**Europasaurus fMRI Project Note**

# Document Information

All meeting document <https://docs.google.com/document/d/1fASTRoCoz-IecPkXmGmRkfsb4xFPJbQgdSHs9lkSmp4/edit>

Team colab notebook <https://colab.research.google.com/drive/1AGl1IaLngwuGx7oNH61rL0gGJAKmDZWu>

Presentation slides

​​<https://docs.google.com/presentation/u/1/d/1stG0-HQz97qVYppv5Qo8aIzjJ60HxZMYDjSduVa1KOI/edit?usp=drive_web&ouid=108967866021905784064>

# Team Information

**Europasaurus Pod**

Pod TA: Antony Puthussery

Room1 Members: Abhilasha, Ana, Cemal, Dora, Engy, Jane

Team Leader: Ana

Project TA: José Biurrun Manresa (check-in everyday around 14:x30 UTC)

Project Mentor: Brendan Ritchie

# Member Information

Brief - @Where you are currently, what your research field is, etc

**Abhilasha** - M.sc chemistry, Bachelor of Biotechnology from Barkattullah university, recently completed data analysis / @India.

**Ana** - 2nd year PhD, @NYC Weill Cornell, multi-modal neuroimaging data (EEG, fMRI + PET), traumatic injury

**Cemal** (:Jamal)- MD and PhD student in Cognitive neuroscience / @Boston,USA, Harvard Medical School / DTI&fMRI in psychosis (schizo, bipolar), from Turkey

**Dora** - Ms in Mathematics, ex-NEC Laboratories associate researcher, now Research Intern - @Johns Hopkins University

**Engy** - Msc in Pharmacogenomics and Structural Bioinformatics @college of Biotechnology , Misr University for science and technology / Egypt.

**Francisco** - Master in Computer Science / Financial inclusion for non-bancarized people in Mexico @ITESO

**Jane** - @Dartmouth(EST) 4rd year PhD in Cognitive Neuroscience, fMRI dataset with naturalistic stimulus (human action, human vs monkey, cs course)

**POD TA: Antony** - Mathematics PhD, graph theory - neuroscience, neurogeometry (2016)

**PROJECT TA: Jose** - Professor @Argentina, (got PhD 11 yrs ago!), neurophysiology of face, sensory-motor integration, biomedical engineering background, EEG (not fMRI)

**PROJECT Mentor: Brendan** - Post Doc National institution of mental health @Washington D.C, high level vision(object recognition, face representation), fMRI + multimodal (hyperscanning+7T), modeling, PhD field: psychology, postdoc @Belgium

# Project Information

**HCP task dataset**

* Barch, D. M., Burgess, G. C., Harms, M. P., Petersen, S. E., Schlaggar, B. L., Corbetta, M., … and Van Essen, D. C. (2013). Function in the human connectome: task-fMRI and individual differences in behavior. Neuroimage, 80: 169-189. doi: [10.1016/j.neuroimage.2013.05.033](https://doi.org/10.1016/j.neuroimage.2013.05.033)

Datasets <https://compneuro.neuromatch.io/projects/fMRI/README.html>

* No resting state data, only the task data

# Meeting Notes

## W1D2 Project Thoughts: Brainstorming

**What dataset to work with**

Ana

* HCP- brain - behavior relationships (emotion, gambling, social)
* If possible, not visual perception 🙂
* CCC, statistical learning, resting state vs. ???

Cemal

* Mostly agree , what about structural data?? Not interested with structural data if not preprocessed :) .

Abhilasha

* visualization of the data
* machine learning algorithms
* Human behavior on different actions
* Logistic regression

Jane

* HCP task datasets
* Preprocessed saves our pain
* Not interested in HCP retinotopy, Kay natural images: too visual cortex, low level visual perception
* Rich data, can choose any topics and different analysis depending on independent questions

Dora

* HCP task datasets and HCP retinotopy
* Easy and mediate datasets, not advanced
* Simple Neural Network, dimension reduction, visualize, classification, prediction

**Feedback**

Jose

* The common research goal of the project?
* **Research question first**, not the tools/methods (structural,ML, etc)
* Then check if the research question has been dealt (literature survey)
* Design the research approach, analysis to answer the question

**Brainstorming Part 2**

Jane

* How the visual cortex is involved even when the task is irrelevant with visual stimulus (language understanding?)
* Personal preference: **language**/story understanding

Ana

* **Resting** state scans are correlated with language task/emotion
* Not against language approach

Cemal

* added project templates

RDM

<https://compneuro.neuromatch.io/_images/MappingBrainRepresentationwithfMRI.svg>

Visual information

<https://compneuro.neuromatch.io/_images/VisualInformationAcrossRegions.svg>

Face

[**https://compneuro.neuromatch.io/\_images/NeuralBasisOfFacePerception.svg**](https://compneuro.neuromatch.io/_images/NeuralBasisOfFacePerception.svg)

Abhilasha

* **Emotion** Stress & anxiety
  + Jane: Maybe possible correlation with tasks/resting
    - Regarding resting /task related brain network features
  + Cemal: brain network features of subgroups (cognitive, clinical), sex differences?
  + Ana: menstrual cycle data & person data also are there

Francisco

* Above Sounds interesting
* No strong preference
* Want to apply machine learning models/modeling

Engy

* Q: How can I know the cases of the images/participants? How possible medications affect participants?
  + A: neurotypical population so hopefully not related with medications

### Todo

* 20 minutes
  + ~~Read research paper~~
  + Look into dataset
  + ~~Think of the research question/possible analysis~~

## W1D3 Project

### Meeting information

Jul-12-2023 13:00 - 17:00 UTC

Ana, Abhilasha, Cemal, Dora, Engy, Jane

### Meeting notes

**Meeting Outline**

* Read the HCP paper
* Play with the colab

HCP manual

[Connectome - HCP 3T Task fMRI Protocol Overview (humanconnectome.org)](https://www.humanconnectome.org/hcp-protocols-ya-task-fmri)

**When Jose comes**

* Ask about the math condition problem we’re having

Index out of the range

[Dora, don’t know if it has been solved or not, if solved, just delete my answer, I found the env[idx][i], which is a list of the column number of data, contains values larger than 316, I guess that might because we have part of the datasets, I choose subjects[5], that works, but there should be some subjects that can not work] FIXED!!!

**IDEA FORECASTING**

* Maybe we are interested in language, looking at visual cortex activations while listening to auditory stories. —Lit maps
* Can we **decode** between two conditions?

Between regions?, Does ATL actually activate?

* **Dynamic functional connectivity** analysis - story listening

How the network features are different between conditions

### Todo

* Read in project templates to grasp the idea how the cog neuro/fmri research/analysis are executed
* **Brainstorm**: Think of more potential testable hypothesis
* Look up some doable codes/githubs/websites to try out the analysis

E.X connectivity analysis, RSA, HMM(event segmentation), PCA, Decoding, SVM,

* **~~Colab~~**~~: Let’s figure out what’s happening with the math data dimension??~~
* **LitReview**: Let’s bring a 3-5 minutes update each person/link related with what they found in the literature regarding this HCP dataset

## W1D4 Project

### [Dora] About the data EVs(Explanatory Variables)

The size of each explanatory variable

<https://docs.google.com/document/d/1TQZHhXW-IZZOBfci6CKqBGR_bsvaCIH8LootKbTJFaw/edit?usp=sharing>

**Colab Looking into evs\_txt files**

<https://colab.research.google.com/drive/1Xpc-j4zebKEpxt89L97qF0AC4BBvF1J-#scrollTo=arobhuTaYVVr&uniqifier=1>

Notes from Meeting with Project TA: (Ana’s lose notes)

-decoding whole brain, weights and correlate with functional connectivity map

each index is a TR of a block

-subsampling for indices within the block, beginning of the block vs the end of the block?

consistency of the FC across the different blocks of the same condition

-treat each block as a trial, you can do a cross validated OLS estimate, multiply the weights from that data to the design matrix or the left out data

-Typically HRF is one HRF, step function would be whole duration of the block. Import the HRF library and do a comparison across two conditions and do we see a difference in which HRF function fits between tasks. iterative comparison

-we have network information, GLM single paper we see systematic difference in what captures the HRF signal. variation between network or within network

-does matter for some region and not other regions between parcels.

-beta is a proxy for a signal strength, by better modeling the dynamics of that we can get a better estimate of the strength of that signal. if you change how you model the HRF. it tells you latency, amplitude.

-basic FC analysis, similarity of the HRF across parcels, see if theres a relationship between HRF similarity and network FC

## W1D5 Project

project calender : <https://compneuro.neuromatch.io/tutorials/Schedule/daily_schedules.html>

How long can we make the segments until they become mirrored again?

Look more into the evolution of functional connectivity over time.

## W2D1 Project

### Meeting Information

Ana, Abhilasha, Dora, Jane

2023-July-17 13:00-16:00 UTC

* Cemal absent for Jul 17,20,24
* Writing the proposal for tomorrow

### Meeting Notes

**Nilearn connectivity**

<https://nilearn.github.io/stable/modules/generated/nilearn.connectome.ConnectivityMeasure.html#nilearn.connectome.ConnectivityMeasure>

**GLM Single**

Paper <https://elifesciences.org/articles/77599>

Github <https://github.com/cvnlab/GLMsingle>

Block Design Example

<https://htmlpreview.github.io/?https://github.com/kendrickkay/GLMsingle/blob/main/examples/example2.html>

Block Design Example Video (short) <https://www.youtube.com/watch?v=yb3Nn7Han8o&ab_channel=JacobPrince>

Block Design Example Video (long)

<https://www.youtube.com/watch?v=OvxOUn0-tn0&ab_channel=MITCBMM>

* Can check it out on your own! Quite long

**Brain storming ideas**

Different regions has better HRF?

For different tasks?

-> Per region, per task

**Jose feedback and discussions**

Tyring more to understand the task, and the GLM single: e.g. what is the ‘good/better’ fit of the HRF model in GLM single?

**How to apply our data**

How to deal with different durations for each trial

* Average across trials

<https://www.frontiersin.org/articles/10.3389/fninf.2019.00010/full#h3>

* What other solutions could be?

### Coursework

#### Coursework: Step 1-4

<https://compneuro.neuromatch.io/tutorials/W2D1_ModelingPractice/student/W2D1_Tutorial1.html>

**Tomorrow: Step 5-10**

<https://compneuro.neuromatch.io/projects/modelingsteps/ModelingSteps_5through10.html>

**Purpose of NMA:**

**How better as an individual can formulate the question?**

**\*Not about the end-result but about the scientific process\***

#### After Step 1

* **Think!1 Effectiveness of GLM Single**

How much better/more reliable is using a repertoire of HRF functions to model BOLD data in task fMRI than using the canonical HRF? Does the improvement vary by region and/or task? Is the HRF function that best fits the data consistent per region across tasks, is it consistent within network? Does this improve decoding?

**Group feedback**

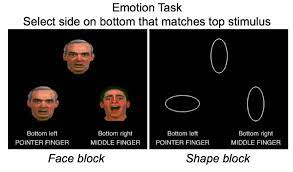
* Interesting question: how do these relate to FC?
* Methodological approach: how does this new method improves other analysis
* **Think! 2 Relationship between tasks for individual differences/tendencies**

Would the functional connectivity density among participants for story task correlate with how the amygdala is activated in emotion task? Could it be used as a evidence where if you have more empathy (- more amygdala activity/number or portion of voxels that decodes emotions better) than you would be more engaged in the story understanding? How would this features interact with non-perspective taking cognitive task such as mathematics taks (and other tasks)?

**Group feedback**

* Q: Emotion includes?

A: Fear or Anger, but we only have fear/neut



* Potentially less types of analysis involved?
* More neuromatch-y?
* Think! 3 something fun here? Emotion decoding performance

Between fear and anger? How would it be? What regions would contribute more in this decoding performance? What would that mean?

**Group feedback**

* 360 regions by regions decoding the condition

#### 

#### After Step 2

* **Add in the literature review**
* **~~AFTER today’s NMA, before tomorrow’s NMA~~**
* **After the literature review**

What could you make the questioning and scientific thinking better?

What has been done in the literature review?

How could you sharpen the formulative scientific thinking from the findings in the literature review?

#### After Step 3

**Determine basic ingredients:**

* Time series for each parcellated region (given)
* Stimulus Duration
* Where the regions are (surface coarseness, not amydala/subcortical area)
* What the tasks are, how are they different in those above parameters

Material links

<https://github.com/avisha-04/NMA-Project-HCP-FMRI-Emotions-Task/blob/main/README.md>

<https://github.com/SocialDragonsNeuromatch/NeuromatchProject>

#### After Step 4

**NMA Dataset based on what atlas? Glasser**

* HCP colab

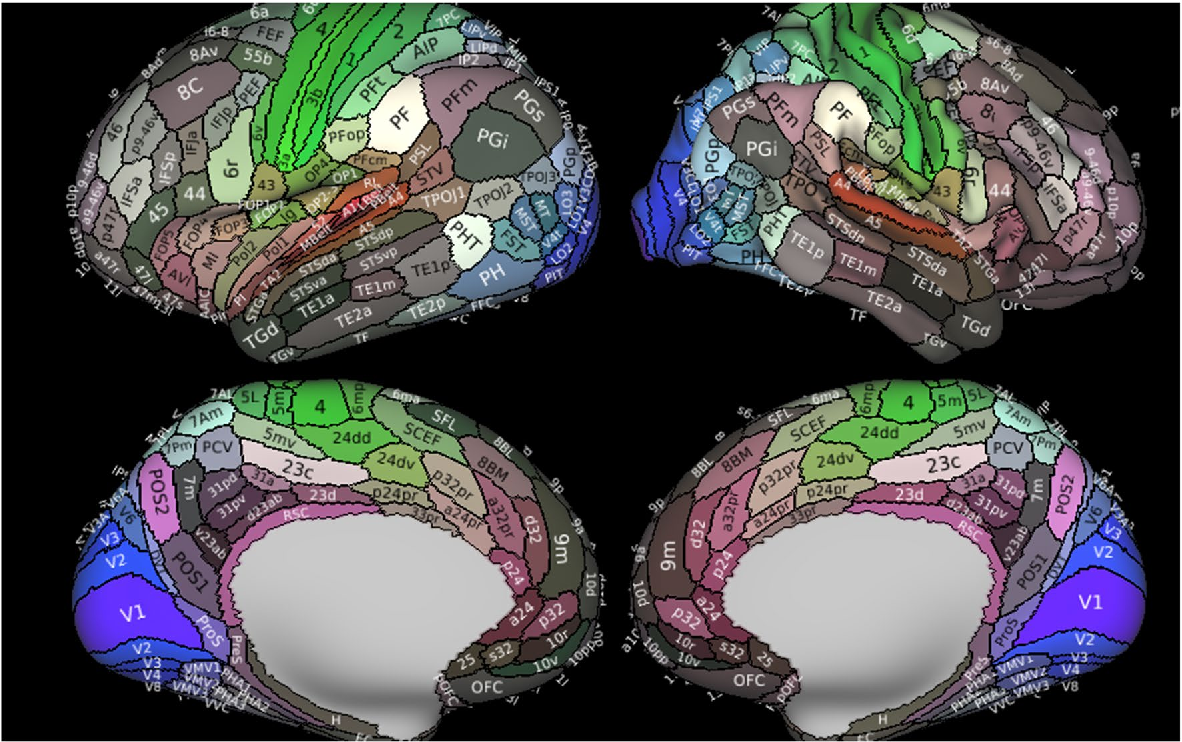
“# The data have already been aggregated into ROIs from the Glasser parcellation”

* Other materials

<https://neurostars.org/t/glasser-360-atlas-in-nilearn/25991/4>

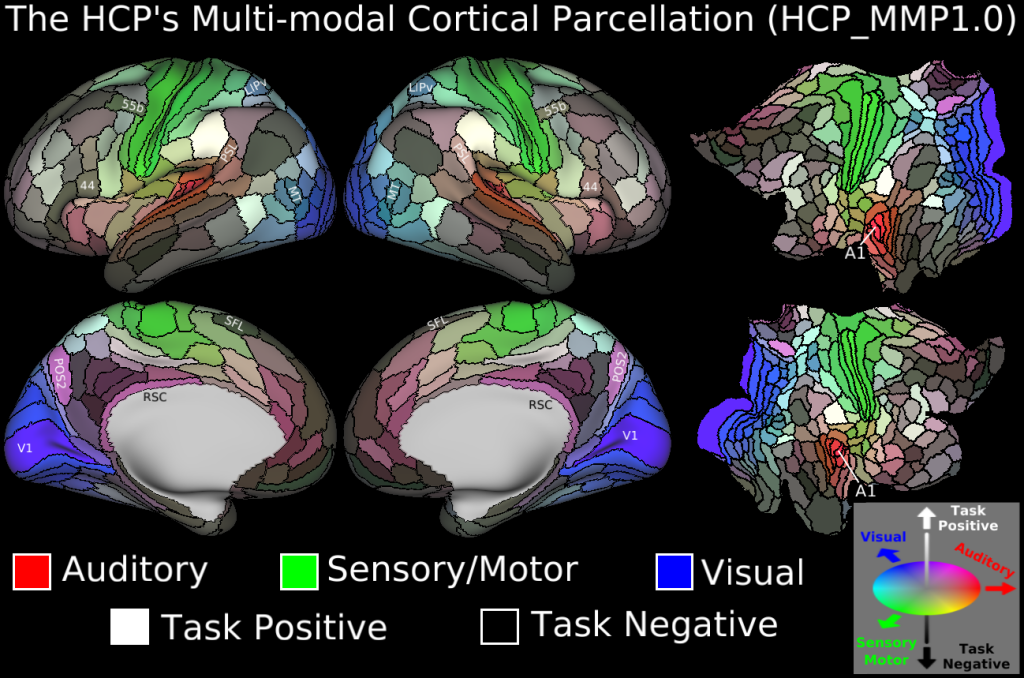
<https://figshare.com/articles/dataset/HCP-MMP1_0_projected_on_fsaverage/3498446?file=5528837>

* 360 region names



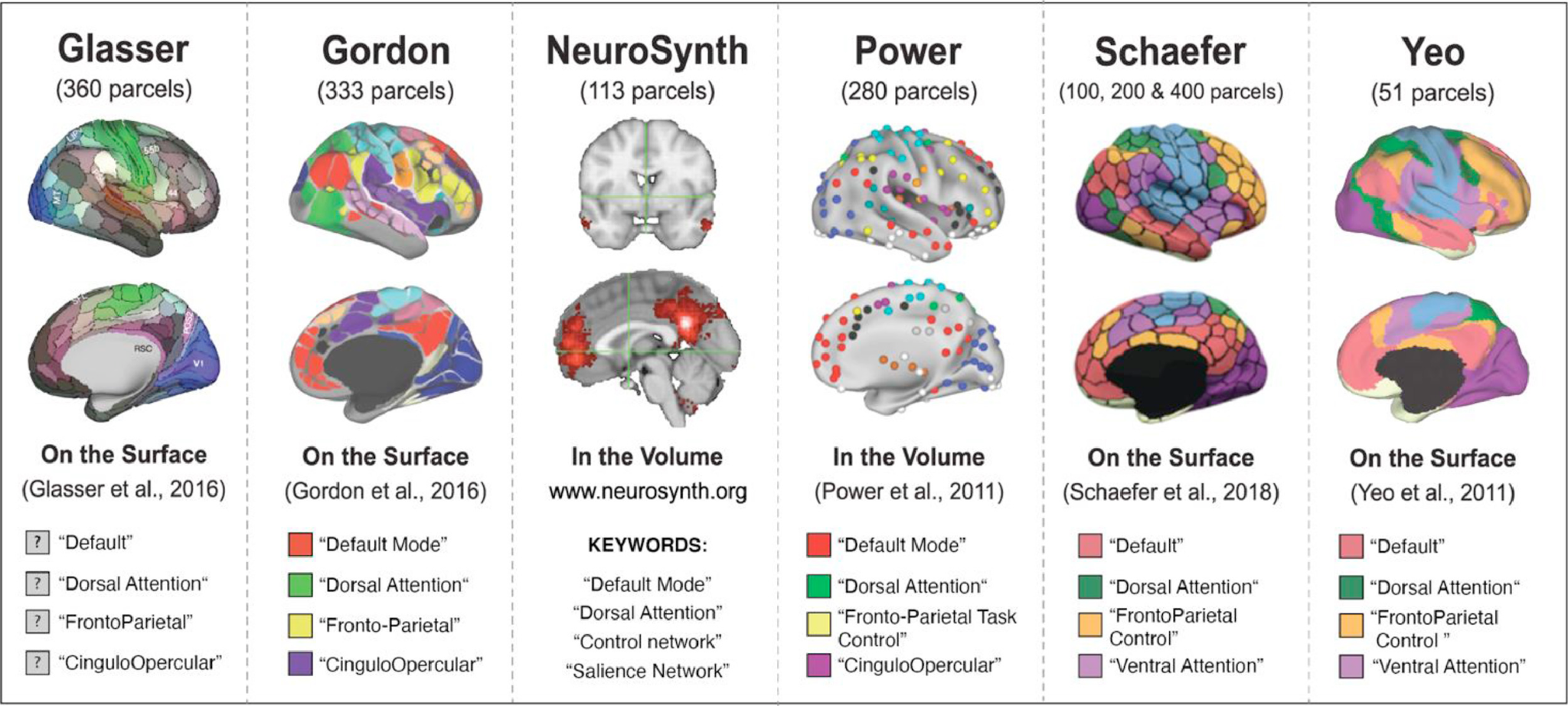
<https://www.neuromythography.com/encyclopedia/glasser-parcellation/>

* Color code



<https://balsa.wustl.edu/study/RVVG>

* For comparison with other atlas



<https://www.sciencedirect.com/science/article/pii/S1053811921007606#fig0002>

* Since we don’t have the amygdala, we could look into theory of mind - and its related surface parcellation instead of using the emotion task (paired with amygdala and insula)?

**Jane throws in papers 💣**

* Activation of the default network during a theory of mind task predicts individual differences in agreeableness and social cognitive ability

<https://link.springer.com/article/10.3758/s13415-021-00955-0>

“In each participant, **average blood oxygen level dependent responses were calculated for default network regions** associated with social cognition, and **structural equation modeling** was used to test associations of personality and task performance with activation in those brain regions. **Default network activation in the dorsal medial subsystem** was greater for social versus random animations. Default network activation in response to social animations **predicted better performance on social cognition tasks** and, to a lesser degree, higher Agreeableness. Neural response to social stimuli in the default network may be associated with effective **social processing** and could have downstream effects on social interactions.”

Research Questions

* Could the default network activation in the dorsal medial subsystem also predict their performance on story understanding task (behavioral score)? And also math (why not)
* How would it correlated with the pattern during the story understanding task(fMRI)?
* How would it be correlated with the pattern during the emotion task(fMRI)?

Discussion

* Behavioral score ceiling effect
* Correlation too simple for NMA
  + Could be using other numbers: RSA correlation, Connectivity density numbers?
* Shared genetic aetiology between cognitive performance and brain activations in language and math tasks

<https://www.nature.com/articles/s41598-018-35665-0>

Something not so relevant to the topic but interesting

* Design of Deep Learning Model for Task-Evoked fMRI Data Classification

<https://www.hindawi.com/journals/cin/2021/6660866/>

* For classification analysis with CNN
* Cross-network interactions in social cognition: A review of findings on task related brain activation and connectivity

<https://pubmed.ncbi.nlm.nih.gov/32653744/>

**Ana**

* PET scan for localizing - [https://doi.org/10.1016/0010-0277(95)00692-R](https://doi-org.ezproxy.med.cornell.edu/10.1016/0010-0277(95)00692-R)
* Thalia - understanding animate agent - <https://doi-org.ezproxy.med.cornell.edu/10.1111/j.1467-9280.2007.01923.x>
* Binder NeuroImage: story vs math task
  + Greater activation for story condition - https://www.sciencedirect.com/science/article/abs/pii/S1053811910012486
* Speech comprehension paper - [https://doi.org/10.1016/j.heares.2013.09.011](https://doi-org.ezproxy.med.cornell.edu/10.1016/j.heares.2013.09.011)
* Social concepts are represented in the superior anterior temporal cortex - <https://doi.org/10.1073/pnas.0607061104>
* GLM single - IF NEEDED <https://elifesciences.org/articles/77599>
* Cool paper

Meditation, psychedelic

<https://www.biologicalpsychiatrycnni.org/article/S2451-9022(23)00174-X/fulltext#%20>

Engy

<http://article.aascit.org/file/pdf/9290821.pdf>

[Pragmatic markers: the missing link between language and Theory of Mind | SpringerLink](https://link.springer.com/article/10.1007/s11229-020-02768-z)

[Evol\_of\_language\_&\_ToM.pdf (southampton.ac.uk)](https://web-archive.southampton.ac.uk/cogprints.org/3317/1/Evol_of_language_&_ToM.pdf)

Abhilasha

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4011498/>

Dora

<https://www.sciencedirect.com/science/article/pii/S0010945220301933>

* What does the connectivity mean review

### Discussions

* “Given the requirement of repeated discrete events, GLMsingle is not applicable to resting-state data, since they contain no explicit task structure. Similarly, GLMsingle is not suitable for experiments that involve continuous event structures – for example, movie watching, storytelling, dynamic exploration, game-playing – unless certain events within the task are coded as discrete, repeated instances. For example, the appearance on-screen of a particular character could be treated as a repeated “event” in constructing a design matrix. Or, as another example, certain words or parts of speech could be treated as “events” within a continuous auditory or linguistic experiment.”
* From GLM Single paper <https://elifesciences.org/articles/77599>
* ~~Question To Brendan: can GLM single be applied to our story vs math task?~~

Basically the trial by trial: GLM denoise coupled with HRF libraries

If the dataset/approach is the block design, you could just go for the GLM denoise

## W2D2 Project: Proposal submission

### Meeting Information

All

### Meeting Notes

* Literature survey 30 minutes

Sharing the Literature survey

Ana

* 2020 NeuroMatch project

Task: **social cognition task**

Decoding: high performance and low performance

Lasso regression / ridge regression

Connectivity patterns, effective connectivity, Random interaction, mental interaction.

LINK: <https://compneuro.neuromatch.io/projects/docs/projects_2020/fMRI.html>, first slide deck, page 70

-apply-> activation of the **theory of mind task** - behavioral data

See the decoding accuracy map across the regions

Correlating social cognition task with theory of mind task

Jane

* Based on this literature: Activation of the default network during a theory of mind task predicts individual differences in agreeableness and social cognitive ability
* Cited the above paper

The Dark Side of Mentalizing: Learning Signals in the Default Network During Social

4 Exchanges Support Cooperation and Exploitation

<https://www.biorxiv.org/content/10.1101/2023.05.03.538867v1.full.pdf>

HCP gambling task, how reward-punish task difference could be also influenced by this default network signals

* If we had the resting state: we could use the DMN connectivity during the resting state to predict the scores in

Engy

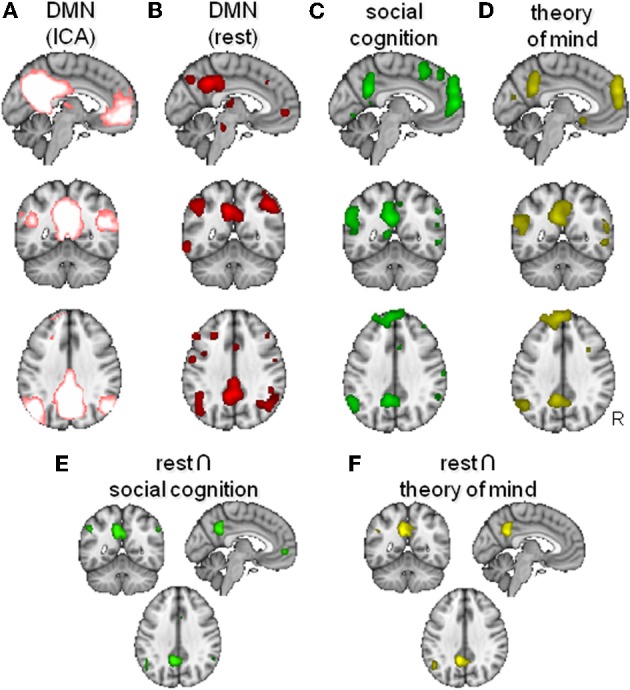
* https://link.springer.com/article/10.1007/s11229-020-02768-z
* Behavioral & philosophical approach
* Could be used as an interpretation for the human cognition

Dora

?

Abhilasha

* HCP data paper <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4011498/>
* DMN and social brain <https://pubmed.ncbi.nlm.nih.gov/22737119/>



* Social interaction
* - whether the object had a mental interaction

Cemal  
- okay with the direction/idea

### Conversion Discussion

Team members Thoughts

* Stick with language data for the efficiency : not using other new tasks (gambling)
* but i would suggest: use multiple tasks!

**Research question**

* Based on the literature and findings of social cognition/theory of mind task, brain activation in certain regions in DMN could predict certain personality (sociableness/agreeableness) and behaviors. In this coherent flow we could try to predict the connectivity patterns (RDM/RSA) in language vs mathematics data. How it could correlate with behavioral performance. Our hypothesis is that the DMN nodes would have more number of edges to other regions in the 360 regions (atlas) and the connectivity strength (correlation values) from DMN would be stronger during story task compared to the math task.

**Jose Feedback: be careful with the terminology**

Personality: too broad term

Predict: not really prediction but association or positive correlation, linear relationship

Certain regions: activation in it, not with the region itself

Idea itself

You would want to predict the connectivity pattern as a hypothesis

How do you measure the connectivity pattern? Continuous variable? Or discrete variable?

What is the behavioral performance in this tasks? So 0/1 logistic regression than the linear correlation -> check the logistics as you move on the process

As an engineer perspective, the feedback focuses on how to quantify and measure, more than the emphasis on the cognitive task itself or the cognitive concepts underlying the tasks

Connectivity analysis

EEG (>64 channels) different feature as the spatial resolution and localization is difficult (need the separate modeling for the source localization)

EEG/ECOG -> temporal dynamics

Sensory-motor integration : pain biomarker

Main concerns

Precision, validity of the measurement

* Could narrow down the the connectivity prediction?

How is the FC in the DMN affected by the choice of the HRF? Does this affect how much there is a relationship between the tasks?

## W2D3 Project

Ritchie Feedback

* ~~Reaction time in the data~~
* Explore the possibility of reaction time

Look into the reaction time to see if there’s correlation with the connectivity pattern or have the pattern of psychophysics curve for the reaction time

* GLM single

They use 20 different HRFs, which you can check it out

-> in conclusion, not so good idea in this flow of project to use GLM single, but try looking into GLM denoise and the HRF libraries itself

<https://onlinelibrary.wiley.com/doi/10.1002/mrm.27146>

<https://github.com/cvnlab/GLMsingle/tree/main/glmsingle/hrf>

Has the tsv file with libraries

get canonical hrf library.tsv

## W2D4 Project

Looking into the resting state- LOL maybe not

Reaction time analysis

* Look into individuals how across them vary

**The code for this exists in the colab, look for “Loading behavioral data” you can make the histograms easily by just changing which column makes the histogram**

* + Histogram of reaction time
  + Histogram of accuracies
* Calculate all subject’s 360 by 360 connectivity- try to limit the connectivity matrix to the default mode network labels
* Look how the connectivity pattern changes if the nodes from the same grouping (such as dmn) -> sort the 360 regions next to same grouping

Keep in mind:

Tomorrow is the abstract due date!(21/7/2023)

[Daily guide for projects — Neuromatch Academy: Computational Neuroscience](https://compneuro.neuromatch.io/projects/docs/project_guidance.html#w2-project-time)

**Resting state analysis**

Resting colab 2021

Code for load HCP

<https://colab.research.google.com/github/NeuromatchAcademy/course-content/blob/main/projects/fMRI/load_hcp.ipynb>

[https://colab.research.google.com/drive/17TCm3](https://colab.research.google.com/drive/17TCm30RVHDQKYPCdE-dxVC6-MdZvOvC6?usp=sharing)

[0RVHDQKYPCdE-dxVC6-MdZvOvC6?usp=sharing](https://colab.research.google.com/drive/17TCm30RVHDQKYPCdE-dxVC6-MdZvOvC6?usp=sharing)

GLM slide useful to understand with fMRI

<https://www.tnu.ethz.ch/fileadmin/user_upload/teaching/Methods_Models2017/04_GLM_HS2017.pdf>

* I’m also sure that watching youtube might be much more kind way to explain things in these days, there are some good short good lectures in youtubes

## W2D5 Project: Abstract submission

**Brendan Feedback**

* Reaction time

Single estimate for all runs

* AFNI, SPM

-> could concatenate for all runs

Predictors for what resolution?

All runs?

Single runs?

Single run per condition (4) x subjects

All runs concatenated(averaged) per condition (2) x subjects

**Resources**

Nipype Beginner's Guide

Python : gives OLS, GLM estimation

<https://miykael.github.io/nipype-beginner-s-guide/neuroimaging.html>

Q: Motion regressor available?

A: Probably not, all preprocessed

**Team member emails**

abhimewada1991@gmail.com

cemaldemirlek@gmail.com

J.brendan.w.ritchie@gmail.com

yangzhiyuzyyy@gmail.com

**Working division talk**

**For Ana’s reference**

You to Everyone (Jul 21, 2023, 10:24 AM)

currently:

Jane : working on connectivity

Abhilasha: working on reaction time

Cemal and Dora if you’re working on anything let us know!

so we don’t overlap and make figures for the abstracts in the given time

Cemal Demirlek to Everyone (Jul 21, 2023, 10:25 AM)

Cemal: got lost and trying to catch the project and NMA :( sorry. I am also busy with 2 labs and 1 clinic :( trying to figure out them, too

I am so sorry

364-Engy Fayez to Everyone (Jul 21, 2023, 10:32 AM)

hi everyone , sorry for being late , it was hard to get in

You to Everyone (Jul 21, 2023, 10:33 AM)

For Engy:

We are currently:

Jane : working on connectivity

Abhilasha: working on reaction time

Cemal: got lost and trying to catch the project and NMA :( sorry. I am also busy with 2 labs and 1 clinic :( trying to figure out them, too I am so sorry

Dora I’m also assuming you’re doing something else? if you’re working on anything let us know! so we don’t overlap and make figures for the abstracts in the given time

and ana went to hospital, coming back soon

364-Engy Fayez to Everyone (Jul 21, 2023, 10:35 AM)

I just checked the check list you made on google docs , I found some codes on GitHub m it may help, just checking them with what we are doing

You to Everyone (Jul 21, 2023, 10:37 AM)

no worries! what kind of code are you looking for?

GLM? connectivity? RT?

364-Engy Fayez to Everyone (Jul 21, 2023, 10:37 AM)

connectivity and GLM

You to Everyone (Jul 21, 2023, 10:37 AM)

connectivity might be okay, and GLM could need a hand! but anything you find please let us know

364-Engy Fayez to Everyone (Jul 21, 2023, 10:38 AM)

I found both , I am just looking into them , I will send them just to be sure they are helpful to avoid wasying time

are we using the abstract guidelines of neuromatch ?

You to Everyone (Jul 21, 2023, 10:39 AM)

yes

https://airtable.com/shr0ozNAhXq6K1p8o

so the goal of today is to have as much data analysis figures as we could to write a not so false argument abstract haha

364-Engy Fayez to Everyone (Jul 21, 2023, 10:40 AM)

oh nice

ok hope so

You to Everyone (Jul 21, 2023, 10:40 AM)

so whatever result figure we all make today would be needed

364-Engy Fayez to Everyone (Jul 21, 2023, 11:06 AM)

would this be helpful

<https://github.com/BNUDM/Functional_Connectivity_Analysis>

364-Engy Fayez to Everyone (Jul 21, 2023, 11:22 AM)

https://github.com/shubhe25p/Working-Memory-Demand-in-Social-Cognition

sorry what

it seems not , yes

Dora Zhiyu Yang to Everyone (Jul 21, 2023, 11:37 AM)

catching up and also in other meeting ,but would like to be assigned explicitly and exactly parts.

364-Engy Fayez to Everyone (Jul 21, 2023, 11:52 AM)

Is this like the steps we are going through , just to be confident about my understanding: <https://drive.google.com/file/d/1S8vFInJvsORuBWgqF5TqhtKKuDFUqyXj/view>

364-Engy Fayez to You (Direct Message) (Jul 21, 2023, 1:18 PM)

Data Preprocessing:

Download and preprocess the HCP resting-state fMRI data for the subjects of interest. This includes performing standard preprocessing steps such as motion correction, slice timing correction, and spatial normalization.

Extract Default Mode Network (DMN) Regions of Interest (ROIs):

Use a predefined DMN atlas (e.g., Power et al., 2011) or perform Independent Component Analysis (ICA) to identify DMN components from the preprocessed fMRI data.

Functional Connectivity Analysis:

Calculate functional connectivity between DMN ROIs and other brain regions using methods like Pearson correlation or partial correlation.

Obtain functional connectivity matrices for each subject, representing the strength of connections between DMN regions and other brain regions.

Behavioral Data:

Gather behavioral performance data for language and mathematics tasks from the HCP dataset or other relevant sources.

Representational Similarity Analysis (RSA):

Perform Representational Similarity Analysis (RSA) or Representational Dissimilarity Analysis (RDM) to compare patterns of connectivity matrices with patterns of behavioral performance for both story and mathematics tasks.

Use appropriate distance metrics (e.g., correlation distance) to measure the similarity between connectivity patterns and behavioral performance across subjects.

Statistical Analysis:

Perform statistical tests (e.g., t-tests, correlation analysis) to assess the relationship between DMN connectivity patterns and behavioral performance for language and mathematics tasks.

Explore whether connectivity patterns within the DMN are predictive of individual differences in performance on these tasks.

Interpretation and Reporting:

Interpret the results and draw conclusions about the relationship between DMN connectivity, theory of mind representation, and performance in language and mathematics tasks.

Prepare a report or paper presenting the findings with relevant figures and statistical details.

Please note that implementing this workflow involves using neuroimaging software packages such as FSL, AFNI, or SPM for fMRI data preprocessing and connectivity analysis. Additionally, Python or MATLAB-based libraries like Nilearn or PyMVPA can be used for RSA. It's essential to ensure proper handling and ethical use of the HCP data, adhering to the project's data usage agreements and guidelines. Additionally, the specific details of the workflow may vary depending on the research questions, data availability, and the analysis techniques chosen by the researchers. In the proposed workflow, you would use GLM when analyzing the fMRI data associated with the language and mathematics tasks. GLM allows you to model the relationship between the experimental design (i.e., task conditions or stimuli) and brain activity by fitting a linear model to the data for each voxel (3D volume element) in the brain.

Here's how you can incorporate GLM into the workflow:

Task-Based fMRI Data Analysis:

Preprocess the task-based fMRI data (language and mathematics task data) along with the resting-state data.

Use GLM to model the hemodynamic response to the task conditions (e.g., language task trials and mathematics task trials).

Set up regressors for the task conditions of interest, convolve them with a hemodynamic response function, and include nuisance regressors for motion parameters, global signal, etc.

Obtain task-specific contrast maps representing brain regions showing increased activation during the language and mathematics tasks compared to baseline.

DMN Connectivity Analysis:

Use the preprocessed resting-state fMRI data to calculate functional connectivity between DMN regions and other brain regions, as mentioned earlier in the workflow.

Perform the connectivity analysis separately for each task condition (language and mathematics) to assess how the DMN connectivity patterns change during these tasks.

Representational Similarity Analysis (RSA):

For RSA, you can use the connectivity matrices obtained from the DMN connectivity analysis as input data. Combine the connectivity matrices from the language and mathematics task conditions with the corresponding behavioral performance data.

Statistical Analysis:

Include the GLM-derived contrast maps (from the task-based fMRI analysis) and the connectivity matrices in your statistical analysis. Use GLM or other appropriate statistical tests to examine the relationships between task-specific brain activation and DMN connectivity patterns with behavioral performance. By incorporating GLM in the task-based fMRI analysis, you can identify brain regions that show significant activation during the language and mathematics tasks. This information can then be related to the connectivity patterns within the DMN and how they might be predictive of individual differences in performance during these tasks, as explored through RSA or other statistical analyses.

Keep in mind that the specific implementation and analysis choices depend on the research questions and the hypotheses being tested. Moreover, it's essential to follow established best practices for fMRI data analysis and consult relevant neuroimaging literature and experts when designing and executing the workflow.

You to 364-Engy Fayez (Direct Message) (Jul 21, 2023, 1:24 PM)

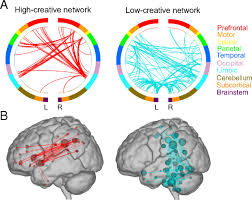
okay! would you help us finding what is the ‘significant’ level of correlation in fMRI connecivity literature? = most commmonly presented as significant correlation in fMRI connectivity analysis?

**Jose feedback**

How much higher of the correlation are you expecting?

Try to find the benchmark for the connectivity

Related with psychology 0.2 to 0.3



* I need code to find the make the above row figures (circular connectivity plot)

#### Must read paper out of ALL NMA

Lakens, Sample size justification

<https://psyarxiv.com/9d3yf/>

#### Expected Output Figures and people who are on it 2 hours before abstract submission

* Abhilasha - Behavioral : Reaction time and accuracy histogram

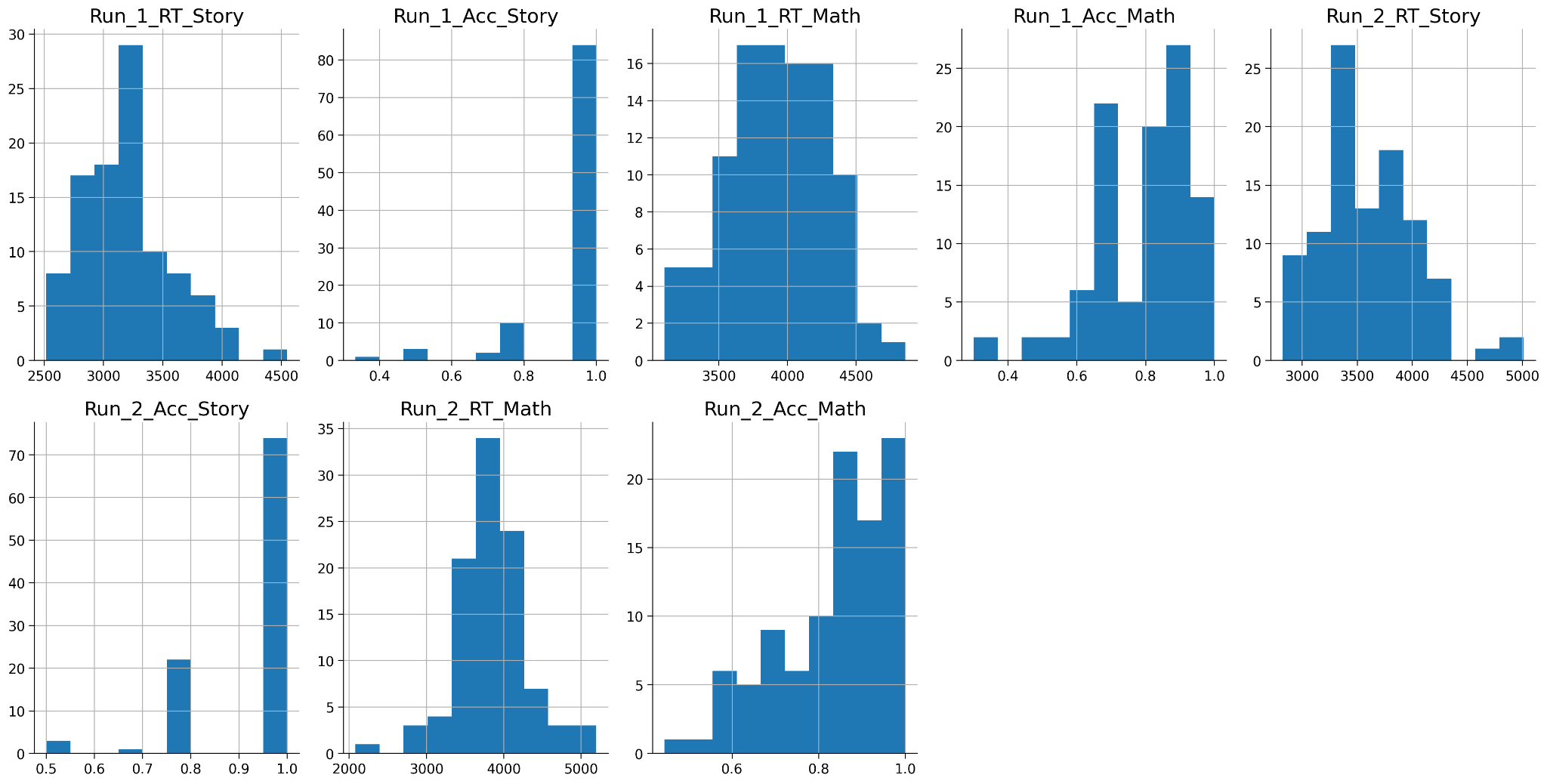
Reaction time histogram

Reaction time by 4 conditions

Accuracy by 4 conditions

Reaction time by math and story

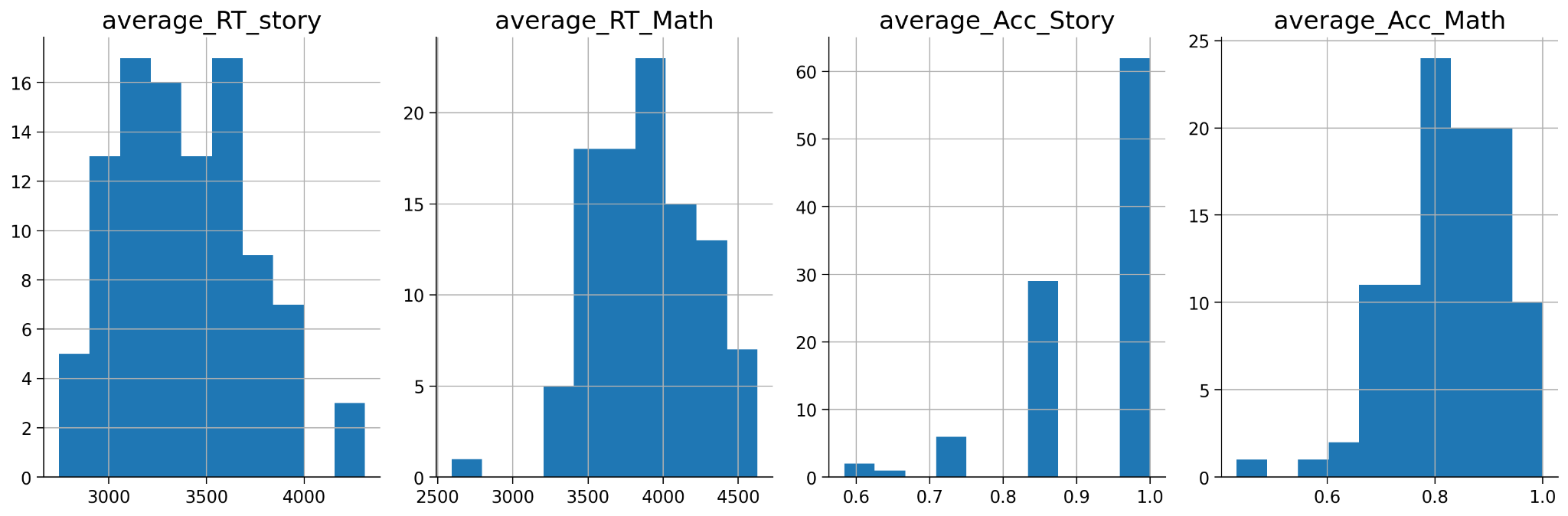
Accuracy by math and story



Summary statistic table (mean and standard deviation)

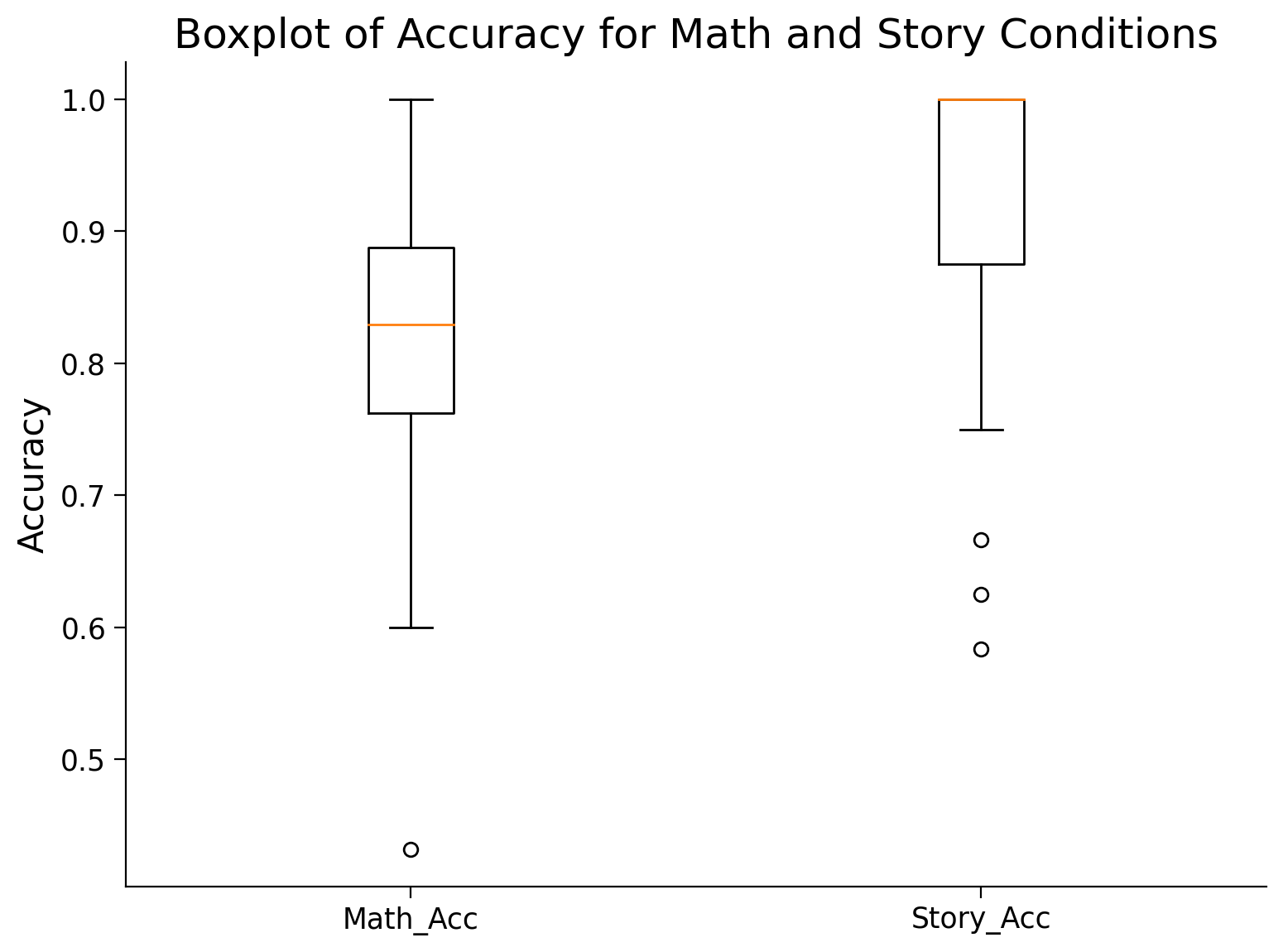
Reaction time

Accuracy



-About the outliers from reaction time and accuracy from both math and story activity





* Jane - fMRI: connectivity

EVERYTHING HERE IS FROM ONE SINGLE PARTICIPANT AT THE MOMENT

Connectivity map by conditions

Connectivity map sorted for the regions to clusters

Connectivity map for averaged for the cluster



|  |  |
| --- | --- |
| story | math |

Next steps

Average across participants for the above map

Look how the ‘Default’ regions are connected to other regions differently for story vs math

Quantify the number of significant connections and strength of the connections

* Ana - Table: behavioral - fMRI

How to model

Could start with the pseudo data array for the connectivity part

While using the behavioral data

* Ana&Dora - Optional output

GLM analysis

* Materials from Engy

[Frontiers | The default mode network and social understanding of others: what do brain connectivity studies tell us (frontiersin.org)](https://www.frontiersin.org/articles/10.3389/fnhum.2014.00074/full)

<https://github.com/dasprabir/NMA_Projects_Emoticonn/blob/master/NMA_Functional_Connectivity.ipynb?short_path=c327762>

<https://github.com/shubhe25p/Working-Memory-Demand-in-Social-Cognition>

* this is to inspire us about abstract writing <https://drive.google.com/file/d/1v1lArAoPny2XeSc1xRj0Fdr6PSV_uLva/view>
* what is the ‘significant’ level of correlation in fMRI connectivity literature?

[Revisiting correlation-based functional connectivity and its relationship with structural connectivity | Network Neuroscience | MIT Press](https://direct.mit.edu/netn/article/4/4/1235/95855/Revisiting-correlation-based-functional)

[Functional connectivity estimation in fMRI data: Influence of preprocessing and time course selection - PMC (nih.gov)](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6871086/)--> it said about r value:

The components that were significantly correlated with the motion parameters [r > 0.5,

[Functional connectivity as revealed by spatial independent component analysis of fMRI measurements during rest - van de Ven - 2004 - Human Brain Mapping - Wiley Online Library](https://onlinelibrary.wiley.com/doi/full/10.1002/hbm.20022)→Components whose time courses were highly correlated (*r* > 0.5) with the estimated motion time courses were discarded from further analysis.

[Proportional thresholding in resting-state fMRI functional connectivity networks and consequences for patient-control connectome studies\_ Issues and recommendations (sciencedirectassets.com)](https://pdf.sciencedirectassets.com/272508/1-s2.0-S1053811917X00062/1-s2.0-S105381191730109X/main.pdf?X-Amz-Security-Token=IQoJb3JpZ2luX2VjEDsaCXVzLWVhc3QtMSJIMEYCIQDc79sMRVYwNpfZu59bgAZniK7ib%2B%2FUa9T9Dk%2BWrZCb%2BwIhAO27beILHFjrCXz7tqo78a0mUIs8M1t81mwSygz2j8wiKrwFCMT%2F%2F%2F%2F%2F%2F%2F%2F%2F%2FwEQBRoMMDU5MDAzNTQ2ODY1IgxDEzYYZLmyeNOC5RgqkAVjOOo42wdxNF4s7XQ46pZVJNpYqyy17DmeibPC6%2F4qNlKacHtLh24bjVbxZq%2BS37lucJMzAUzdHGiYU%2Fe%2F41MRx544z8bH%2F22sAtdNxbZ5hz4J40eet74IHe2e%2FGy3RwEkUAvNaijHwB7gt7PLg60ZVJLBoOc07kbgHQsBR6W%2FdSWagHiOq%2Bwjl5OxgPDlehTZwQtmfVafPcBEyFj7SUFigtqCZGvP5k2O2Tgu%2B4hpfv6Xv%2BdFafa1%2Bx8K0AMOVQI4O4Qz3UEAR3BaxVpt6w%2FW7ZoiY7w4ftGqnlpwYS3%2FuY9T24tPlQltWXyM7cEYFxqoknjnr5kUjZojc8ZrVoR61D%2FF6hNtvZQVRn3y1sjdECeNEN9Ctdy5ZMYzKhYDpaw%2Fv3hVwRFvJYo8%2FLOaS15CCpBqp7UQ%2BujxY%2F15iVDvYEma5qCgfNEfXJR1ICE%2FII4j7S30Z7gIXP2U0zbXTjmZhzVrNlKIoipshMUT3NxSlFgRWBfG4qPSrZMZbFPR441AYlWUsWljuifT0I29MhzlxRx6Bz5LmaxHDsxMmnUPAWqhzAfeak6SVr67smdBP8aHG1aONMSCNQND1vLybhEELuazU%2F8M8qUMeBaDZBdCClFRtaL1zk1H00Mutm2BHJ4SFKE0Xb9V4FSCeugvRbyoZEE%2FeCvOWKBpF%2F3z80116L%2F%2B2jGPJnmUN5XHjuDP7XVI9A17IJoTvyedTDTMIxxIURWQ09uI9rUQum8e%2F67yehaliokgnInZMNLqiXiCmnaJwcfEQiTRBdmFZv5wOG8xqQ6ilxrpykMAY7bF4uvwPiYVEbYW2AGHKtLgqCfBFp%2Ft05T2dSqevbQOkqYIMd7dz6V92WjUe%2FB9l8X1CV%2BxhjDwneulBjqwAaVq8j0IsLHl56%2FnnYWxYl4Yr11ZkOEhWvfSzCHhgAkVq2%2FKrcnpAOfDy4QXjTcVTEbtMDA975GQivxx6MvPCS0BpZa%2BJikC74HFb8MGV2830NH5VkwZE%2F4yGuWoNLEupS29u7GC3p33MSyED77XGOEILKjJlDDhjEmmb5gL8hEn8RHX%2Fi3A57Z7i6EJ1G0qs63MgbH5L6QobtUC2lIHlENyT5Dks1FxbsYxtfdxObxH&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Date=20230721T192556Z&X-Amz-SignedHeaders=host&X-Amz-Expires=300&X-Amz-Credential=ASIAQ3PHCVTYUZ53BX6D%2F20230721%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Signature=2a66edf3b24d39b2a83d7b57f26cc698cd76367bcb1f885fa0b880292be28c59&hash=624e92680cb7a5a560efa50e6964add9547c5a6444165dc7a20110996de0979b&host=68042c943591013ac2b2430a89b270f6af2c76d8dfd086a07176afe7c76c2c61&pii=S105381191730109X&tid=spdf-e5eb332d-d11d-43a2-8497-e5c6446314c0&sid=600f928e95ed4547542bcb897bbd496bf637gxrqa&type=client&tsoh=d3d3LnNjaWVuY2VkaXJlY3QuY29t&ua=03055101045b05515656&rr=7ea5d529dc9f0fe6&cc=eg)-->across the entire HCP dataset GE (r=−0.73, p < 0.001) and C (r=0.62, p < 0.001) significantly correlated to overall FC.

#### Discussion point

* What model should we use for DMN - behavioral?
* OLS? Lasso? Logistics regression?
* Highly likely to use the ridge regression

Multicollinearity of the inputs (not fully independent)

High number of predictor (regions) - low number of variable

* Train - test (N-folding the subjects?)

Scikit Learn: internal cross validations

#### 1 hour before NMA day end

Two teams merge for discussion and progress share

## W3D1 Project

Any note?

## W3D2 Project

#### Meeting information

Ana, Jane, Abhilasha, Cemal, Engy, Dora

#### Possible Slide structure

for the W3D5 presentation at the current model

<https://docs.google.com/presentation/d/1stG0-HQz97qVYppv5Qo8aIzjJ60HxZMYDjSduVa1KOI/edit?usp=sharing>

0. Title

1. Research question
2. Dataset
3. Reaction Time
4. Connectivity Analysis
5. Prediction modeling

6. Thank you

one minute per person is the usual format, but u can have changes, all must have participation in presenting also total time for the group could be 5-6 minutes and 2 minutes of Q&A.

#### Team works

* Jane

Connectivity analysis for all subjects

* Ana

Prediction modeling

* Abhilasha

Slide

* Dora, Engy, Cemal?

GLM analysis?

## W3D3 Project

#### Meeting information

Ana, Jane, Dora, Engy, Abhilasha

All women in STEM! woot

#### Meeting Notes

Problem: Curse of dimensionality

360\*360 per subject is too much for modeling

Solution: PCA?

Question: why not just set default mode network first?

> Still the dimensional issue, getting 2D

<https://scikit-learn.org/stable/modules/generated/sklearn.linear_model.RidgeCV.html>

**Simple thing to test**

Math

Story

* Simple regression model
* Functional connectivity during each task

Within network connectivity

Method 1

Within the default network regions x regions

Method 2

12 cluster x 12 cluster

Single subject, single value

Models have colinearity

**Visualization**

Circle plot

Glass brain

What relationship is making the difference in DMN?

See how it’s different with other network as a predictor

Calcium imaging - fMRI

<https://www.researchsquare.com/article/rs-2823802/v1>

## W3D3 Project

#### 

#### Meeting information

Ana, Jane, Dora, Engy, Abhilasha

All women in STEM! woot

#### Meeting Notes

* Done getting within a network connectivity

-> 100 subjects x 12 networks

- R2 could be negative

<https://scikit-learn.org/stable/modules/generated/sklearn.metrics.r2_score.html#sklearn.metrics.r2_score>

abhilasha mewada to Everyone (Jul 27, 2023, 11:18 AM)

import numpy as np

from sklearn.ensemble import RandomForestRegressor

from sklearn.metrics import mean\_squared\_error

# #instantiate the model

alphas = np.logspace(-3, 5, 100) #I've used this on a previous project, idk

#also need the external cross validation

cv = KFold(n\_splits=10, random\_state=42, shuffle=True)

X = np.array(story\_corr\_matrices)

y =np.array(all\_stats\_df\_average["average\_RT\_story"])

# #build the sets for train and test

for train\_idx, test\_idx in cv.split(X):

X\_train, X\_test = X[train\_idx,], X[test\_idx,]

y\_train, y\_test = y [train\_idx,], y[test\_idx,]

# Step 1: Initialize the Random Forest model

rf\_model = RandomForestRegressor(n\_estimators=100, random\_state=42)

# Step 2: Train the model on the training data

rf\_model.fit(X\_train, y\_train)

# Step 3: Make predictions on the testing datay\_pred = rf\_model.predict(X\_test)

# Step 4: Evaluate the model

mse = mean\_squared\_error(y\_test, y\_pred)

print("Mean Squared Error:", mse)

# Literature Review

Please throw in papers in this section, it would be nice to include your comments!

Q: What other people have found out using this HCP dataset, more specifically, with the tasks we have in our hands?

Q: Or what methods would be interesting to apply in our dataset? E.x. Connectivity analysis, HMM, PCA, SVM, Decoding, Encoding, RSA, EDA etc.

**Note from NMA**

<https://compneuro.neuromatch.io/projects/docs/project_guidance.html>

“Literature review: identify interesting papers The goal of this literature review is to situate your question in context and help you acquire some keywords that you will use in your proposal today.

On your own, start doing a literature review using google searches and **only look at abstracts to select 2-3 promising ones**.

**Report to the whole group what papers you found and pool them together.** Assign one paper per person to read/skim in the next 1h.

On your own, read the paper that was assigned to you. **Make notes in a common google doc shared with your group**, and **especially write down important keywords or concepts which you might use in your proposal**. If you are not connected to an .edu domain or a VPN, try to find full versions of papers on preprint servers like arXiv / bioRxiv. You could also ask your TA to get it for you (and they might in turn ask someone who has access to a university VPN). There might be other options too.

Report back to the group, and try to tell them as much as you understood about the paper. Get into details, but don’t just read to them whole sections from the paper. Ask the other students questions about the papers they are presenting to understand them better.”

**Literature list**

HCP data:

- DOI: [10.1016/j.neuroimage.2022.119352](https://doi.org/10.1016/j.neuroimage.2022.119352) : The human language effective connectome

- DOI: [10.1093/cercor/bhac496](https://doi.org/10.1093/cercor/bhac496): Auditory cortical connectivity in humans

*NOT HCP data:*  
- DOI: [10.1038/s41467-021-25876-x](https://doi.org/10.1038/s41467-021-25876-x): High-level cognition during story listening is reflected in high-order dynamic correlations in neural activity patterns  
-DOI: [10.1016/j.neuroimage.2004.11.006](https://doi.org/10.1016/j.neuroimage.2004.11.006): Listening to talking faces: motor cortical activation during speech perception

- DOI: [10.1016/j.neuroimage.2019.116042](https://doi.org/10.1016/j.neuroimage.2019.116042): Brain dynamics and connectivity networks under natural auditory stimulation  
- DOI: [10.1038/mp.2011.177](https://doi.org/10.1038/mp.2011.177): Resting functional connectivity of language networks: characterization and reproducibility

-DOI: [10.1038/s41593-021-00974-7](https://doi.org/10.1038/s41593-021-00974-7): (not too much related) A mice study showing that the association of an auditory stimulus with a visual stimulus in a behaviorally relevant context leads to experience-dependent suppression of visual responses in the primary visual cortex.

- So many papers related with visual word recognition: DOI: [10.1002/hbm.22792](https://doi.org/10.1002/hbm.22792), DOI: [10.1016/j.neuroimage.2016.01.013](https://doi.org/10.1016/j.neuroimage.2016.01.013)

**Working on story and math task** :

1- [nihms240637.pdf](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2997157/pdf/nihms240637.pdf)

2- [Mapping anterior temporal lobe language areas with fMRI: A multicenter normative study (sciencedirectassets.com)](https://pdf.sciencedirectassets.com/272508/1-s2.0-S1053811910X00209/1-s2.0-S1053811910012486/main.pdf?X-Amz-Security-Token=IQoJb3JpZ2luX2VjEIr%2F%2F%2F%2F%2F%2F%2F%2F%2F%2FwEaCXVzLWVhc3QtMSJHMEUCIQDGvmdqX2ZB26Fm1cqTeJ4weRN0MZNVjsQrK6Eq8UsdtQIgFV23Wqx83%2BU4uvPfi8XHw5wPCi3AiYbS0tFDBiZp%2F6YqsgUIExAFGgwwNTkwMDM1NDY4NjUiDHLXaTvHhrHAl8pWayqPBet4p4JDmeJ3Gb2nITdS1li%2BcOIwWMXcPgtSCL1XhYsPidMpyEIUsH4ASGGL%2B0qQ4bANqfKgbxetEUj10OCncmUfGHWzOaAoWre7zdKLdOFnsy%2FyFlTCqhdfzXW3Am3bFWQOmolu04QD2Ufbe%2FktcOFCibbc7pmdvYD02PdNZRm2k%2B7331xw8OaVI9LaigbOloJMIucnSTZgIhuTdt3dZ0oS2VdkJRSLeXFQHsBCyC8LIE8vl%2BeG5JPIqPd1%2F6pBAanxGsJlK8Y8er2SwFDXlTaarMaxjEhBoimSv3WxofVqRN93xPWVWYb0mh2hwaY83EWY9BeohIzrL6oZ%2Fcm7REgKdKLQS2PX%2FQU3I%2BpcuxwBeGc9ecOsUAUyAolqR5yxvLJYQ0tTYBHLM4HgwFZ12TQ5f%2FsY9ectfb57kXr%2Fl7r7%2FBnOj0m2FZvb5CIHIHGp43rpJJWb16P3TT0BoI3FXK6KPUzGUucfaZsNKbmqWWwRLJr4vDR1qfKy0zVR7%2FVw6BkZdFqnADqS65eMJDvpkhJCYmK93h6%2FjOKRuBClHj9WFR50uPCq8VLWyQHR8t8cn6CUg0KQao1ZwPOU4i5fbN7NmMCw1j8r2lLgG4j2US9LCNXUmaPz1EEKkEEvXnqeVynBrAqlxzNFdHk%2Bl%2BXRJP5B5jLdQ3OrszkyP9HX3qFgatl384AoDUDuv5s%2FqZZGpK49scM%2Fa539m8o3WOZ%2F0w066%2BR%2FFiEQ%2B6VDIWkNkBYSeP1IUz8QWaZuEBhpwWpal96rvveD0K5QLgxuLvdpaq4k%2BPQZkxQ%2BDrJ%2Bm%2Fec1PqypC62k4bKaJy7qhoz8tMXvaqBMdQDDc0HZj%2BaqD0OK2CbjqDjlM71OtPzixGuKoEwlbbEpQY6sQF9qDqG4DBfBXOfdXLE3nFgWiXFauyLiKMgw7g2qttZquZ1n883y%2BPz6Aqk84S%2FkDifhzQj5q3LccbuJKsKusBK4VUYYKlN85xZUsGLL416%2BWwu%2F%2FV%2BGz9TnvI8KtkTcqrV%2Fk662gFOi35k%2FbDSa8G9L0VahzVov8gdNcGMUEQVP1zHrpkpICGCaWlNjNnOpJVsQyX2wQdnyrP1X2nTTqO5KSM4xN%2FNuKc%2BWPLcx0rUM9c%3D&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Date=20230714T104005Z&X-Amz-SignedHeaders=host&X-Amz-Expires=300&X-Amz-Credential=ASIAQ3PHCVTYRMLCDBLJ%2F20230714%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Signature=cc212825ebe5d62aa17ec32e62240035bf4eeee8913ade285836a4ff11a130c0&hash=e7c026c47be41b3dde23560fb34ebea00d7e291680f9a8a012cdabb5be7d99db&host=68042c943591013ac2b2430a89b270f6af2c76d8dfd086a07176afe7c76c2c61&pii=S1053811910012486&tid=spdf-13ad123f-5ac3-4421-a8a0-1a5b8ab86703&sid=af41e8a8327f984da3896c5289cad2f107fdgxrqa&type=client&tsoh=d3d3LnNjaWVuY2VkaXJlY3QuY29t&ua=03055101535753515407&rr=7e69253e58fe185a&cc=eg)  
 3-[Resting‐state functional magnetic resonance imaging versus task‐based activity for language mapping and correlation with perioperative cortical mapping - Lemée - 2019 - Brain and Behavior - Wiley Online Library](https://onlinelibrary.wiley.com/doi/full/10.1002/brb3.1362)

4- this one used HCP : [download\_file (ox.ac.uk)](https://ora.ox.ac.uk/objects/uuid:55087530-0595-463c-86a3-c54a4117b42b/download_file?file_format=application%2Fpdf&safe_filename=Task-free%2BMRI%2Bpredicts%2Bindividual%2Bdifferences%2Bin%2Bbrain%2Bactivity%2Bduring%2Btask%2Bperformance.pdf&type_of_work=Journal+article)

5- this one tell more how hcp language task have been conducted : [Frontiers | Support Vector Machine for Analyzing Contributions of Brain Regions During Task-State fMRI (frontiersin.org)](https://www.frontiersin.org/articles/10.3389/fninf.2019.00010/full#h3)

[Network connectivity predicts language processing in healthy adults (wiley.com)](https://onlinelibrary.wiley.com/doi/epdf/10.1002/hbm.25042)

# Functional Connectome Package/ GitHub to use:

# [Hazperera/Gender\_Prediction\_fMRI\_data: Neuromatch Academy Project 2021 :computer: (github.com)](https://github.com/Hazperera/Gender_Prediction_fMRI_data) Jane’s code: <https://colab.research.google.com/drive/13049AlJYFUcH1yNJ_X03mEYeisAHiflL?usp=sharing>

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# <https://nilearn.github.io/stable/modules/generated/nilearn.connectome.ConnectivityMeasure.html#nilearn.connectome.ConnectivityMeasure>

# NMA Submitted Materials

At the end of the day, what we will turn in as our results/outcomes come in this section

## W2D2 Proposal

<https://compneuro.neuromatch.io/projects/docs/project_guidance.html>

Project proposal

* Try to write a proposal for this project based on the way you understand it now. This should re-use some of the text you wrote down for the four steps, and should include keywords and concepts that you identified in your literature review. Don’t worry too much about the structure of this paragraph! The goal is to get as many words (200-300) on paper as possible. You have the entire day 10 to learn how to write a properly structured scientific abstract.
* It is important to include the concepts which you identified as relevant, and the keywords that go with them.
* When you are ready, please submit your proposal [here](https://airtable.com/shrcYuFYMPh4jGIng). This is not mandatory and can be submitted at any time. We won’t evaluate this, but we will use it to keep track of the overall progress of the groups.

Proposal submission link

<https://airtable.com/shrcYuFYMPh4jGIng>

### Submitted proposal

How is the theory of mind representation related to your level of engagement in the story? Previous research has reported the relationship between brain activation patterns in the Default Mode Network (DMN) and individual differences in personality traits, specifically sociableness and agreeableness (Udochi et al., 2021). Based on this knowledge, in this proposal, we aim to examine how the connectivity patterns within the reported DMN regions relate to performance in language and mathematics tasks. By exploring functional connectivity and using Representational Dissimilarity Analysis (RDM) or RSA (Representational Similarity Analysis), we seek to determine whether specific connectivity patterns and strengths within the DMN can predict behavioral performance and how the results differ in story task and mathematics task. Our hypothesis posits that the DMN nodes will exhibit a greater number of edges with other brain regions in previously reported social cognition regions and theory of mind regions. In addition, we hypothesize that the strength of connectivity, as measured by correlation values, will be stronger during a story task compared to a math task.

## W2D5 Abstract

<https://airtable.com/shr0ozNAhXq6K1p8o>  
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* Information we want to add/something new from our proposal
* Jane: fMRI connectivity: DMN for story does seem to have more connection and strength to other regions
* Abhilasha: human behavior: Reaction time and accuracy does seem to have individual differences : no ceiling effect?
  + Interesting outlier number story>math
* Engy: literature survey:

Benchmark fMRI connectivity correlation value expected r-value = .05 r = .02

Revisiting correlation-based functional connectivity and its relationship with structural connectivity | Network Neuroscience | MIT Press

Functional connectivity estimation in fMRI data: Influence of preprocessing and time course selection - PMC (nih.gov)--> it said about r value:

The components that were significantly correlated with the motion parameters [r > 0.5,

Functional connectivity as revealed by spatial independent component analysis of fMRI measurements during rest - van de Ven - 2004 - Human Brain Mapping - Wiley Online Library→Components whose time courses were highly correlated (r > 0.5) with the estimated motion time courses were discarded from further analysis.

Proportional thresholding in resting-state fMRI functional connectivity networks and consequences for patient-control connectome studies\_ Issues and recommendations (sciencedirectassets.com)-->across the entire HCP dataset GE (r=−0.73, p < 0.001) and C (r=0.62, p < 0.001) significantly correlated to overall FC.

* + Paper links

<https://link.springer.com/article/10.1007/s11682-020-00304-8>

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6871086/

* Ana: Ridge regression modeling & Writing

### Submitted Abstract

How active is your theory of mind representation while listening to a story? Previous research has reported the relationship between brain activation patterns in the Default Mode Network (DMN) and individual differences in personality traits (Udochi et al., 2021). Based on this knowledge, we aim to examine how the activation and connectivity patterns within the reported DMN regions relate to performance in language and mathematics tasks. Our hypothesis is in two parts. First, we hypothesize that the strength of functional connectivity, as measured by Pearson correlation values, will be stronger during the story task compared to the math task. Secondly, we hypothesize that a model will have improved prediction accuracy in the story condition versus the math condition, driven by the activity of the DMN used to predict performance. This will be reflected by greater values on the weight vectors assigned by the cross validated ridge regression model. Exploratory analysis of functional connectivity of the HCP language task data showed that the DMN has a trend of higher correlation values to other networks during the story versus the math task. As a future analysis, we will use the computed functional connectivity as an input to a cross-validated ridge regression model to predict subject-specific differences in performance (measured via accuracy and reaction time).

## W3D2

## Problems to solve!!

* ~~All subjects need to have the same length of time series, so we need to find the min length of the subjects and cut all the time series to that length~~
* ~~The nilearn connectivity package expects that the data that is input is a list of subjects, this change is already implemented in the code but it needs to be ran to check for errors once the above ^^ is done~~
* Then we need to do a PCA on the FC matrices to reduce the dimensionality of the data. We can decide via scree plot how many componentes we want to include —> need to make the scree plot, first step is done

[Sci-Hub | Detecting Functional Connectivity in fMRI Using PCA and Regression Analysis. Brain Topography, 22(2), 134–144 | 10.1007/s10548-009-0095-4](https://sci-hub.se/http://dx.doi.org/10.1007/s10548-009-0095-4)

* We use the PCA components as the input (“X”) for our ridge regression model

## W3D4

**Engy :**

**1- What’s the difference between using “correlation” vs “partial correlation” for the connectivity metric?**

If correlation is used as the connectivity metric for fMRI data analysis, the interpretation of the results may be affected by the presence of indirect connections. This means that two regions may appear to be functionally connected even if they are not directly connected. Therefore, the interpretation of the results should take into account the possibility of indirect connections.

If partial correlation is used as the connectivity metric for fMRI data analysis, the interpretation of the results may be more accurate and reliable. Partial correlation can better capture the direct connections between regions and is less sensitive to indirect connections. Therefore, the interpretation of the results may be more straightforward and less affected by the presence of indirect connections.

[An Efficient and Reliable Statistical Method for Estimating Functional Connectivity in Large Scale Brain Networks Using Partial Correlation - PMC (nih.gov)](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4876368/)

[Testing Group Differences in Brain Functional Connectivity: Using Correlations or Partial Correlations? - PMC (nih.gov)](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4432782/)

[Differences Between Bivariate And Partial Correlation | Difference Between](http://www.differencebetween.net/business/marketing-business/differences-between-bivariate-and-partial-correlation/)

**2-if we use another model besides ridge regression, what would we use? (i.e. SVR?)**

**3- python tools for visualization :**

[**inm7/cbptools: CBPtools: A Python package for regional connectivity-based parcellation (github.com)**](https://github.com/inm7/cbptools)

[**wiheto/netplotbrain: A package to create simple 3D network visualizations on a brain. (github.com)**](https://github.com/wiheto/netplotbrain)

[**NeuroPycon: An open-source python toolbox for fast multi-modal and reproducible brain connectivity pipelines - ScienceDirect**](https://www.sciencedirect.com/science/article/pii/S1053811920305061) **→** [**Compute PSD on sensor space — ephypype 0.5 documentation (neuropycon.github.io)**](https://neuropycon.github.io/ephypype/auto_examples/plot_power.html)

## circular visualization in Python

## [mne.viz.plot\_connectivity\_circle — MNE 0.14.1 documentation (harvard.edu)](https://www.nmr.mgh.harvard.edu/mne/0.14/generated/mne.viz.plot_connectivity_circle.html)

## [moshi4/pyCirclize: Circular visualization in Python (Circos Plot, Chord Diagram) (github.com)](https://github.com/moshi4/pyCirclize)

## Display corresponding graph on glass brain: [Functional connectivity and resting state — MRI analysis in Python using Nipype, Nilearn and more (peerherholz.github.io)](https://peerherholz.github.io/workshop_weizmann/advanced/functional_connectivity.html)

**Link collecting most common tolls for MRI analysis and visualization**

[**OSF | Tools for MRI Research Wiki**](https://osf.io/w2y7q/wiki/2.%20Functional%20and%20Structural%20MRI%20analysis/)

[**Brain Connectivity Toolbox (google.com)**](https://sites.google.com/site/bctnet/)

**Full tutorial in python for whole thing :**

[**Functional Neuroimaging Analysis in Python (carpentries-incubator.github.io)**](https://carpentries-incubator.github.io/SDC-BIDS-fMRI/aio/index.html)

## W3D5 Expected outcome slides

At the end of the NMA project sessions we want and need

Title slide : Project title, member names, TA names

Introduction: research question

Dataset: dataset explanation

Analysis:

Conclusion/Discussion: