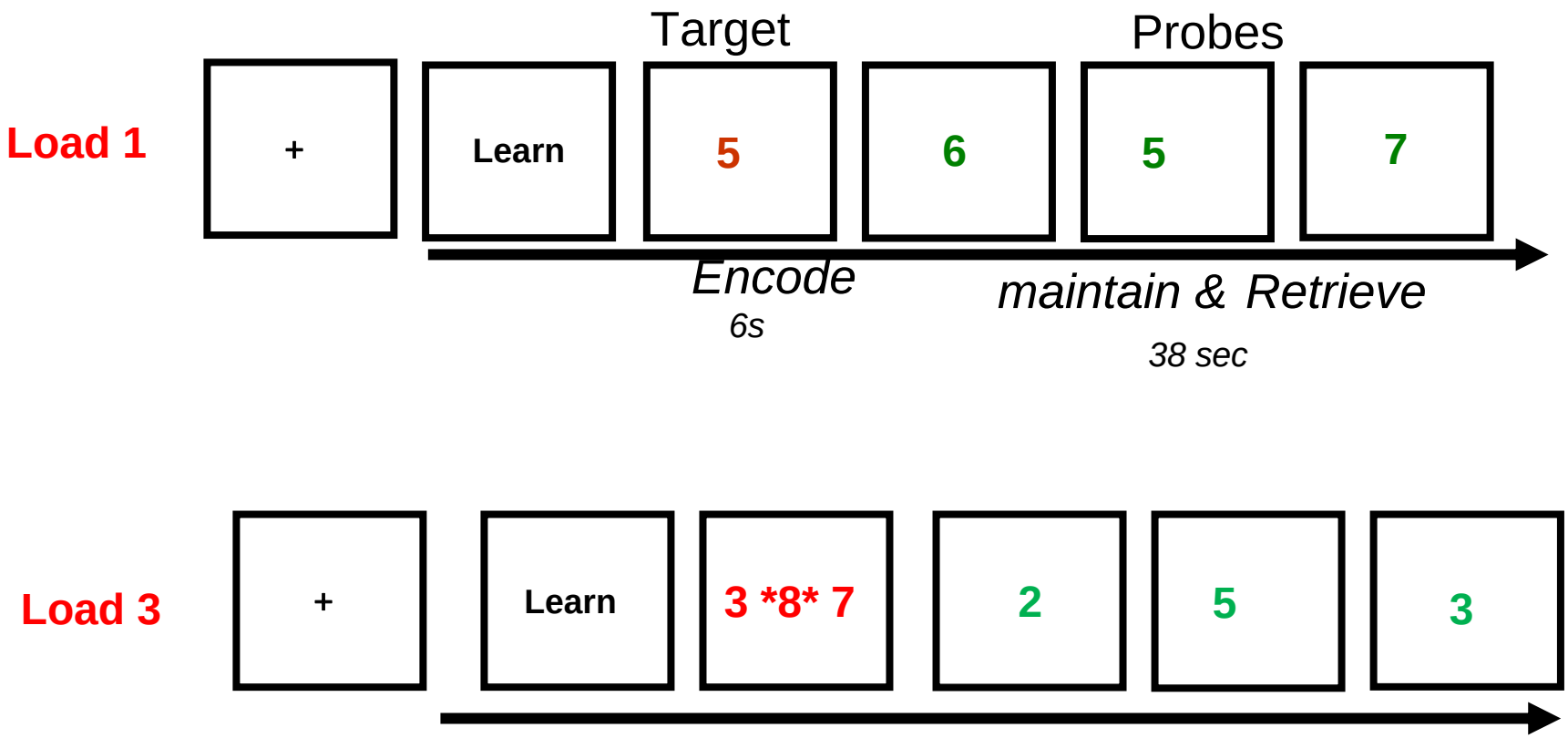
- **supported by prefrontal cortex, parietal cortex, anterior cingulate, and basal ganglia**

Sternberg WM Task

- **encoding, maintenance, retrieval components of WM (event-related design)**

- **paramentric design: influence of load (the amount of information) on brain functions (blocked & event-related designs)**

Working Memory



Sternberg Item Recognition Paradigm (SIRP)

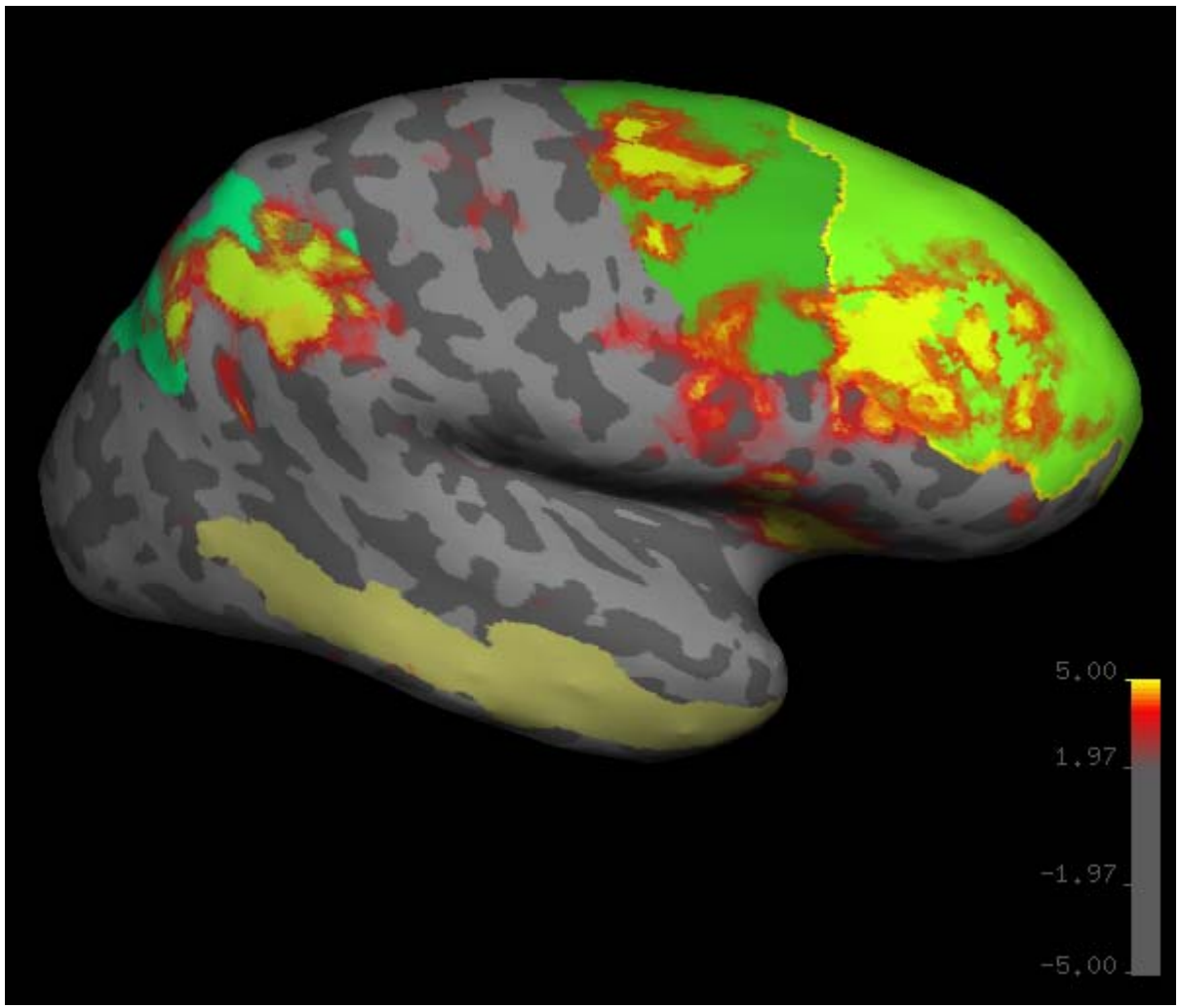
Sternberg Task:
Group analysis (n=10)

HIGH (5) – LOW(1) Working Memory Load:

Green regions: ROIs of 3 working memory related areas (DLPFC, DLPMC, IPS) and 1 control region (MTG)

IPS
(intraparietal sulcus)

MTG
(middle temp gyrus)



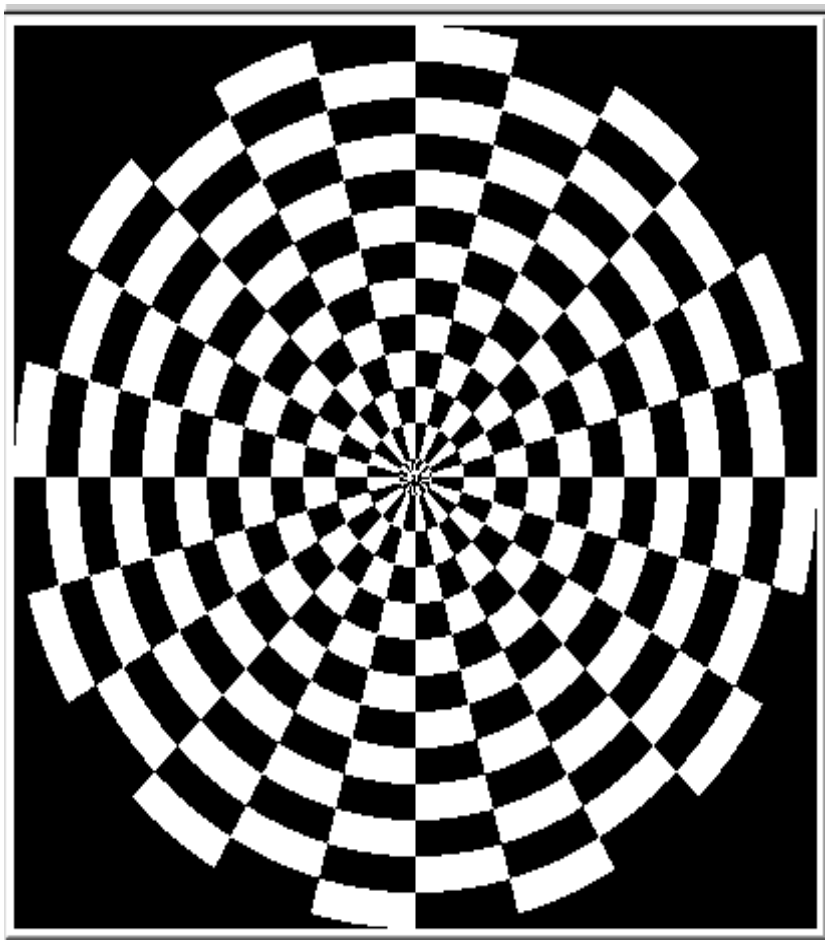
DLPMC
(dorsal lateral premotor cortex)

DLPFC
(dorsal lateral prefrontal cortex)

Randy Gollub

Sensorimotor Task

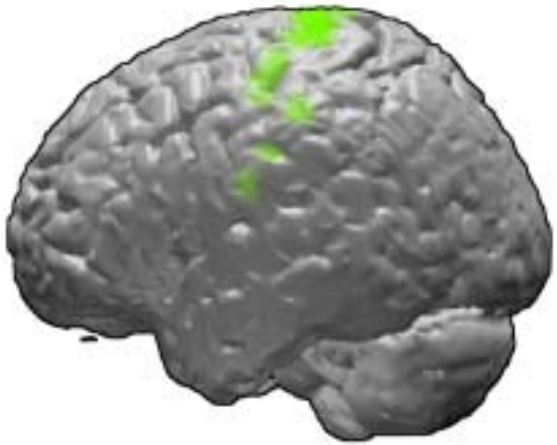
The task consists of a block design with block durations of 16s on/off. When checkerboard appears, subject taps fingers with their dominant hand and the off-block is fixation/no tapping. There are 15 total, 16s blocks. (4 min)

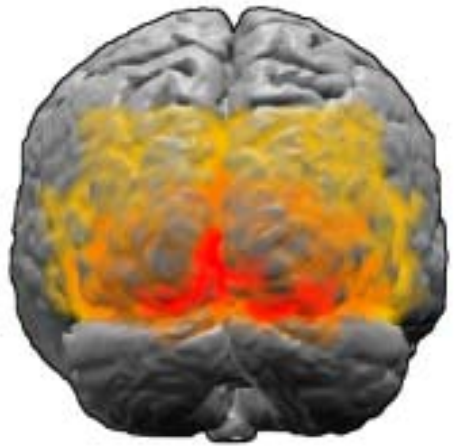


On block parameters: ISI ranges from 500-1000ms, average ISI = 762ms, std. dev = 156ms.
21 checkerboard flashes per on block, each checkerboard flash duration = 200ms.
The sequence begins with an off block.Scanner triggers the paradigm (after the dummy scans). ***fBIRN (functional biomedical informatics research network)***

Motor and Visual Cortex

Motor cortex - BA4 shown in green
Visual cortex - BA 17,18,19 from rear view of brain
BA 17 is shown in red.
BA 18 is orange
BA 19 is yellow



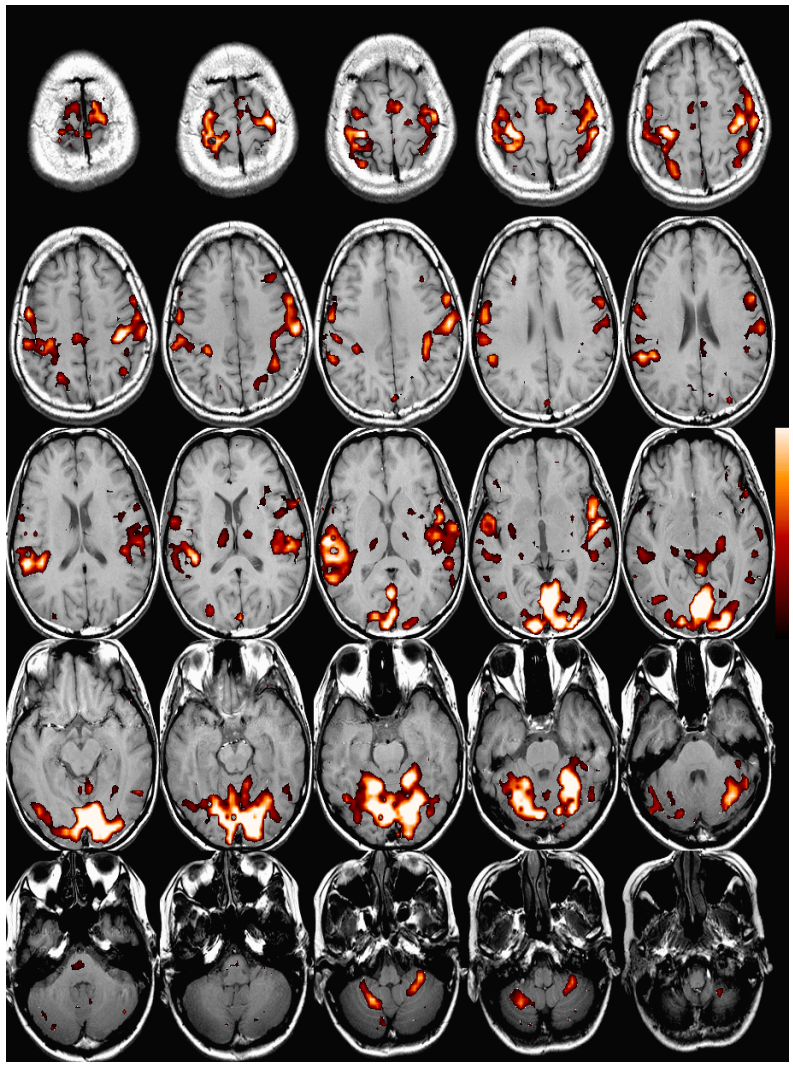


You'll see LEFT motor cortex (green), since the subject is responding with the right hand, and you'll see bilateral visual cortex.

Brain surface extracted from structural MRI data (Wellcome Dept. Imaging Neuroscience, UCL, UK). Brodmann Area data is based on information from the online Talairach demon (electronic version of Talairach and Tournoux, 1988).

Example of Sensorimotor Task activation

(with visual, motor & auditory)



Note: This task has an additional auditory component so you see temporal lobe activation as well as motor and visual. In addition, the subject is responding with both hands so you see bilateral motor activation as opposed to only the left hemisphere motor (contralateral to response hand)

fBIRN (functional biomedical informatics research network)
Gary Glover, Stanford University

Neuro3D & Sensorimotor Task