

A Connectivity-based Psychometric Prediction Framework for Brain-behavior Relationship Studies

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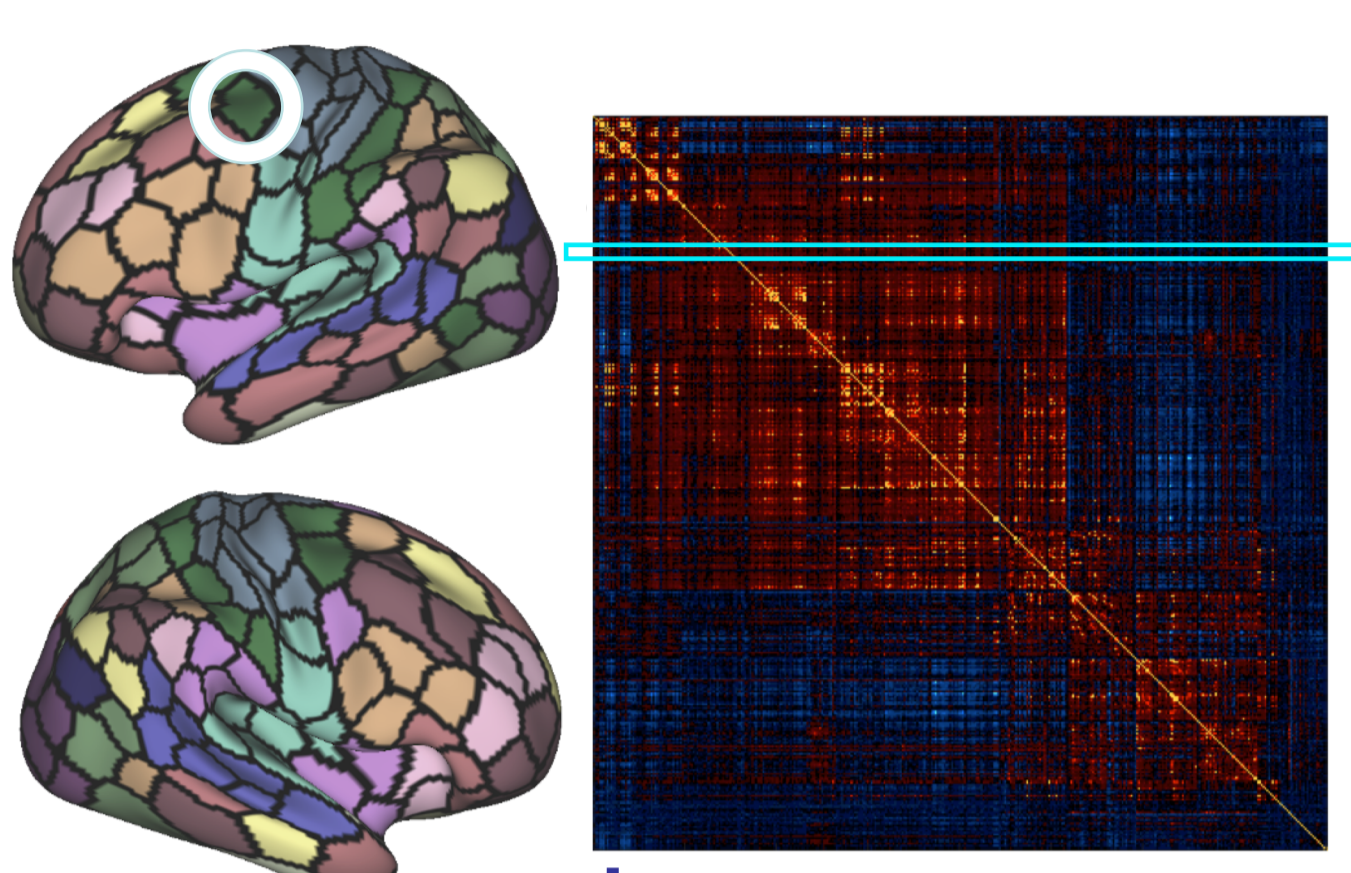
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Introduction

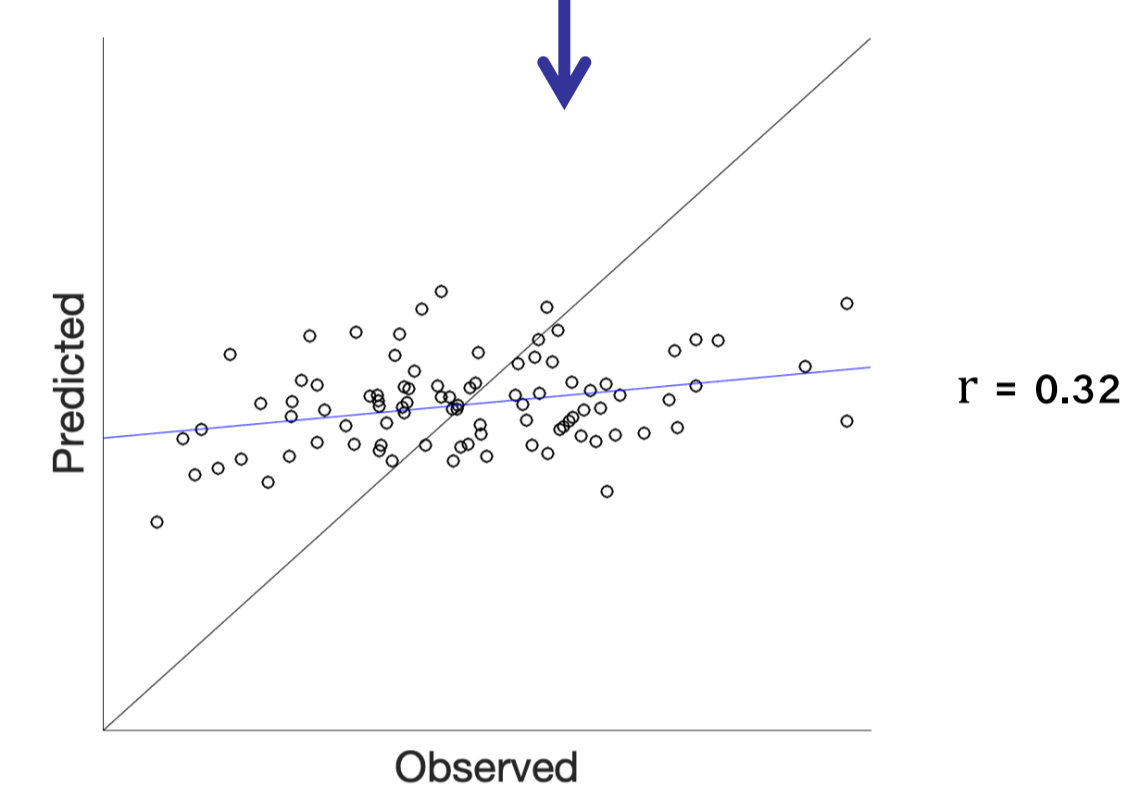
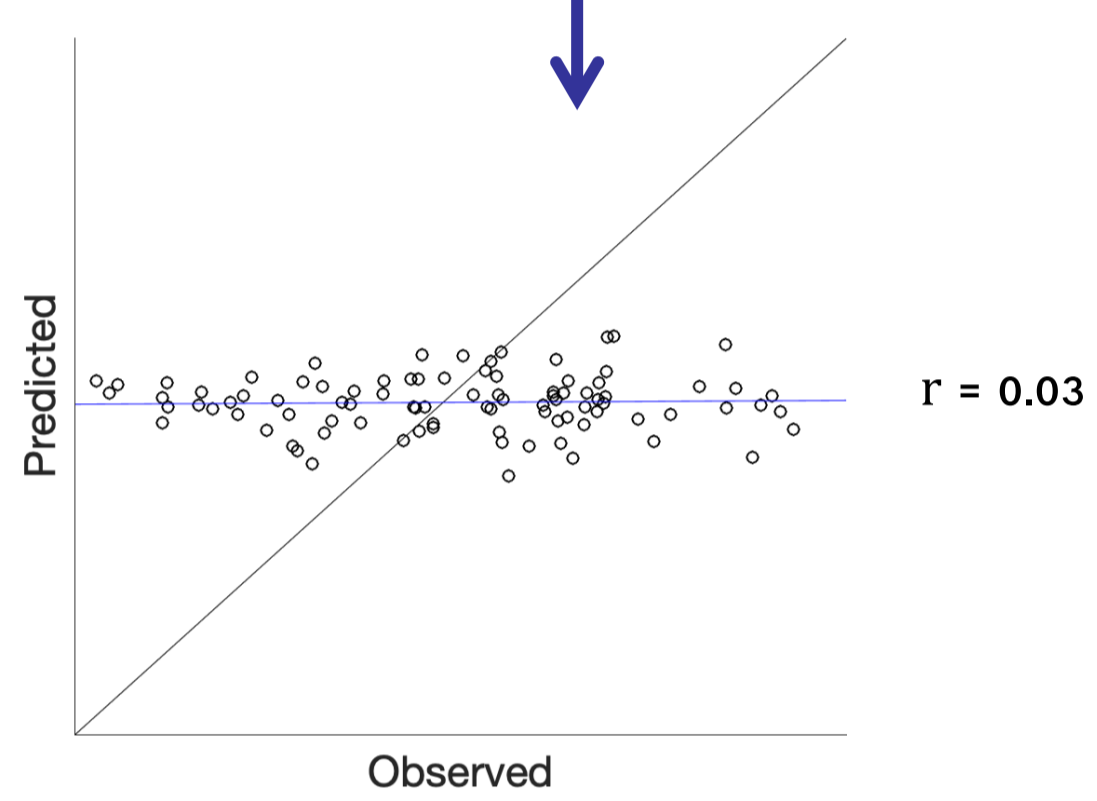
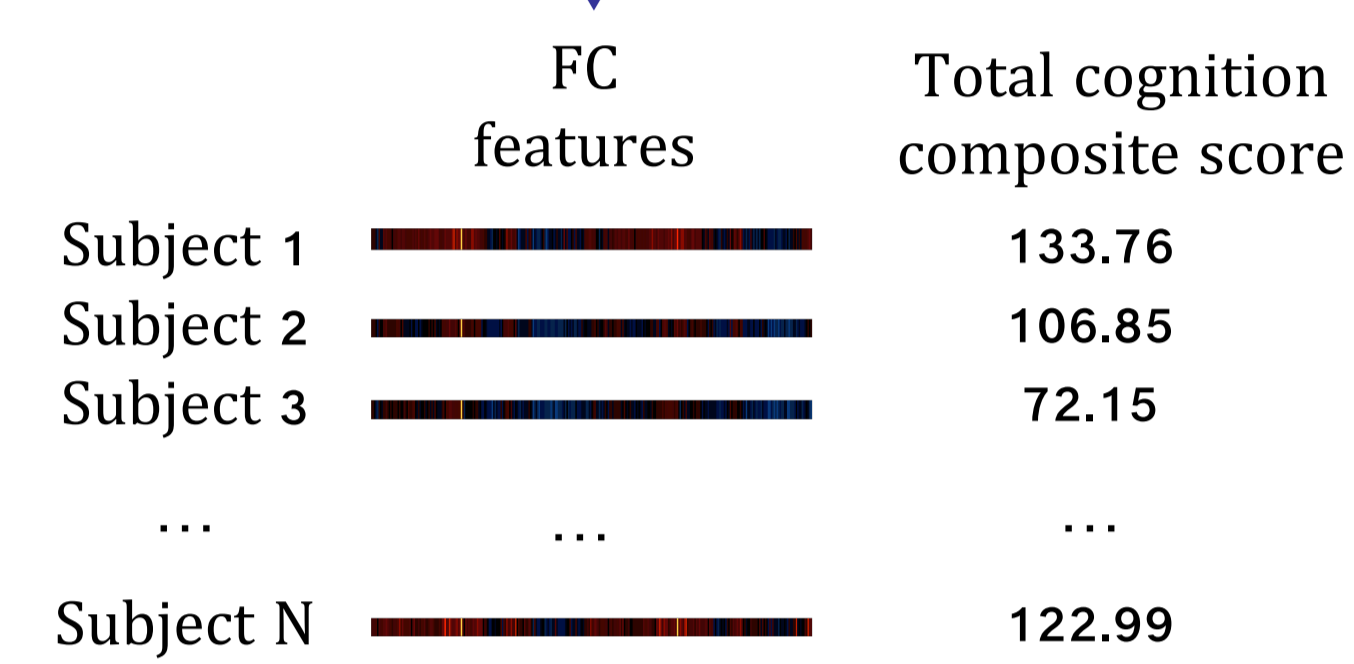
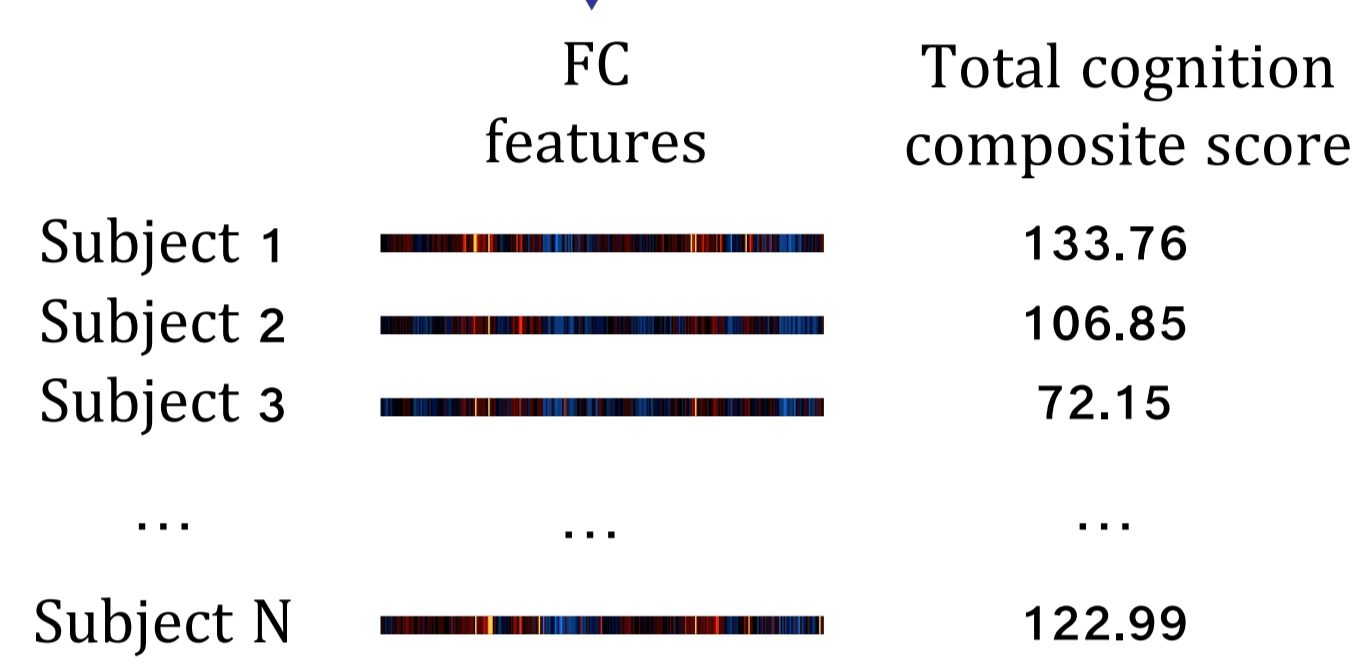
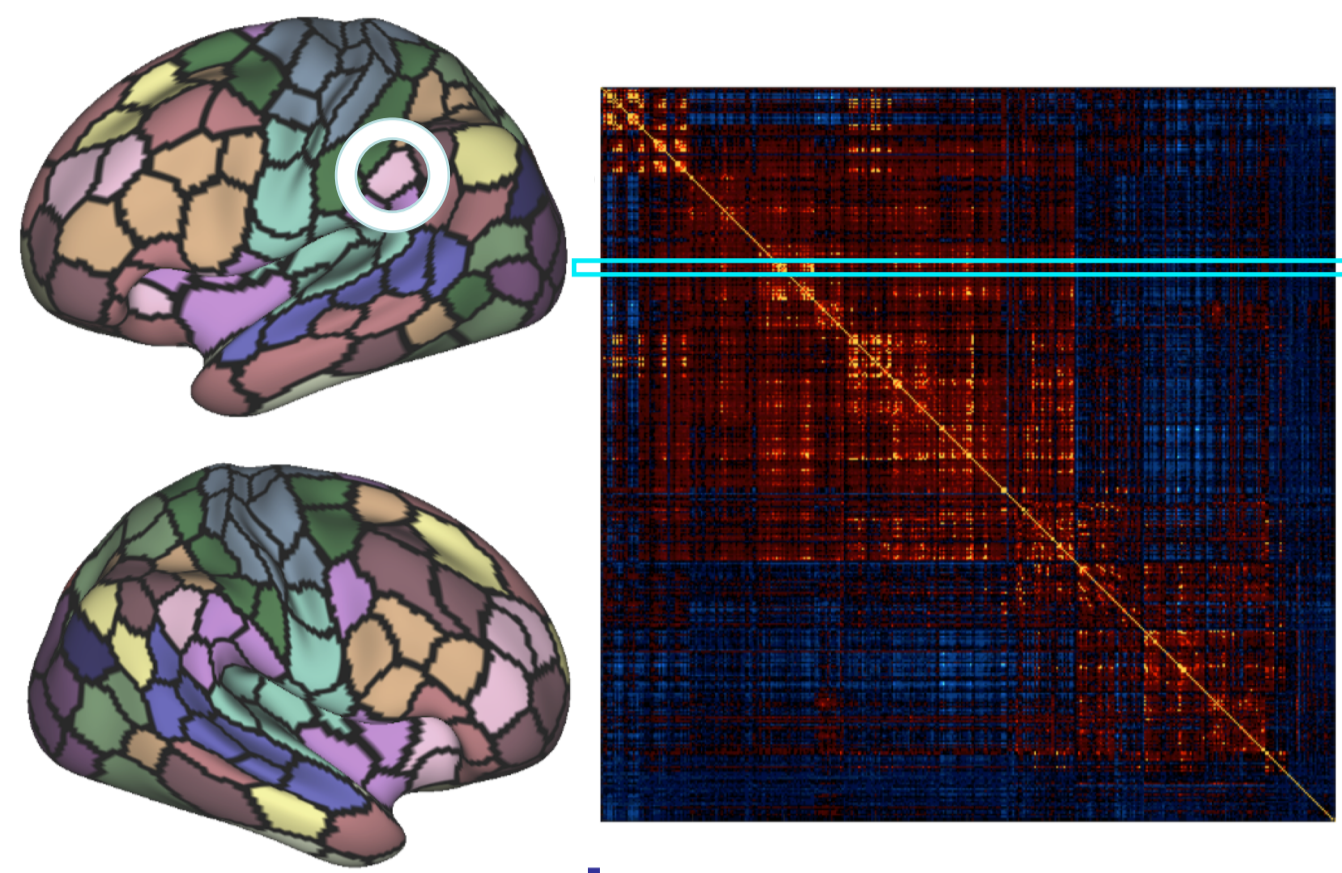
- Recent availability of population-based datasets with psychometric characterization [1] opens promising perspectives to investigate the relationships between interindividual variability in brain regions' connectivity and behavioral phenotypes
- The multivariate nature of connectivity-based prediction models severely limits interpretation from a cognitive neuroscience perspective.
- To address this issue, we propose a connectivity-based psychometric prediction (CBPP) framework based on individual region's connectivity profile.

Methods

Parcel 1



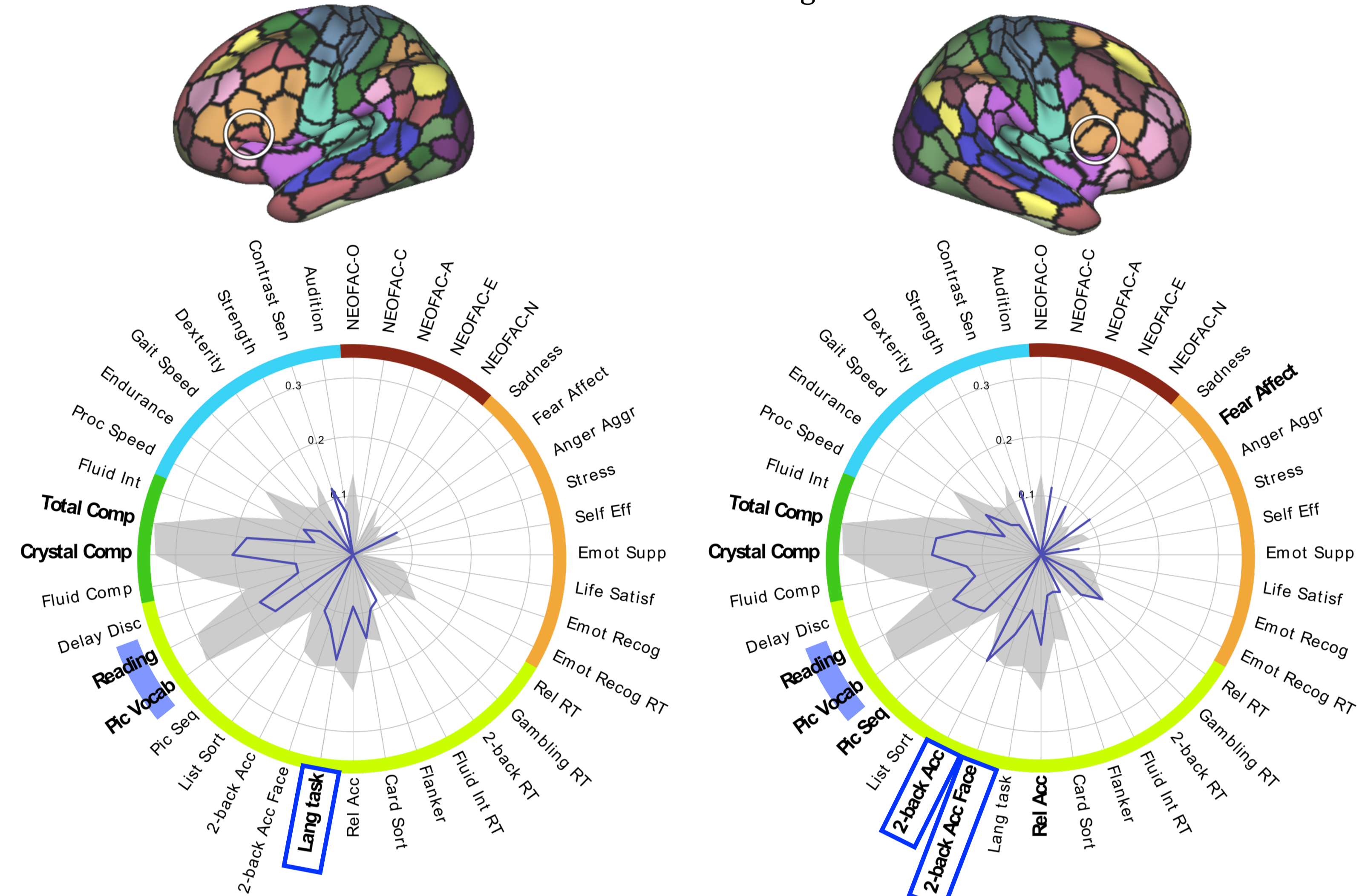
Parcel 2



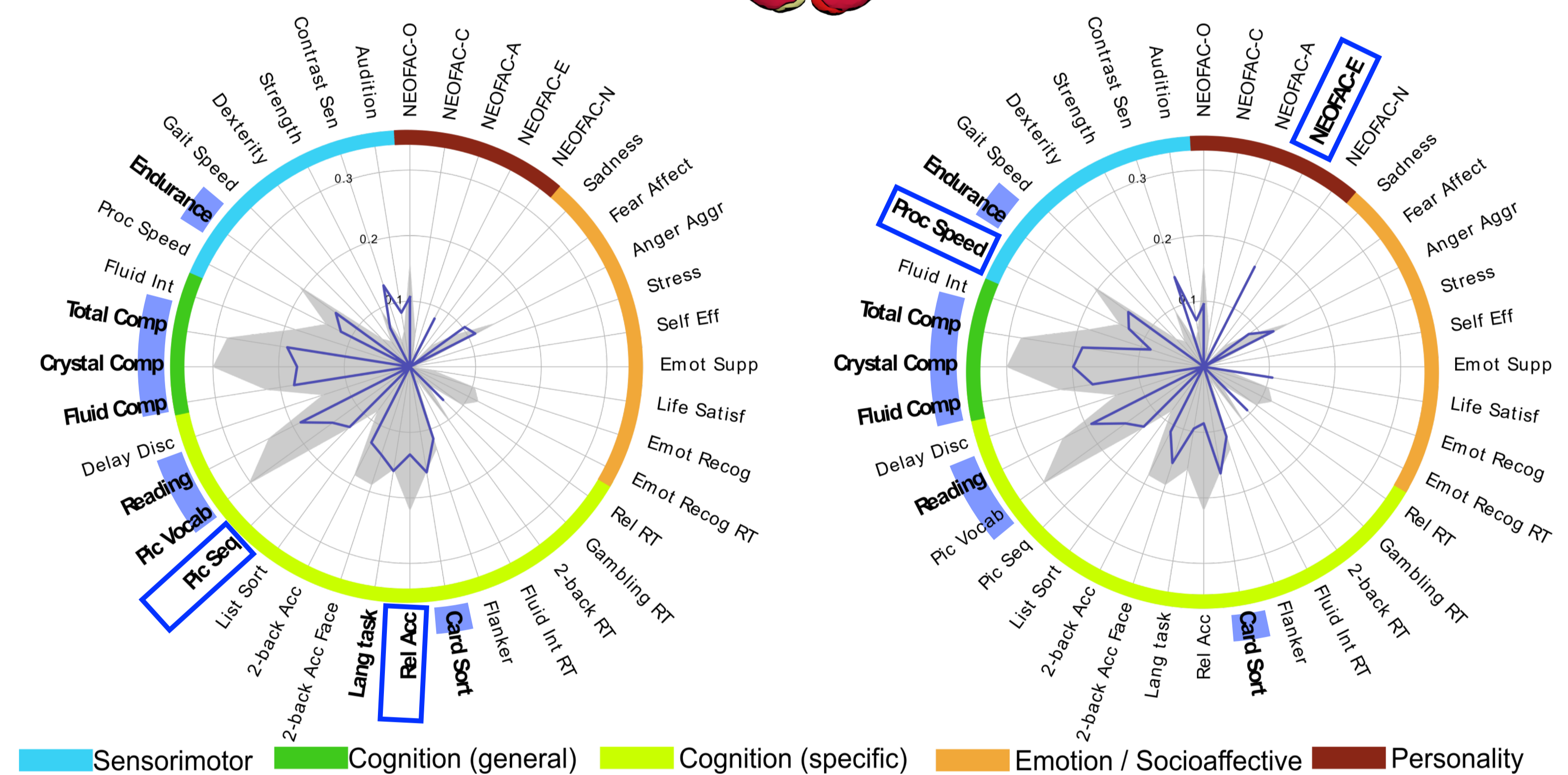
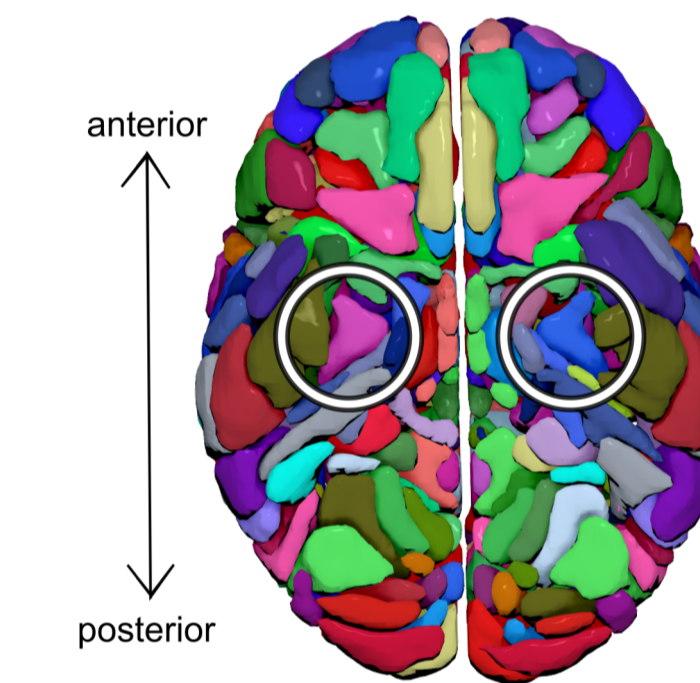
Brain region's perspective

Psychometric profiles

Parcels in Broca region



Parcels in anterior hippocampus



Legend: Sensorimotor (blue), Cognition (general) (green), Cognition (specific) (yellow), Emotion / Socioaffective (orange), Personality (red)

- Permutation testing performed by 1000 repeats of 10-fold cross-validation
- Bolded psychometric variables also showed significant accuracy using normalized root mean squared deviation measure [5]

Data: HCP S1200 Release [1]

- 40 psychometric variables
- 9 confounding variables (sex, age, age², sex*age, sex*age², handedness, brain volume, intracranial volume, acquisition quarter)
- > 900 subjects with ICA-FIX denoised resting-state fMRI data

Parcellation: 300-parcel Schaefer atlas [2], 384-parcel AICHA atlas [3]

Functional connectivity: Pearson correlation

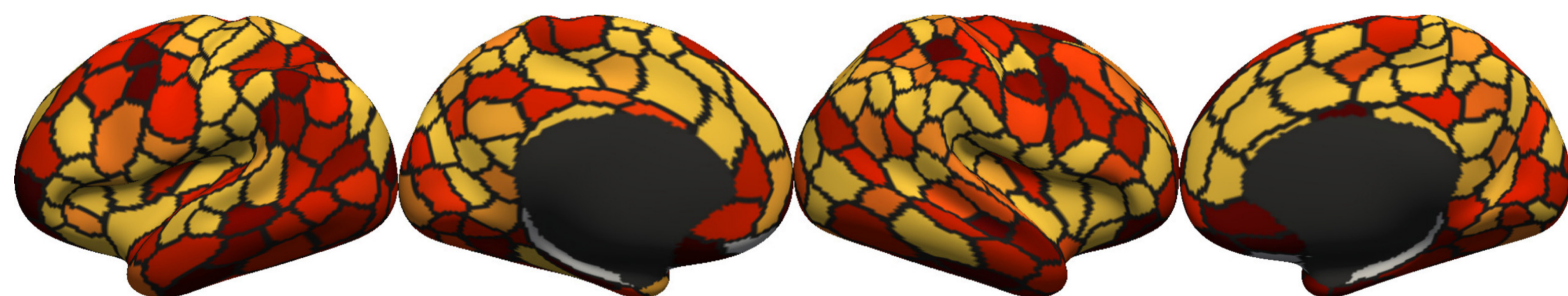
Prediction: Support vector regression [4] with 10 repeats of 10-fold cross-validation, with family members always kept in the same fold

Evaluation: Pearson correlation between predicted and observed values

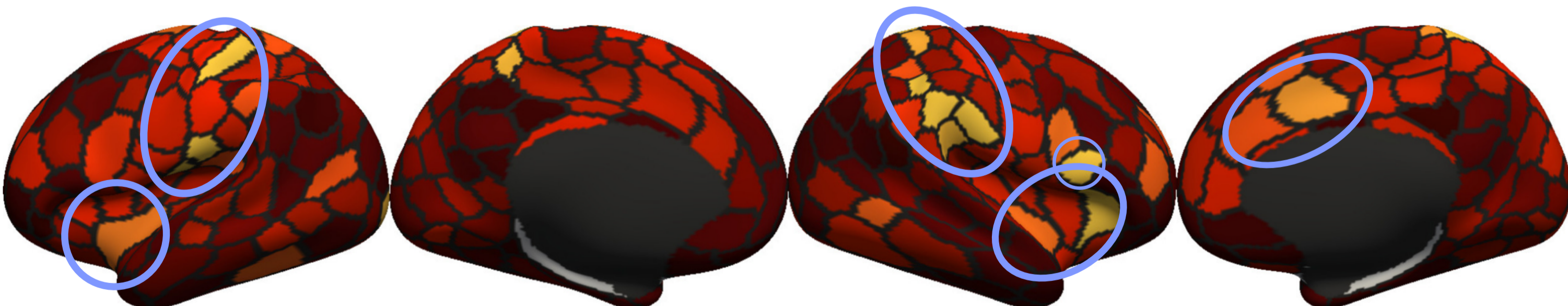
Psychometric variable's perspective

Prediction accuracy distribution

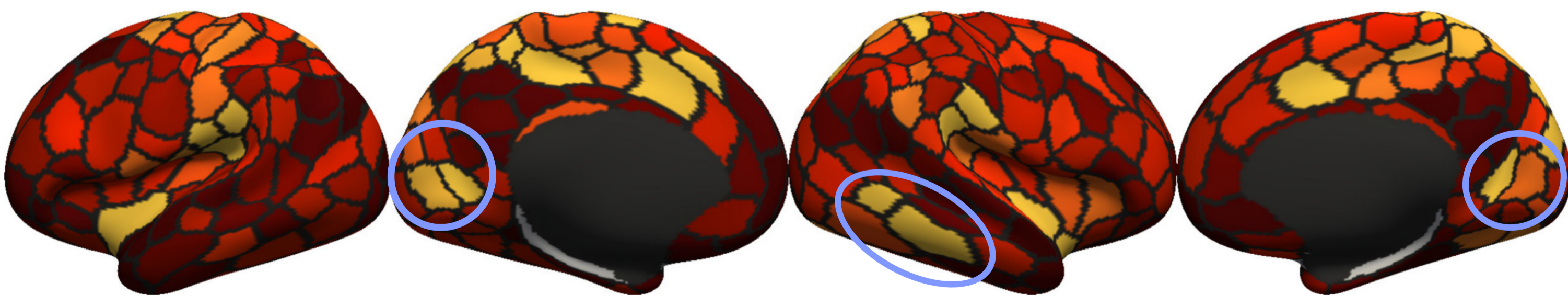
Crystallized cognition composite score



(Working memory) 2-back task accuracy



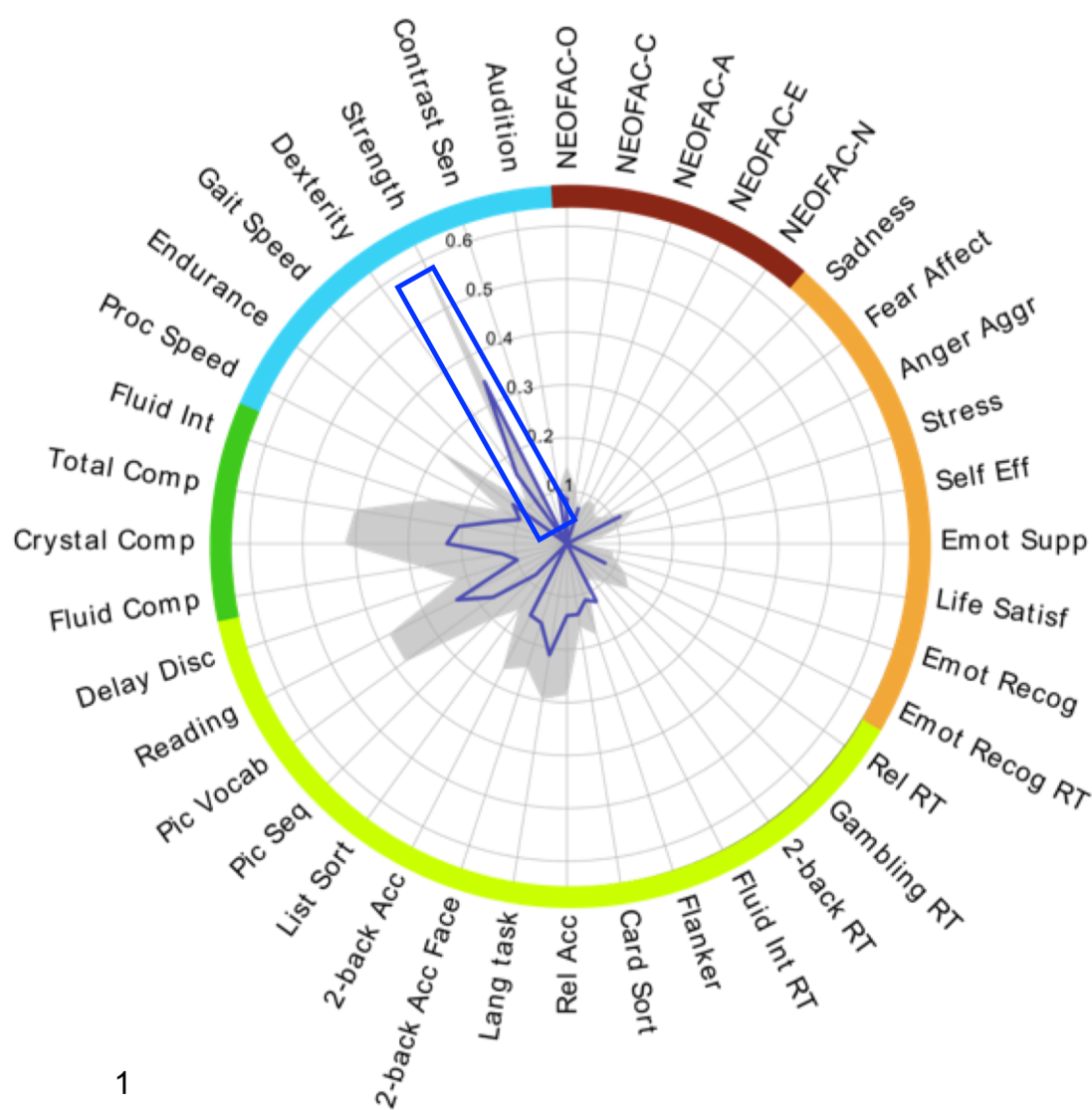
(Working memory) 2-back face task accuracy



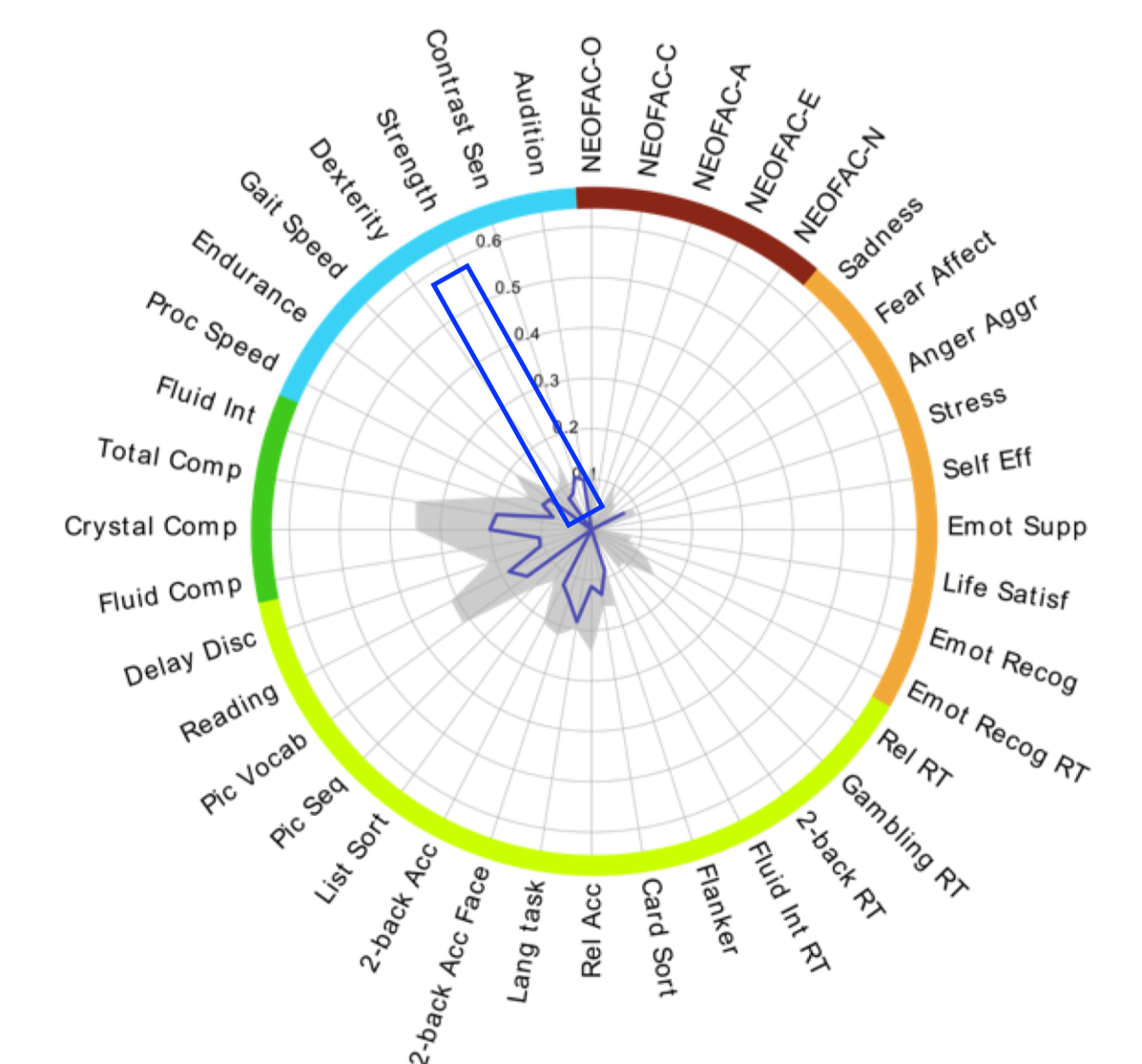
0 0.2

Effects of confounds

No confound



Controlling for sex & brain volume



Conclusion

- Our region-based approach offers insights into brain-behavior relationships with two possible applications, investigating either a specific brain region's profile or a specific psychometric variable
- As a result, we could assess the effects of different data processing (e.g. confounds) on prediction based on neurobiological validity instead of only prediction accuracies

References: [1] Van Essen DC, et al. 2012. "The Human Connectome Project: a data acquisition perspective". *Neuroimage*. [2] Schaefer A, et al. 2018. Local-Global parcellation of the human cerebral cortex from intrinsic functional connectivity MRI. *Cerebral Cortex*. [3] Joliot M, et al. 2015. "AICHA: An atlas of intrinsic connectivity of homotopic areas". *Journal of Neuroscience Methods*. [4] Cortes C and Vapnik VN. 1995. "Support-vector networks". *Machine Learning*. [5] Dubois J, et al. 2018. "Resting-state functional brain connectivity best predicts personality dimensions of openness to experience". *Personality Neuroscience*.

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