



UCLA Brain Mapping Center

# Neuro 222

## Brain Imaging and Brain Stimulation

Course Overview and Project Discussion  
3 October 2023

# Session Objectives

- Review course content.
- Introduce ourselves to each other and discuss research interests.
- Discuss class project ideas.

# Module 1: Brain Imaging

Week	Date	Topic	Instructor
0	9/28/2023	Course Introduction Neuroanatomy	<a href="#">Iacoboni</a> / <a href="#">Joshi</a> / <a href="#">Shattuck</a> <a href="#">Allan MacKenzie-Graham, PhD</a>
<b>1</b>	<b>10/3/2023</b>	<b>Course Overview/Project Discussion</b>	<a href="#">Iacoboni</a> / <a href="#">Joshi</a> / <a href="#">Shattuck</a>
1	10/5/2023	Neuroanatomy	<a href="#">Allan MacKenzie-Graham, PhD</a>
2	10/10/2023	MR Physics	<a href="#">Robert Welsh, PhD</a>
2	10/12/2023	MR Physics	<a href="#">Robert Welsh, PhD</a>
3	10/17/2023	Structural MRI	<a href="#">David Shattuck, PhD</a>
3	10/19/2023	Diffusion MRI	<a href="#">David Shattuck, PhD</a>
4	10/24/2023	Functional MRI (fMRI)	<a href="#">Martin Monti, PhD</a>
4	10/26/2023	Positron Emission tomography (PET)	<a href="#">Roger Woods, MD</a>
5	10/31/2023	Shape Modeling/Statistical Analysis	<a href="#">Shantanu Joshi, PhD</a>
5	11/2/2023	Review Brain Imaging	<a href="#">Iacoboni</a> / <a href="#">Joshi</a> / <a href="#">Shattuck</a>

# Module Part 2: Brain Stimulation

Week	Date	Topic	Instructor
6	11/7/2023	Transcranial Magnetic Stimulation (TMS) Physiology and Circuitry	<a href="#">Marco Iacoboni, MD PhD</a>
6	11/9/2023	TMS Perturbation and Mapping	<a href="#">Marco Iacoboni, MD PhD</a>
7	11/14/2023	TMS Treatment and Safety	<a href="#">Marco Iacoboni, MD PhD</a>
7	11/16/2023	Transcranial Direct Current Stimulation (tDCS) & Head Modeling/Simulation	<a href="#">Mayank Jog, PhD</a>
8	11/21/2023	Transcranial Ultrasound (tUS)	<a href="#">Martin Monti, PhD</a>
8	11/23/2023	Thanksgiving Break (no lecture)	
9	11/28/2023	Deep Brain Stimulation	<a href="#">Martin Seeber, PhD</a>
<b>9</b>	<b>11/30/2023</b>	<b>Exam Review</b>	<a href="#">Iacoboni</a> / <a href="#">Joshi</a> / <a href="#">Shattuck</a>
<b>10</b>	<b>12/5/2023</b>	<b>Project Presentations - Part 1</b>	
<b>10</b>	<b>12/7/2023</b>	<b>Project Presentations - Part 2</b>	

Updated

# Introduce Yourself!

- Name
- Degree / program
- Research area
- What you hope to get out of this course
- What topics appeal to you for a course project

# Projects

- The goal of the projects is to provide you with hands-on experience using computational tools for studying brain imaging and brain stimulation data.
- We encourage team projects that make use of the broad range of experience within the class.
- We encourage you to explore your own ideas and study things that are of most interest to you.
- We will facilitate your projects by helping you conceptualize your research, identify suitable software and data to use, and discuss your project as the quarter progresses.

## Week

1	develop ideas, project groups, discuss with us
2	
3	finalize project concept
4	perform project and prepare presentation
5	
6	
7	
8	
9	
10	present project in class

## Timeline

# Common Project Elements

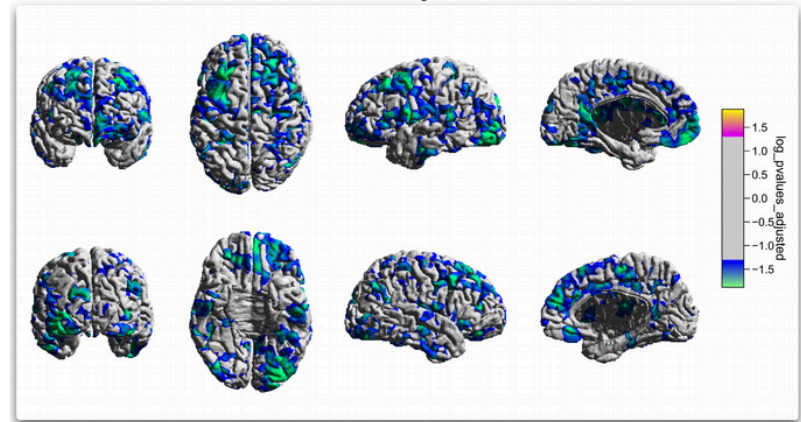
- Data: there are several publicly-available, open-access datasets that could be used for your project.
  - OpenNeuro (<https://openneuro.org>)
  - FCON1000 ([http://fcon\\_1000.projects.nitrc.org/fcpClassic/FcpTable.html](http://fcon_1000.projects.nitrc.org/fcpClassic/FcpTable.html))
  - OASIS (<https://www.oasis-brains.org/>)
- Software: there are many freely available packages
  - Brain Imaging (sMRI, dMRI, fMRI): [BrainSuite](#), [FreeSurfer](#), [FSL](#), [SPM](#), [AFNI](#), [MRtrix3](#)
  - Brain Stimulation (tDCS, TMS, tUS): [SimNIBS](#), [ROAST](#), [Sim4Life](#), [StimVis](#), [k-Wave](#), [TUSX](#)



# Project Example – Anatomical MRI

- With T1-weighted MRI, we can identify tissue types and measure anatomical structures.
- An anatomical MRI study might perform group-level comparison of subject attributes measured from MRI.
  - Requires use of software tools to extract attributes (e.g., cortical thickness, grey matter content, size of anatomical structures).
  - Requires group data for comparison – there are several publicly-available open-access datasets that could be used for this.
- You will learn about these concepts during the lectures in Week 3 and 5.

Surface-based cortical thickness analysis



# Project Example – Diffusion MRI

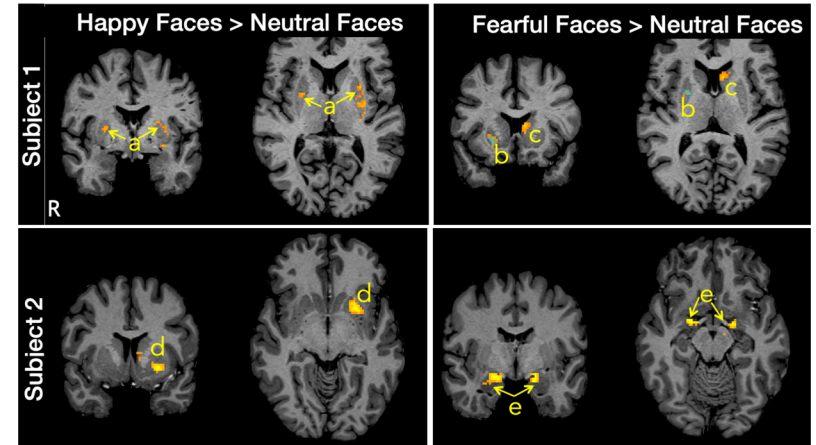
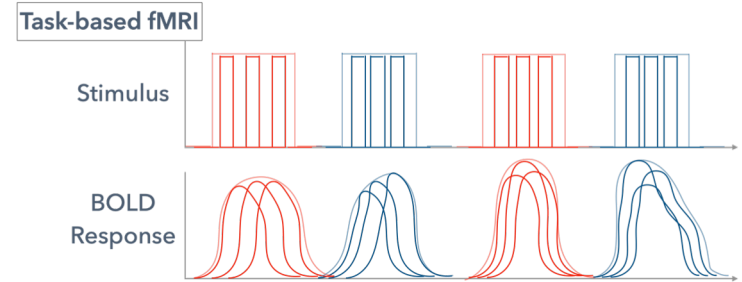
- Diffusion MRI (dMRI) enables us to quantify the microstructure of brain tissue and infer information about structural brain connectivity.
- A dMRI study might perform group-level comparison of microstructural properties at the voxel-level.
- A dMRI study might examine brain connectivity using computational tractography.
- We will explore dMRI during Week 3.



Streamlines computed from diffusion MRI.

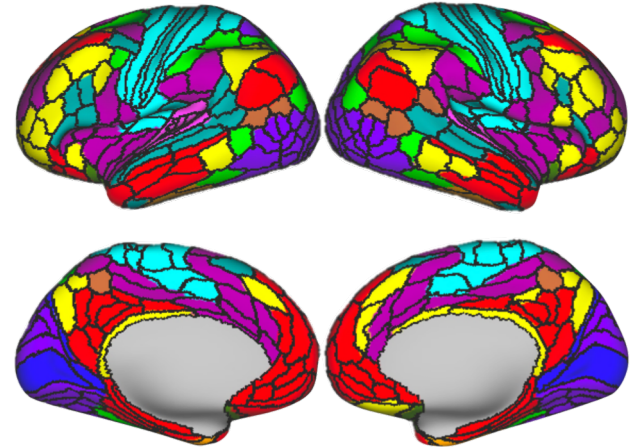
# Project Example – task-based functional MRI

- The task-based functional MRI (tfMRI) paradigm helps us to associate task-related activity (motor, visual, cognition) with specific brain regions.
- Examples of tasks include: i) finger tapping task, ii) N-back task, iii) emotion recognition (via faces), iv) response-inhibition (Go No Go).
- You can use fMRI data from a finger-tapping task from a single individual to map their activity patterns in the cortex (hint: motor) – single-subject-analysis.
- You can also perform a group-level-analysis to find differences in brain activity for a response-inhibition task between controls and participants with bipolar disorder.
- You will learn about these concepts during the fMRI lecture in Week 4.



# Project Example – resting state functional MRI

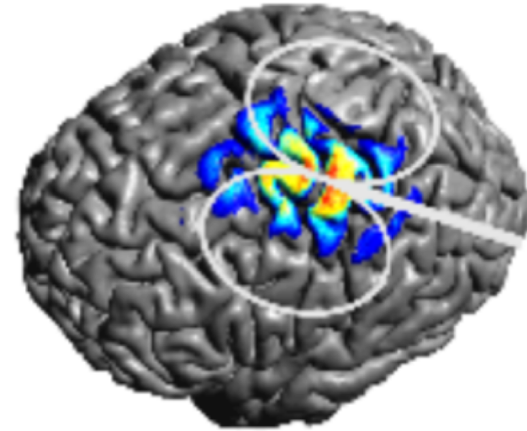
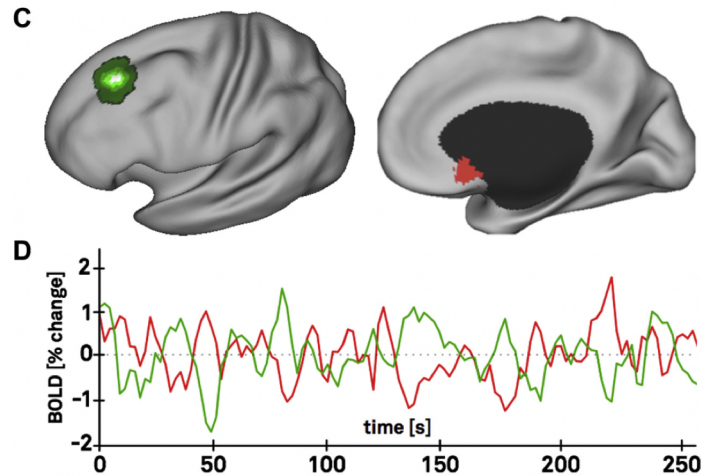
- The resting-state functional MRI (rsfMRI) paradigm is useful in discovering brain dynamics – or intrinsic brain activity patterns (common to us all) that are present even when not engaged in a task.
- Unlike task-fMRI, rsfMRI is best suited for analysis at a population level.
- You can analyze a population of rsfMRI scans to discover the default mode network (DMN) in the brain. This network constitutes regions from the dorsal medial prefrontal cortex, posterior cingulate cortex, precuneus and the angular gyrus.
- You will learn about these concepts during the lectures in Week 4.



*Glasser et al. 2016*



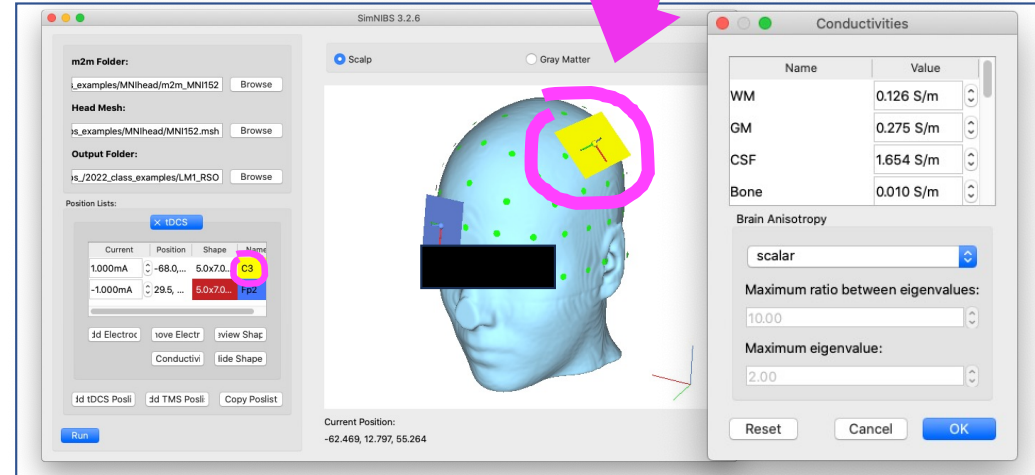
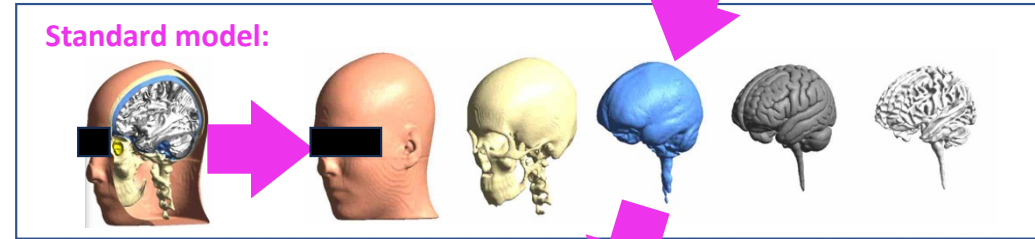
# Project Example – TMS Simulation



- Resting state functional connectivity between DLPFC cortical site and sgACC seems to predict TMS treatment response in depression (Weigand et al, 2018; discussed in the TMS lecture on Week 7).
- You can use existing datasets and simulation tools like SIMNIBS to find the best TMS position for best stimulating the DLPFC group of sites with higher resting state functional connectivity with sgACC.

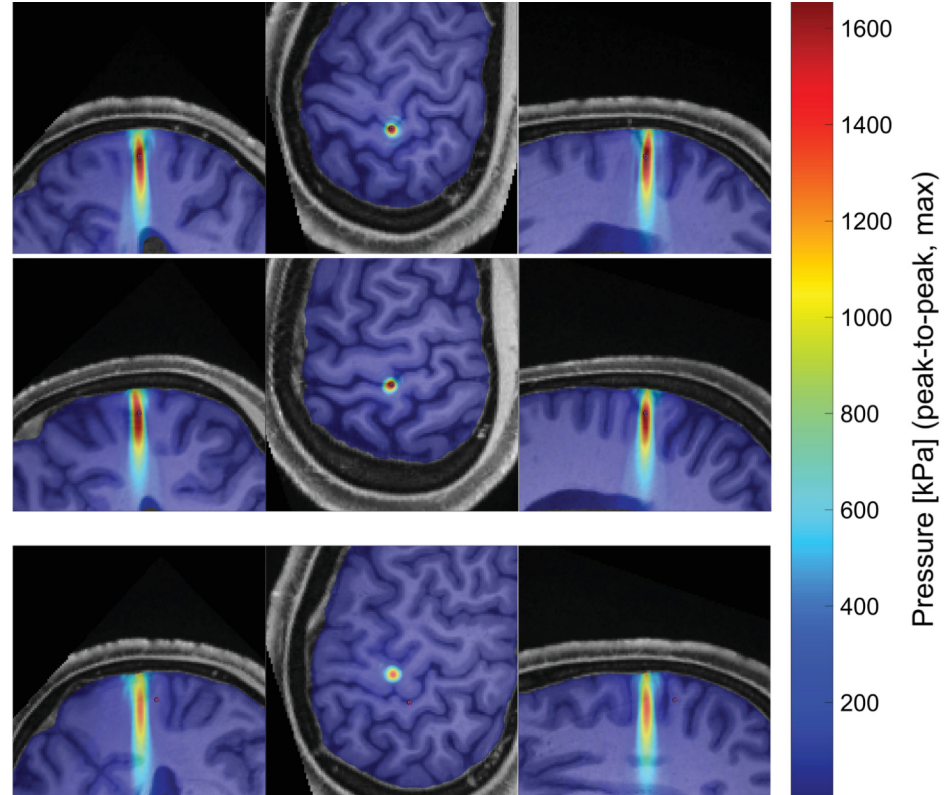
# Project Example – tDCS modeling

- One of the challenges in tDCS brain stimulation is to devise effective electrode setups to target a brain location of interest.
- Electrode size, inter-electrode distance, #electrodes provide a rich parameter space that can be explored using computational models (i.e., simulations)
  - Requires use of software tools and basic statistics to extract attributes (e.g., average electric-field, current-density).
  - Head models and simulation software packages are open-source and freely available.
- You will learn about these concepts during the lecture on tDCS in Week 7.



# Project Example – tUS Simulation

- This is a study that sonicated M1 in the attempt to generate motor evoked potentials (MEPs), which are typically observed with TMS.
- Open-source acoustics package [k-Wave](#) was used within a toolbox called [TUSX](#) that processes MR or CT images for simulations run in k-Wave.
- You will learn about these concepts during lectures in Weeks 6 & 7 (TMS) and 8 (tUS).



# TMS Seminar Tomorrow

**UCLA**  
NEUROMODULATION  
SEMINAR SERIES



**Meeting Location:**  
Semel Institute  
Room 27-418

For online attendance,  
[CLICK HERE.](#)

**Meeting ID:**  
973 0135 9180  
**Passcode:**  
427820

**SCALING A  
SUCCESS  
STORY: WHAT'S  
LEFT TO SOLVE  
BEFORE  
UNIVERSAL  
ACCESS TO  
TMS?**

Jonathan Downar, MD PhD  
*University of Toronto*



**WEDNESDAY,  
OCTOBER 4TH  
11AM TO 12 PM**

## ABSTRACT

Recent progress in therapeutic rTMS protocols has demonstrated the technical feasibility of rapid remission for a high proportion of patients, across a growing number of indications. Now, for the first time, an opportunity therefore exists to achieve meaningful, measurable reductions in the overall prevalence of mood and anxiety disorders in our lifetimes. However, scaling TMS to reach millions of people will require a series of problems to be solved in terms of technical complexity, logistical convenience, and cost, while maintaining strong quality assurance. Here we will review the key problems to be resolved, and for each of these problems, a potential solution for which supporting evidence is now being gathered. A viable pathway and timeline to widespread implementation of TMS access then emerges from the evidence available so far.