Predictive models of IQ from functional connectivity data may not be sex specific

Javid Dadashkarimi [1] Dustin Scheinost [2]

[1]Department of Computer Science, Yale University, New Haven, CT

[2]Department of Radiology and Biomedical Imaging, Yale School of Medicine, New Haven, CT

Introduction

1. Functional connectomics is derived from **functional magnetic resonance imaging (fMRI)** for individual and group differences in brain organization.
2. **Predictive models** have long been used to predict behavioral measures.
3. But the question is if these models are sex specific? If a model built on one group is generalizes to the other?

Sex Specific Pipeline of IQ

A **fMRI** data consisting of k tasks acquired from two groups of participants (i.e., male vs female);

B **Parcellate** the brain into N **nodes**;

C Average **timeseries** for each node;

D Generate connectomes $\mathbf{x}_i \in \mathbb{R}^{N\times N}$ for **each task** using the time series (e.g., we have 9 different connectome for a person in HCP);

E Treat these edges as features;

F Train a predictive model on one sex, and test on the same group.

G Train a predictive model in one sex and test on the opposite sex.

H Train a predictive model that classifies participants based on sex.

I visualize the models;

Sex Specific Models

ID	Collection	#male	#female	size	age	#tasks
HCP	Human Connectome Project	241	274	515	28 ± 3.98	9

Table 1:Characteristics for the HCP and PNC datasets.

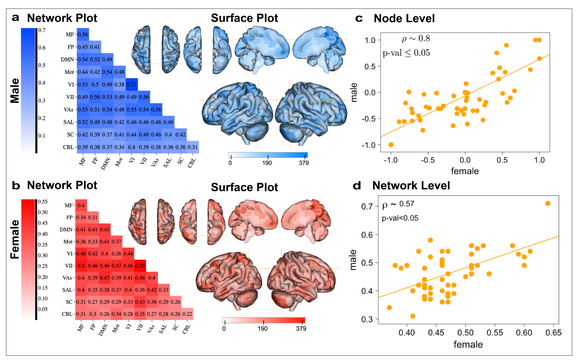

Figure 1:Network and degree plots and correlation of sex specific models.

Sex Specific Predictive Model Pipeline

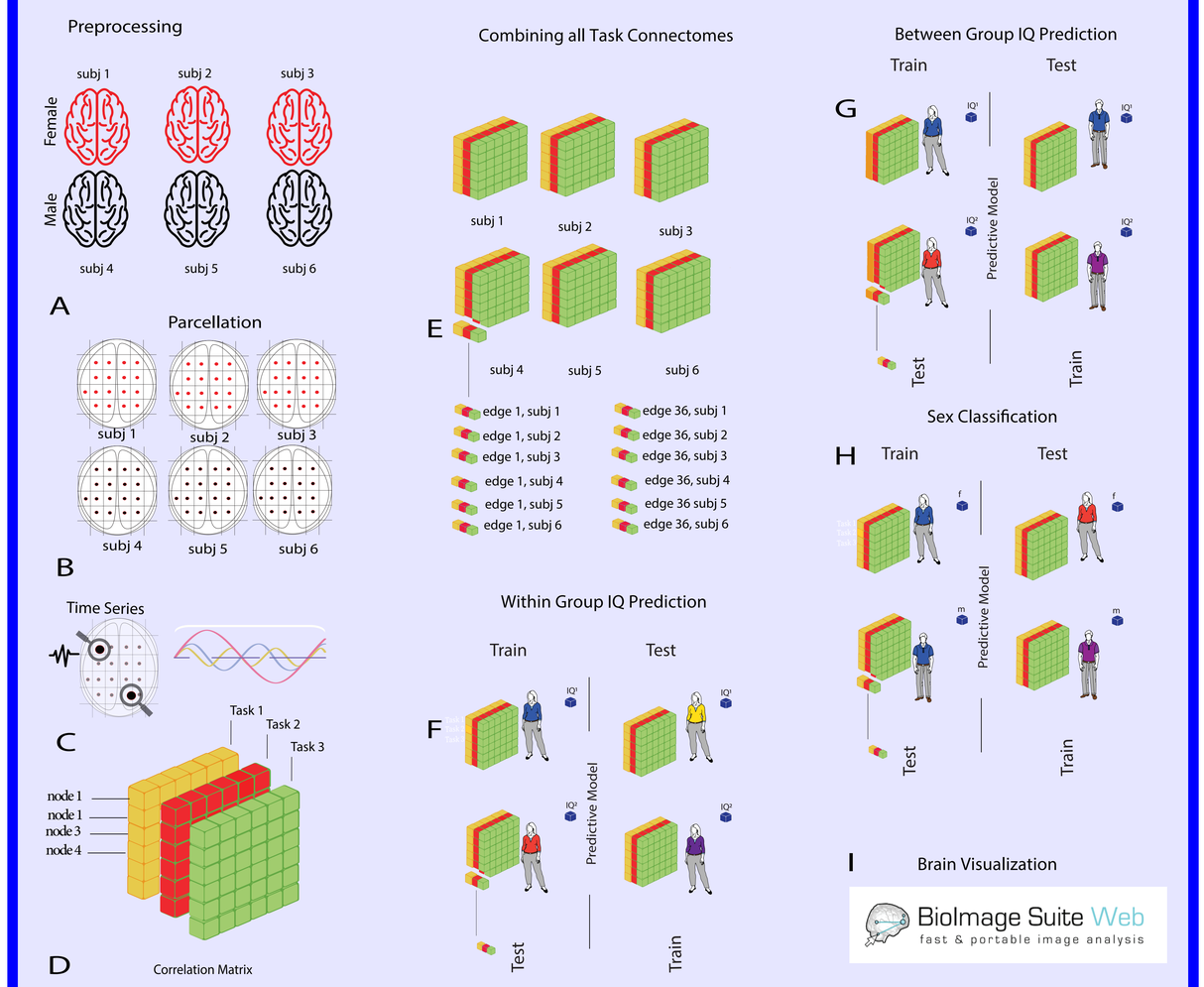

Figure 2:Pipeline of preprocessing (A to D), mass univariate edge-wise analysis (E to G), and mass multi-variate edge-wise analysis (H to J).

Cross-sex Prediction

1 We divide participants into two groups with equal size (e.g., 200 in HCP).

2 We train ridge connectome based predictive model (rCPM) on each group

3 Then we test the models on opposite side:

$$\min_{\beta}(Y - \beta X)^2 + \lambda||\beta|| \tag{1}$$

where $Y \in \mathbb{R}^N$ is the vector of IQ measures, $\beta \in \mathbb{R}^K$ is the coefficient vector and $X \in \mathbb{R}^{K\times N}$ is the feature matrix.

Cross-sex Prediction

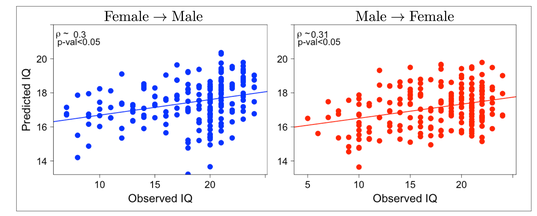

Figure 3:Pearson correlation of predicted and observed IQ.

Influence of Brain States

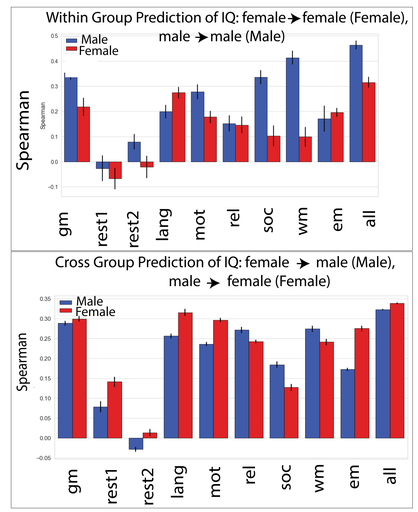

Figure 4:Influence of difference brain states within group (top) and between group (bottom).

Classification of Sex

	Predicted Female	Predicted Male
Observed Female	266	8
Observed Male	19	222
	285	230

Conclusion

We investigated sex specificity of predictive models. Experimental results show that predictive models may not be sex specific in combined connectomes and specific tasks.

Email: javid.dadashkarimi@yale.edu