Introduction to fMRI Data Analysis

Course Overview

Luke Chang, PhD
Dartmouth College

What is neuroimaging?

What is neuroimaging?

- Structural
- Functional

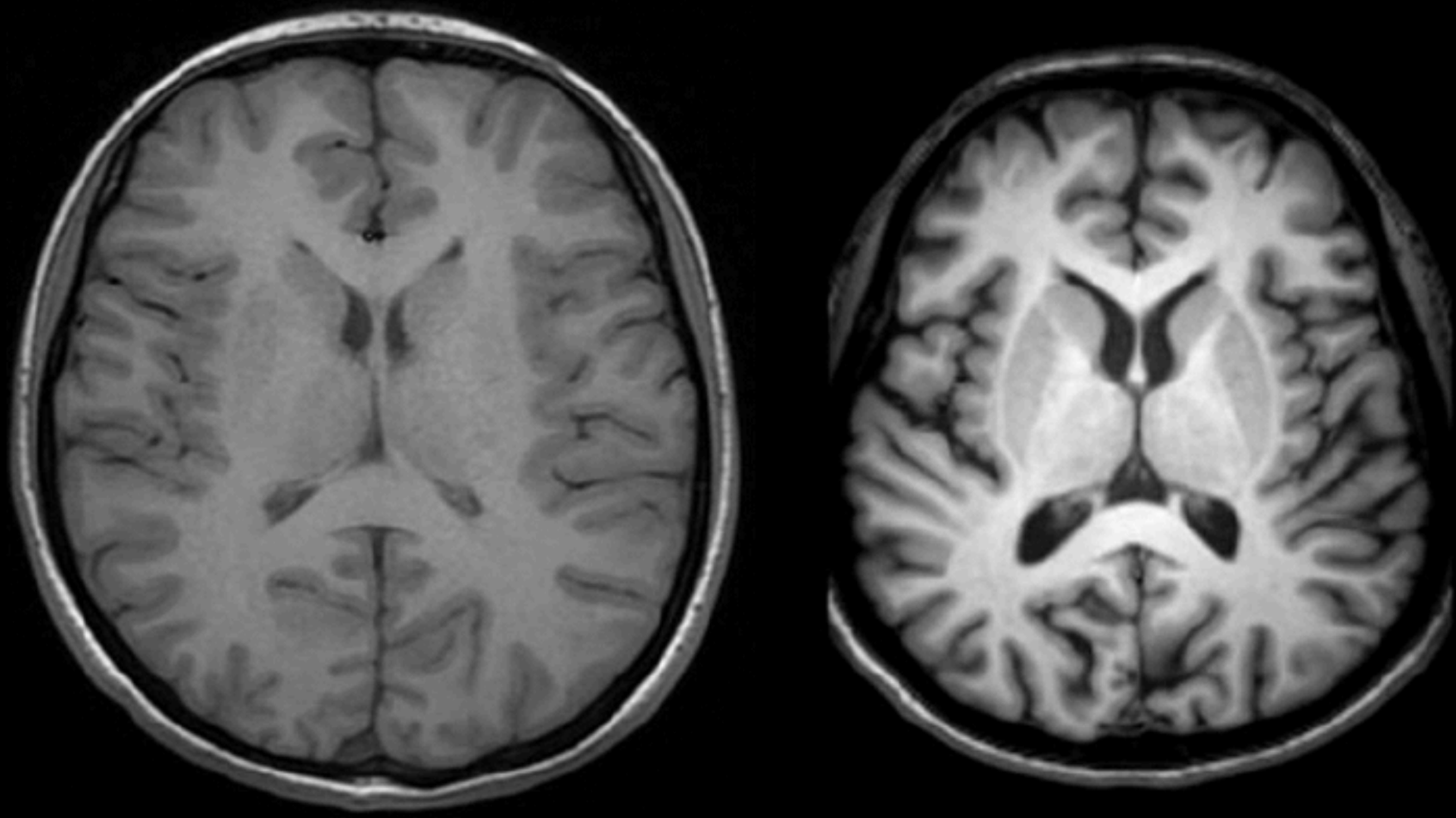
Dartmouth is special!

1999 Dartmouth became the 1st Liberal Arts College in the world to have their own scanner

Undergrads can scan their theses for free!

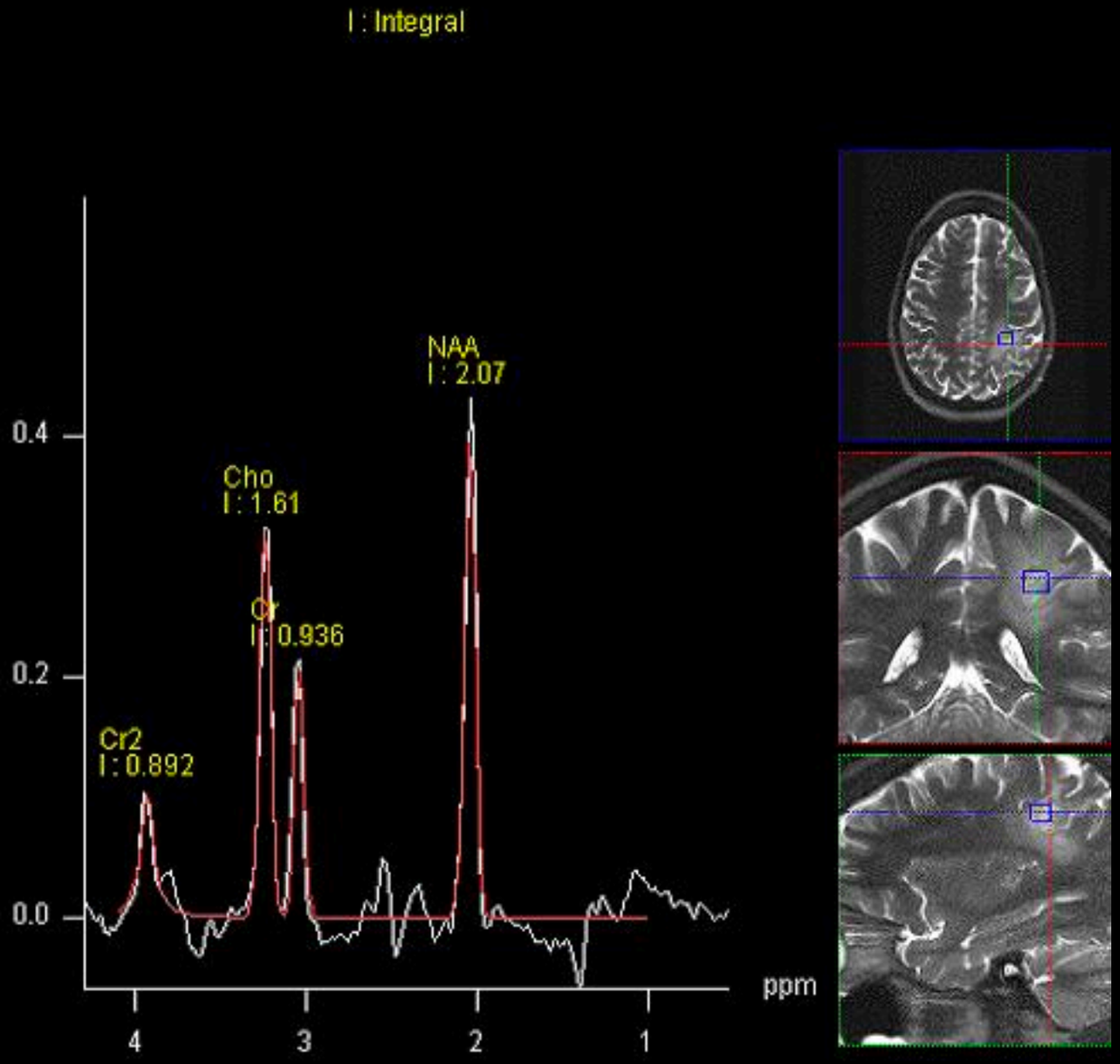
Structural Imaging

T1 Weighted Structural MRI

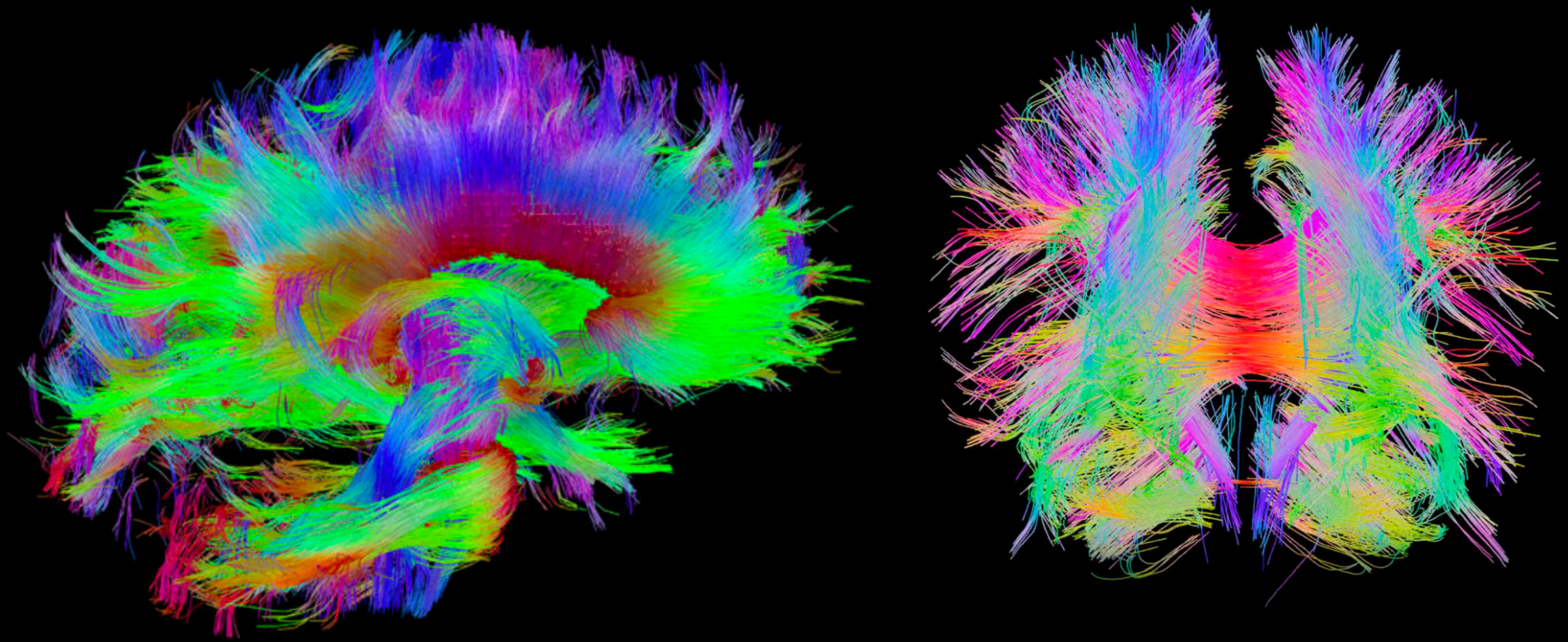


Magnetic Resonance Angiography (MRA)

Magnetic Resonance Spectroscopy (MRS)

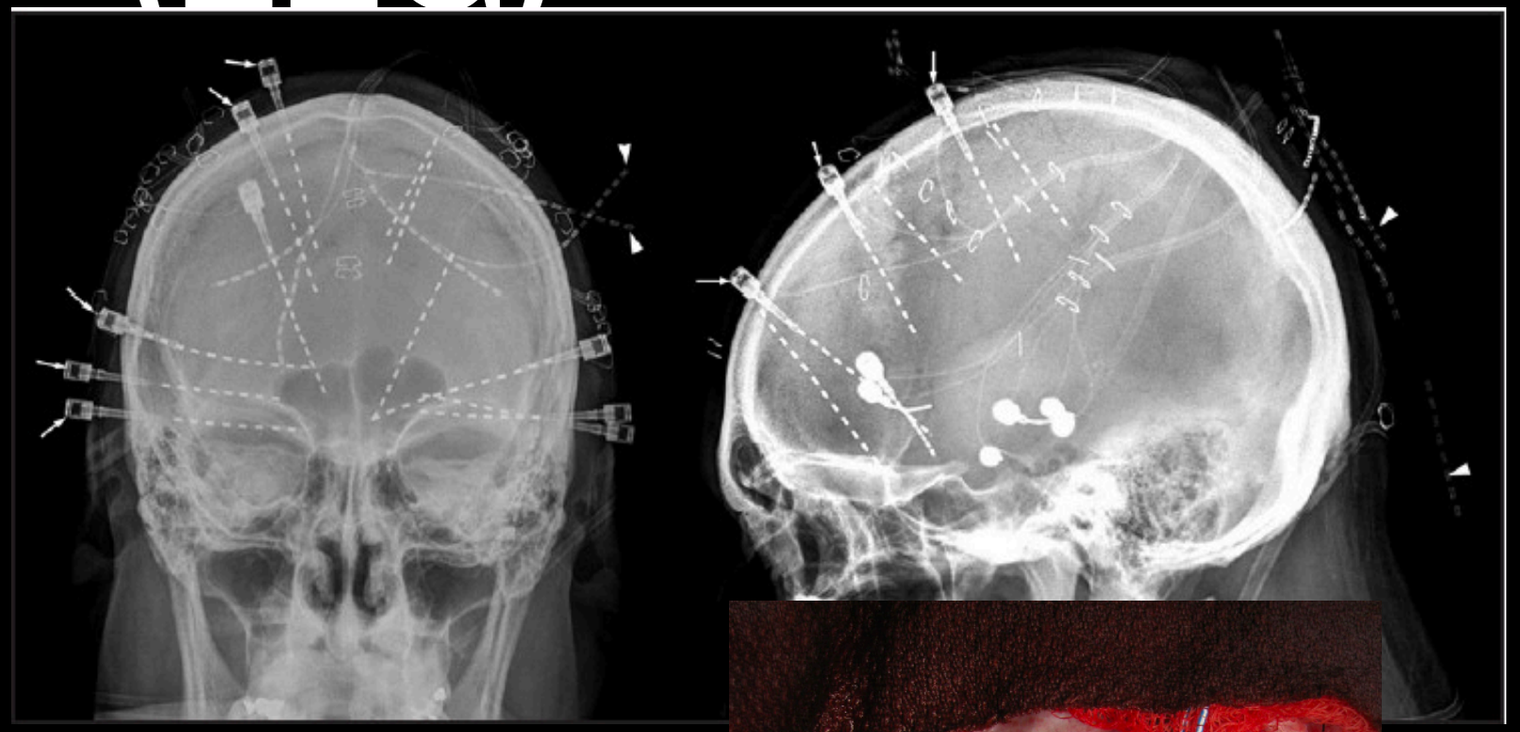


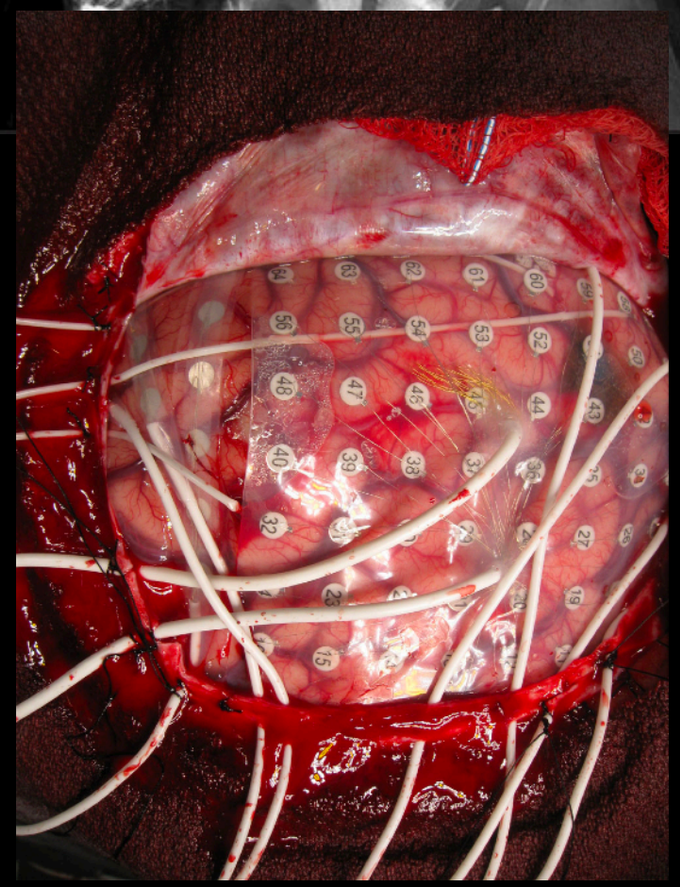
Diffusion Weighted Imaging (DTI, DWI)



Functional Imaging

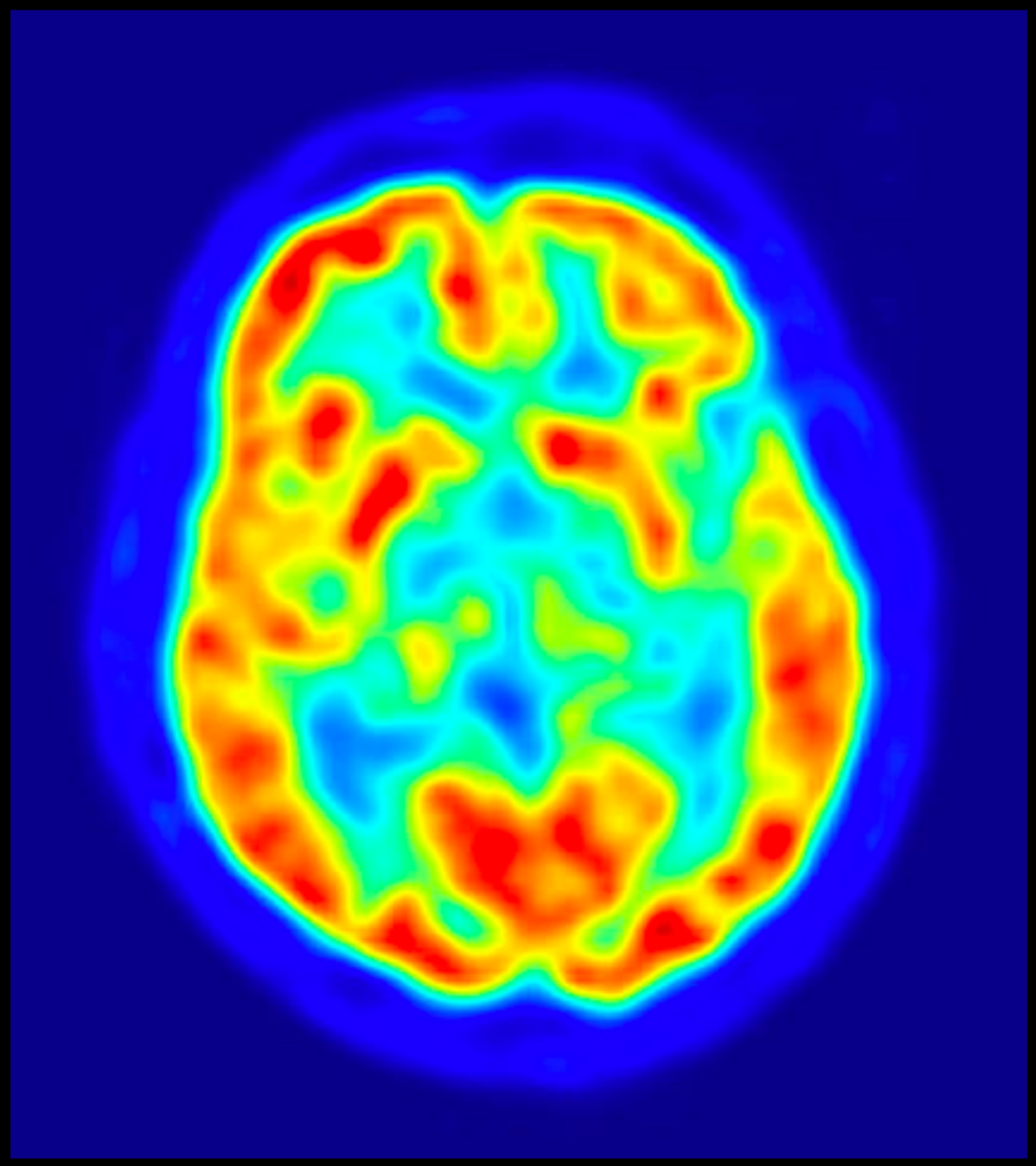
Electroencephalography (EEG)





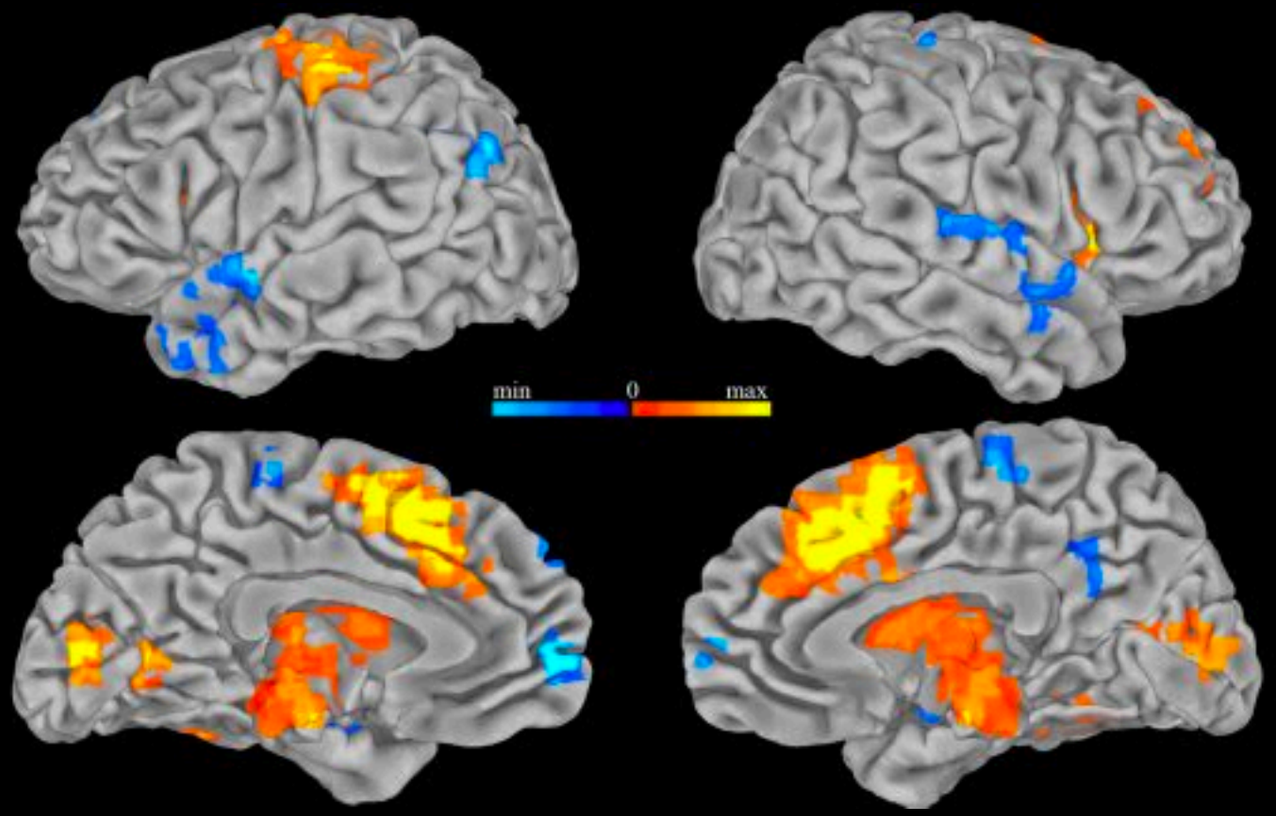
Magnetoencephalography (MEG)

Positron Emission Tomography (PET)

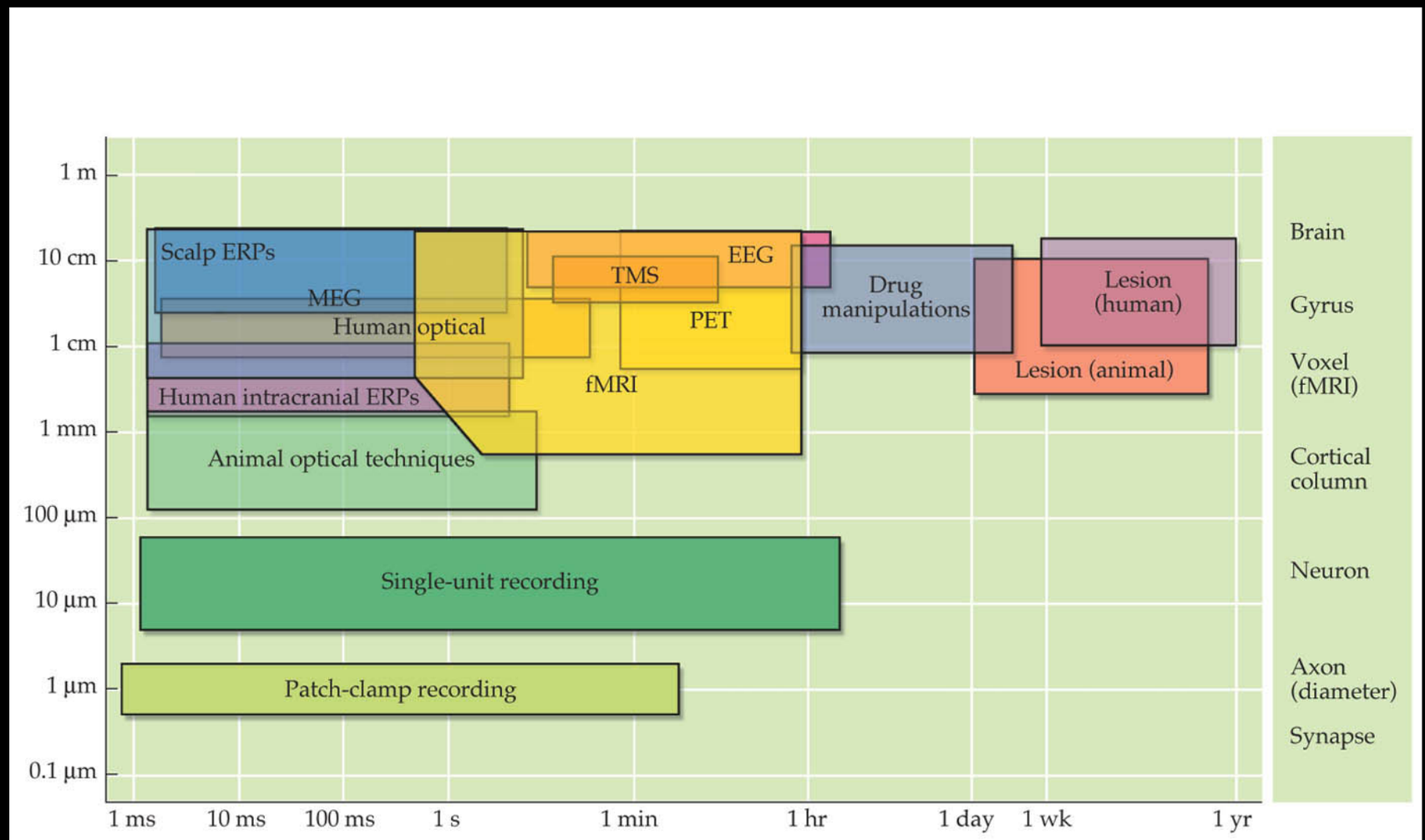


Functional Near-infrared Spectroscopy (fNIRS)

Functional magnetic resonance imaging (fMRI)

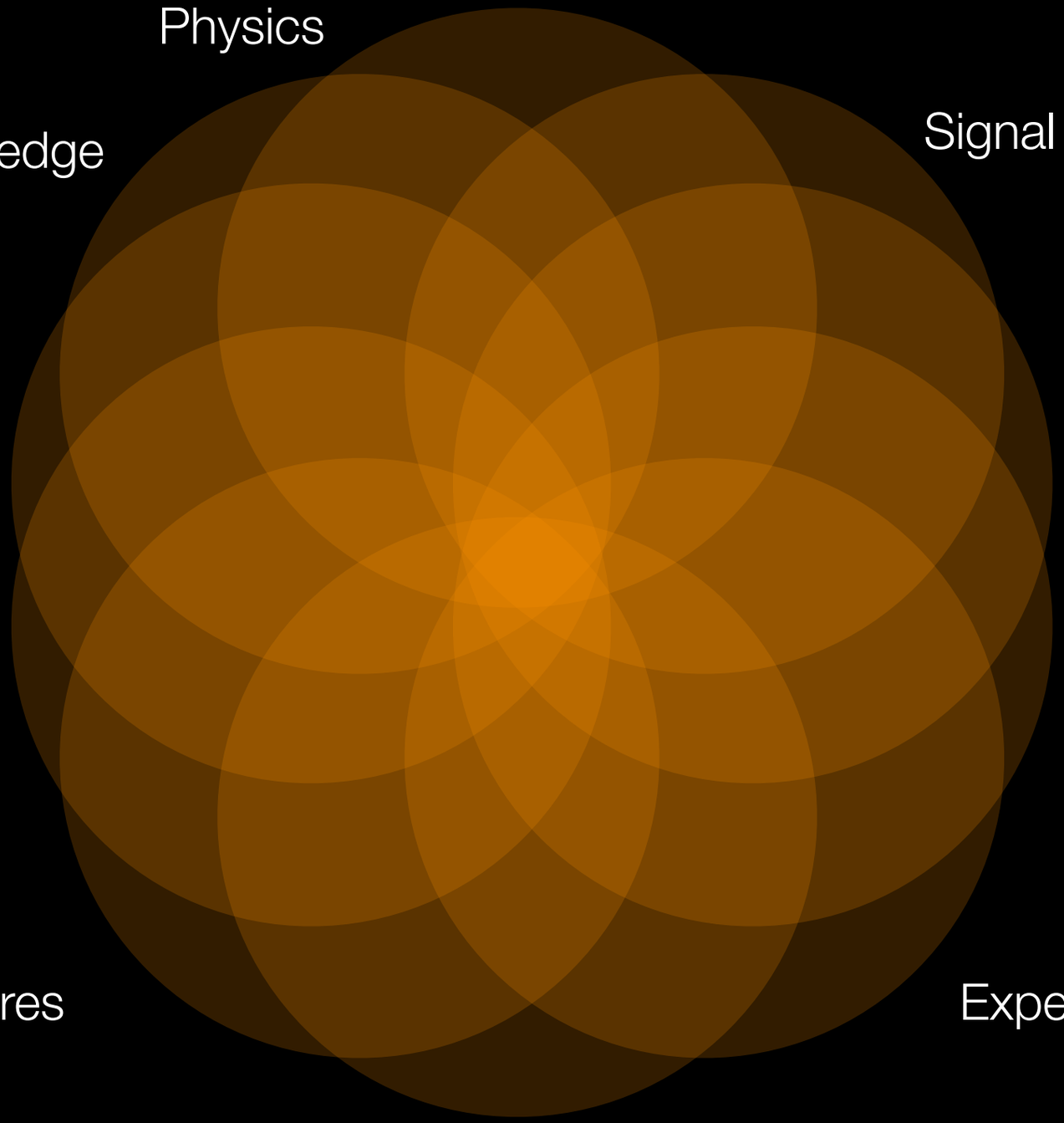


Neuroimaging Spatiotemporal Resolution



FUNCTIONAL MAGNETIC RESONANCE IMAGING, **Figure 1.7**

Neuroimaging is hard!



Physics

Clinical Knowledge

Signal Processing

Functional Neuroanatomy

Programming

Psychology

Statistics

Data Structures

Experimental Design

High performance computing

What are we doing?

- Learning how to analyze fMRI data!
- Learning basics of fMRI data collection
- Learning standard data preprocessing
- Learning how to program in Python
- Learning basic statistics via General Linear Model
- Introducing advanced analysis techniques (connectivity, mvpa, RSA, ISC)

What are we not doing?

- Learning MR physics (take the other Psych60 class, watch videos)
- Learning how to push buttons on standard neuroimaging software packages

Goals

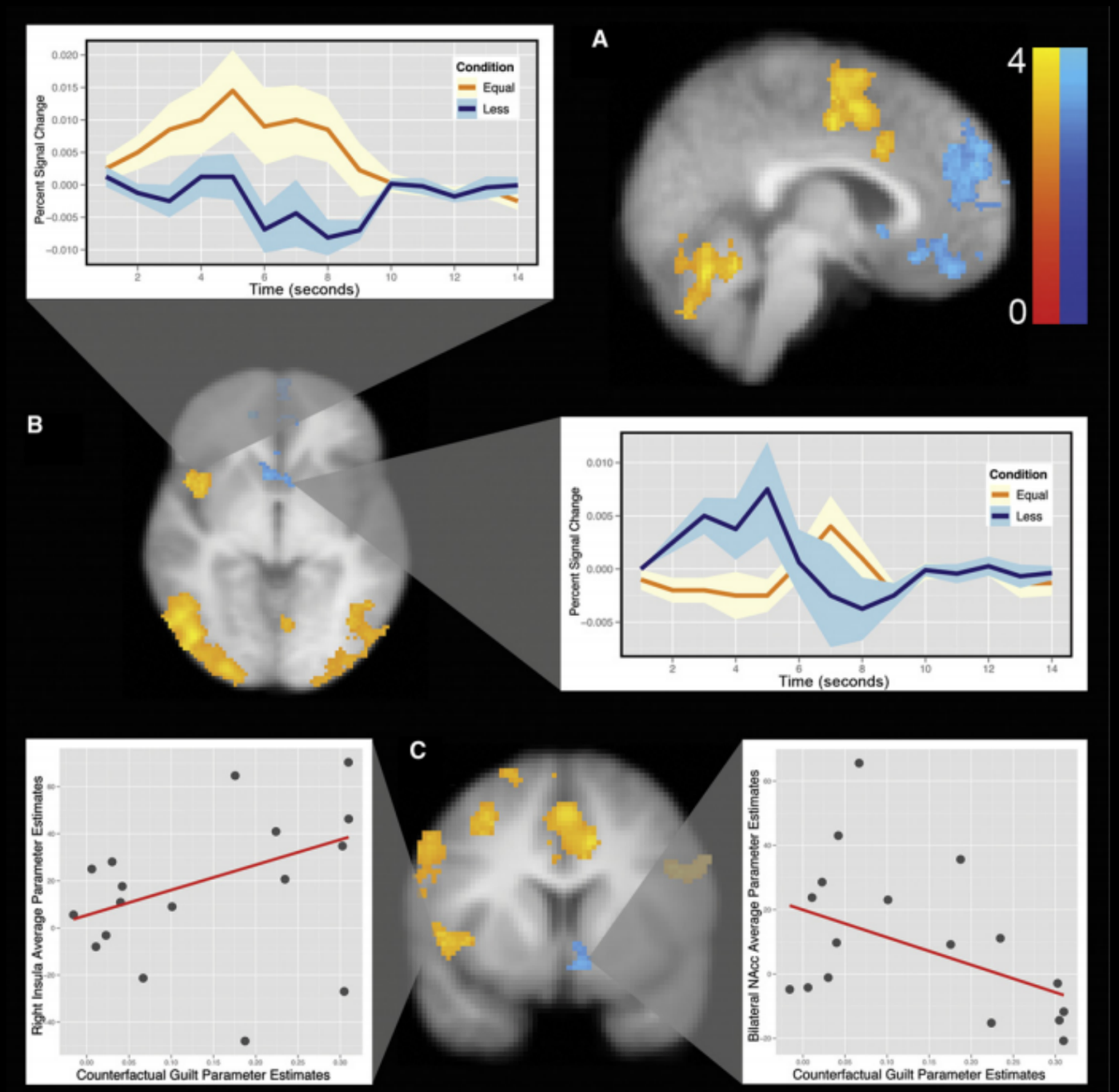
- Learn basics of fMRI signal preprocessing
- Learn basics of fMRI data analysis
- Learn about advanced analyses
- *(Hopefully) you will be ready to work in a lab, analyze your thesis, or start graduate school*

Assignments

- Labs (20%)
- Anatomy Flash Talks (10%)
- Exam (20%)
- Data Collection (10%)
- Final Project (30%)
- Class Participation (10%)

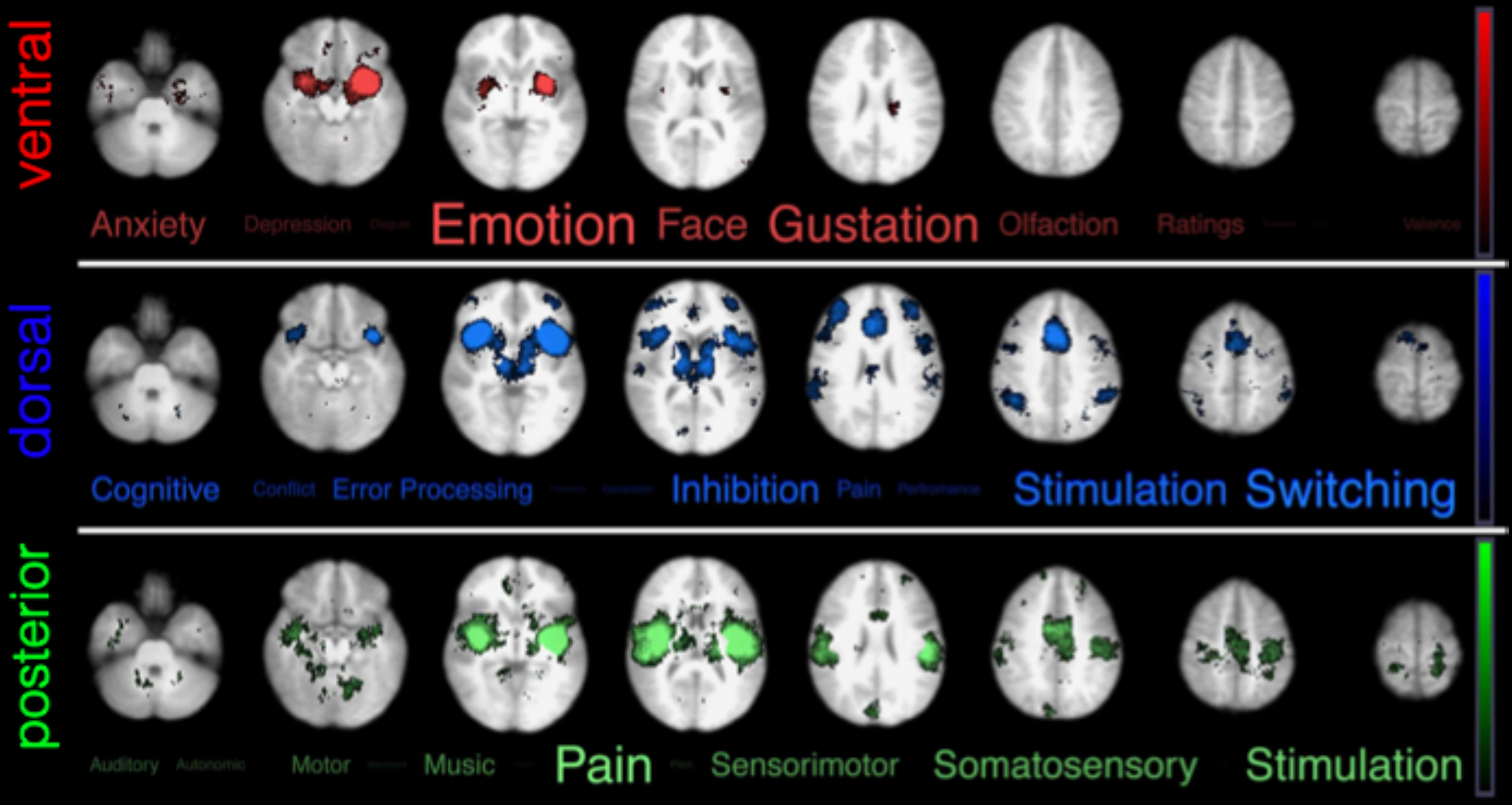
What can we do with fMRI?

Where are feelings encoded?



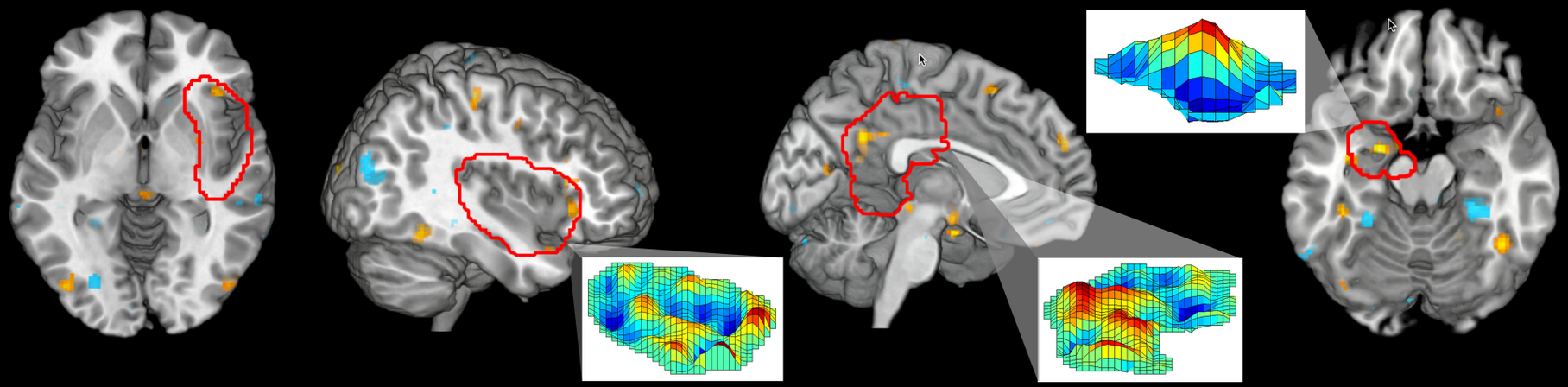
Chang, Smith, Dufwenberg, & Sanfey (2011) Neuron

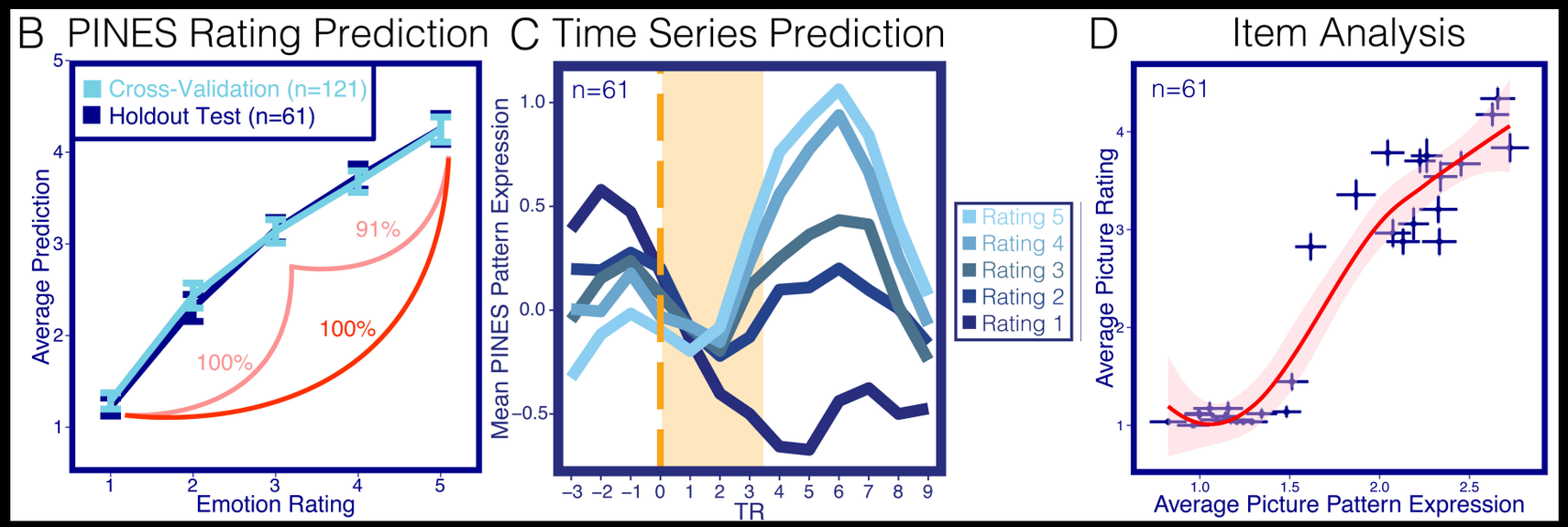
Meta-Analytic Decoding



Chang, Yarkoni, Khaw, Sanfey (2012) Cerebral Cortex

How is someone feeling?

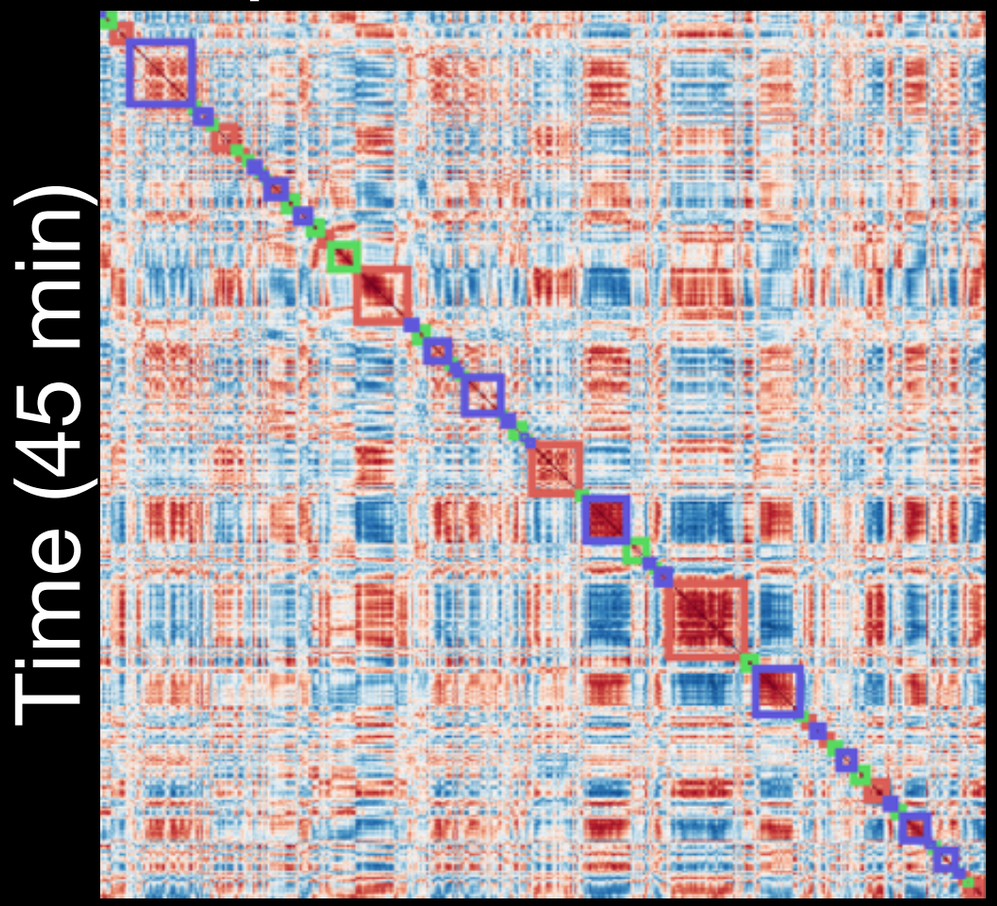


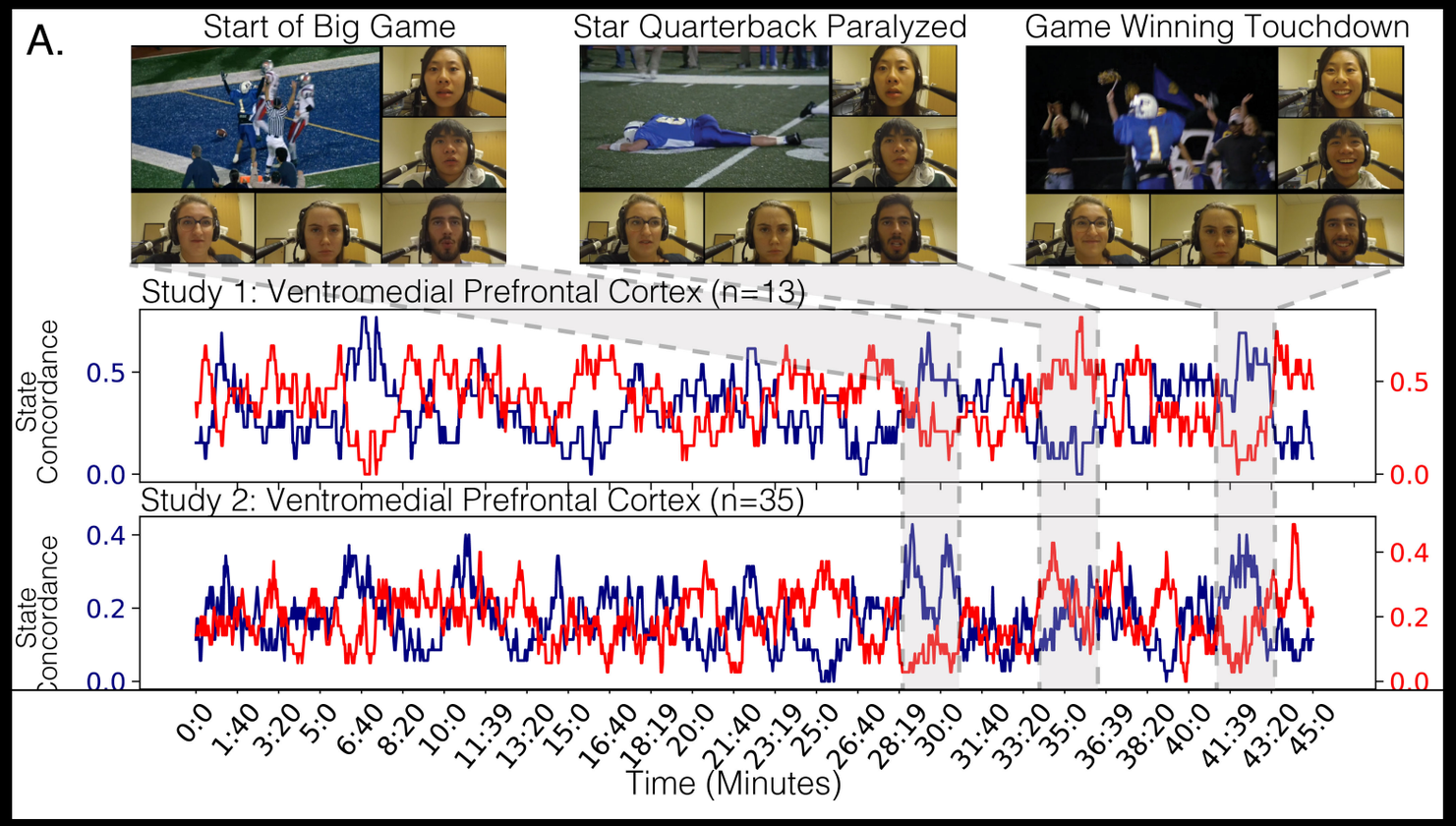


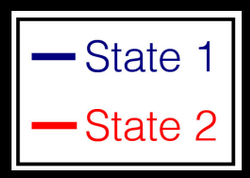
Chang, Gianaros, Manuck, Krishnan, & Wager (2015) PLoS Biology

Temporal Dynamics of Feelings

Temporal Recurrence

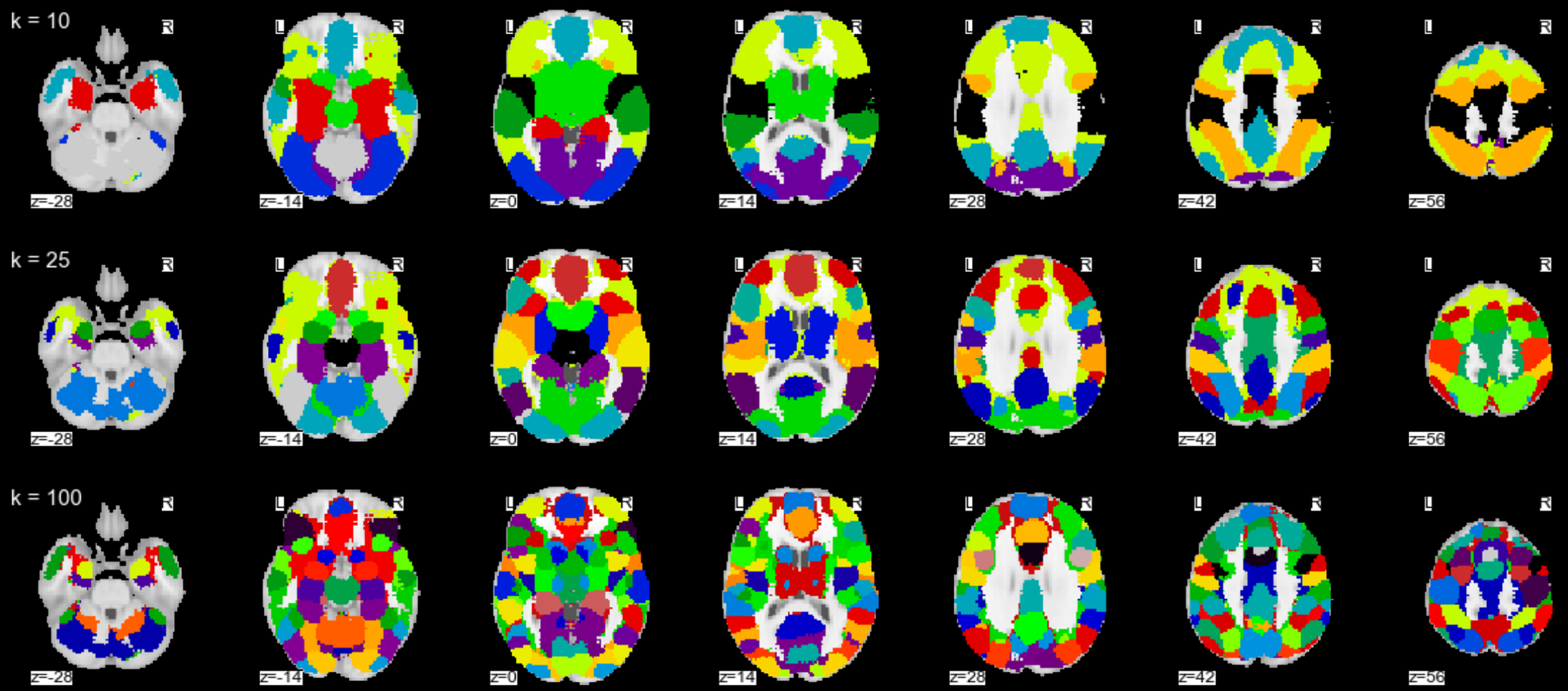






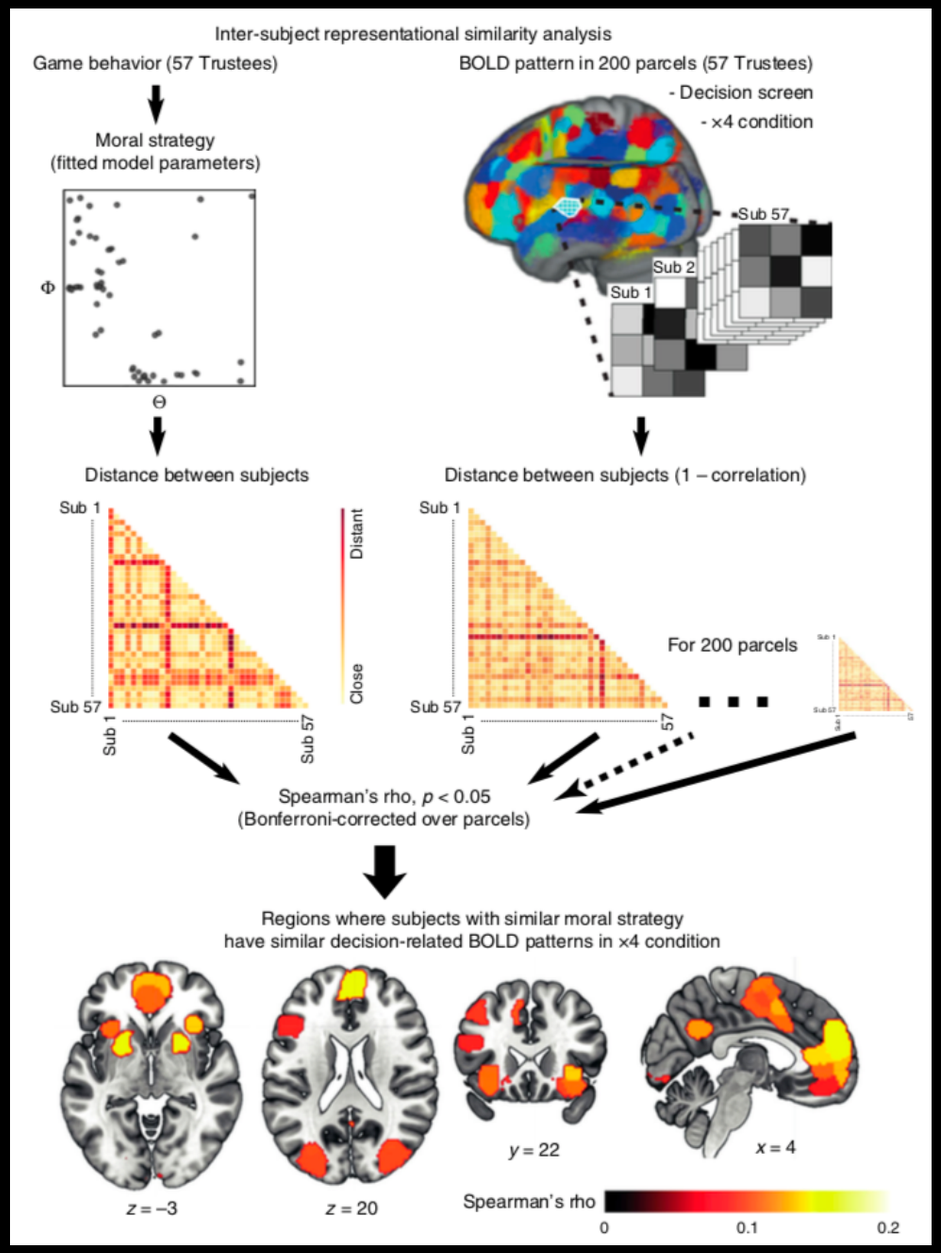
Chang, Jolly, Cheong, Rapuano, Chen, & Manning (Under Review)

How is the brain functionally organized?



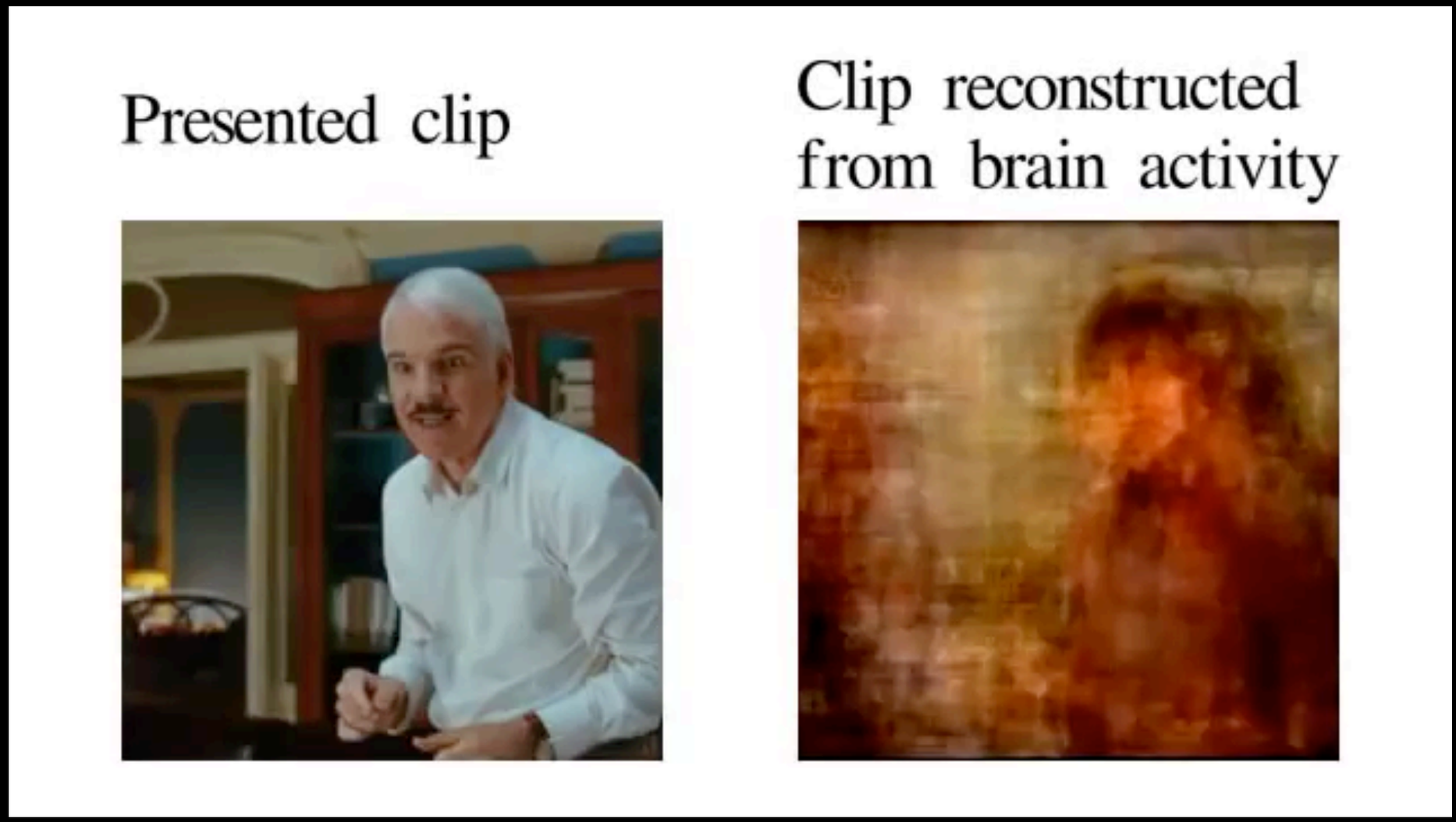
Yarkoni, de la Vega, & Chang (In Preparation)

Where are social preferences computed?



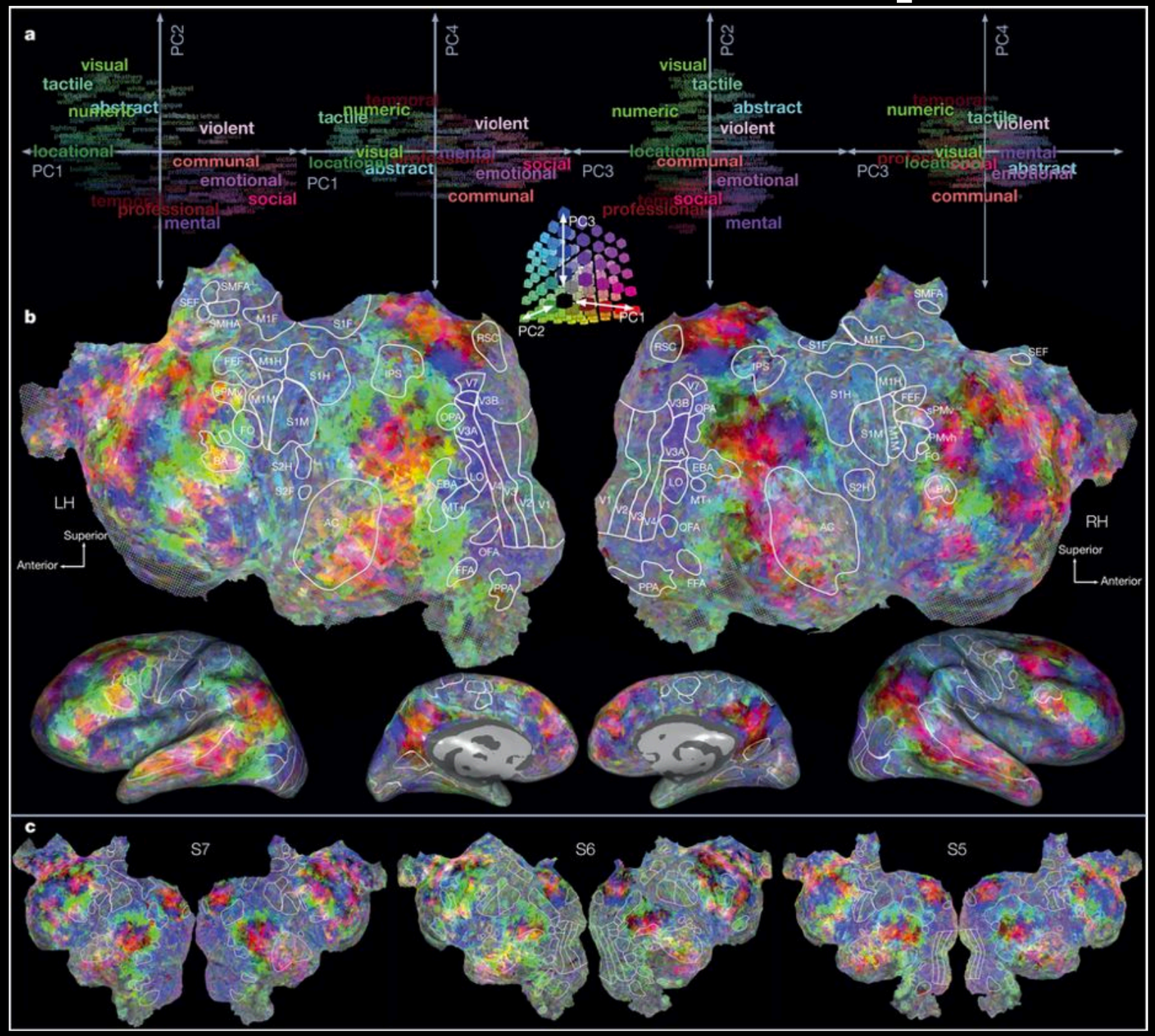
Van Baar, Chang, & Sanfey (2019) Nature Communications

Can we reconstruct input stimuli?



Nishimoto, Vu, Naselaris, Benjamini, Yu & Gallant (2011) Current Biology

Semantic Maps



http://gallantlab.org/huth2016/

Nishimoto, Vu, Naselaris, Benjamini, Yu & Gallant (2011) Current Biology