Weak and Unstable Prediction of Personality from the Structural Connectome

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Introduction

What? Prediction of big five personality trait scores [1] from features of the structural connectome (SC) derived from dwMRI.

Why? Gain understanding of neurobiological basis of personality. Heterogeneous results of prior studies in the field.

How? Expand prior work relating dwMRI measures with personality in two ways:

- Leverage information from the entire SC vs. applying tract-based spatial statistics (e.g. [2]-[4]) or tract-based measures ([5], [6]).
- Cross validated prediction framework for assessing out-of-sample performance vs. correlation analysis.

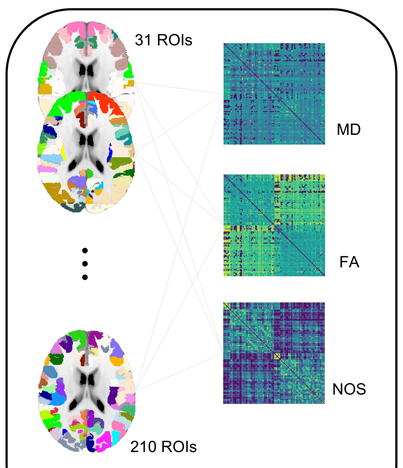
Evaluate large number of different prediction pipelines by varying different pipeline conditions:

- 19 cortical brain parcellations with different granularities
- 3 SC weightings (number of streamlines (NOS) and microstructural (FA, MD))
- 3 subject groups defined by subject sex
- 4 feature classes defining how features are calculated / extracted from the SC and five personality traits.

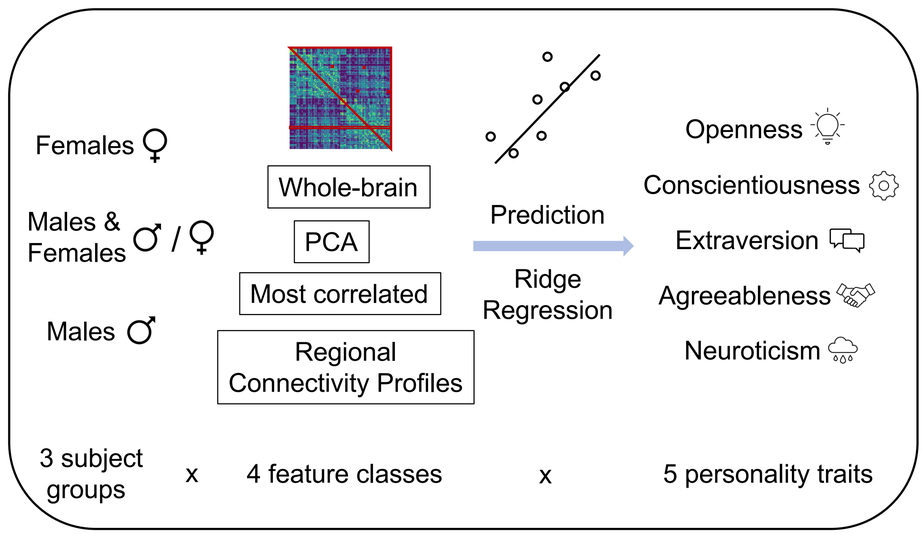
Aims:

1) Determine whether there is an individual predictive relationship between SC and big five personality traits.
2) Evaluate the influence of different settings along the prediction pipeline on the prediction outcome.

Methods



Definition of the SC



Prediction of Personality Trait Scores from SC Features for Different Subject Groups

Data

- 426 unrelated subjects from the Human Connectome Project Young Adult dataset [7]

Feature Classes

- Different numbers of features evaluated for *most correlated* and *PCA* feature classes
- All *regional connectivity profiles* (RCPs) evaluated for each parcellation

Evaluation

- Pearson correlation between empirical and predicted trait scores
- Prediction brain maps averaged across all 19 parcellations based on results of the RCP feature class

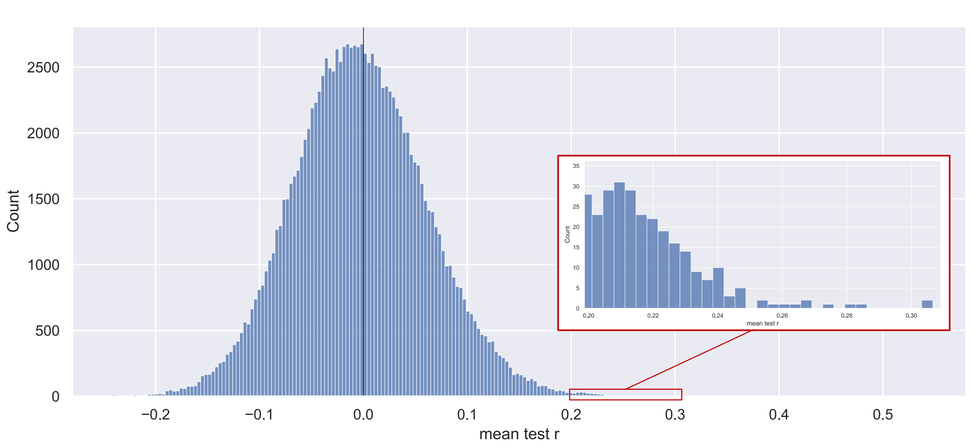
Results

1) Can personality be predicted from the structural connectome?

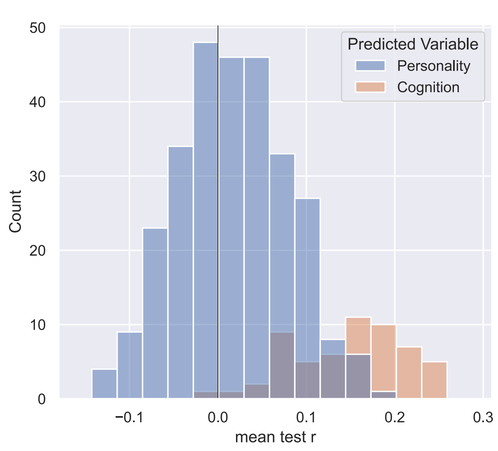
1.1) - Weak prediction (around r = 0) for the vast majority of prediction pipelines
- Only very few correlations of r > 0.2 comparable to FC-based prediction [8-10]

1.2) - Improved prediction of cognition compared to personality. Results for wholebrain feature class and mixed-sex subject group.

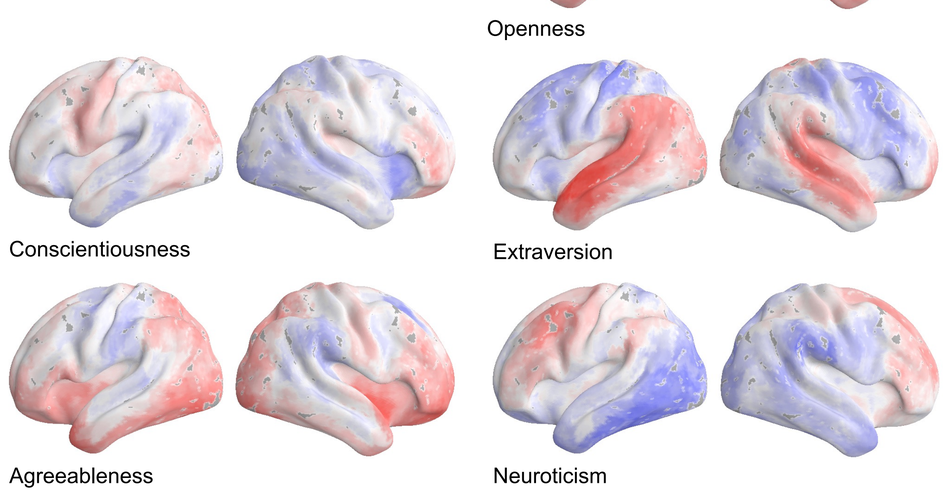
1.3) - Prediction brain maps highlight which regions connections are more or less predictive of a certain trait
→ Different regions connections are related to different personality traits.



1.1 Distribution of mean test set correlations from all evaluated prediction pipelines.



1.2 Predicting personality vs. cognition.

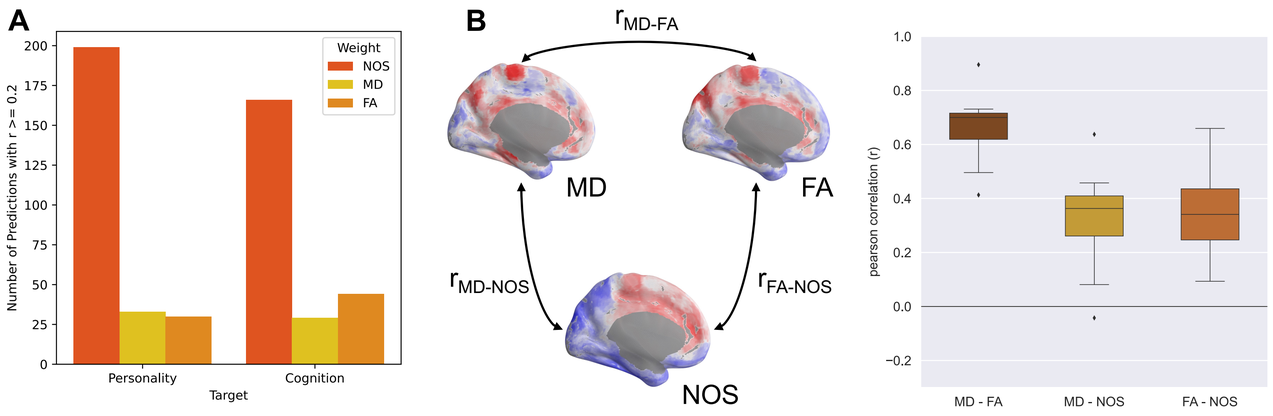


1.3 Prediction brain maps by trait (SC weighting: NOS, mixed-sex subject group)

2) How do different pipeline conditions influence the prediction outcomes?

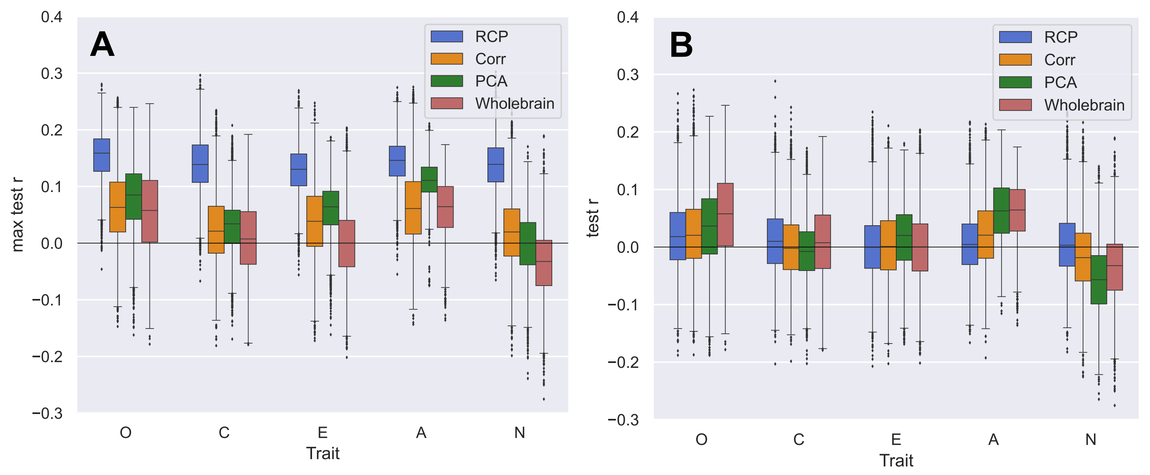
- All pipeline conditions influence prediction results
- For most conditions, no global best option → depends on the combination of different settings

SC Weightings



2.1 Influence of SC weightings on results. **A** Distribution for pipelines with r > 0.2 **B** Influence on prediction brain maps and similarity between prediction brain maps for different weightings.

Feature Classes



2.2 Influence of feature classes on results. Selecting best number of features / best RCP **A** based on test set correlation **B** in inner loop of nested CV.

RCP feature class outperforms the other feature classes.

RCP feature class no longer superior.

⇒ Predictive RCPs can not be reliably selected from the data for the considered sample.

Conclusion

- No linear generalizable relationship between SC and big five personality trait scores → Importance of reporting results from all evaluated pipelines to get complete and realistic picture
- Improved results for predicting cognition → Limitations of the personality target (model of personality, acquisition of trait scores, relationship with the SC)
- All pipeline settings influenced the results. Not many global best settings.
  - **SC weighting:** NOS > FA, MD.
  - **Feature classes:** RCP feature class showed most promising results
    - However, predictive RCPs could not be selected in a CV setting
    - Highlighting the importance of testing for generalization of findings

References: [1] McCrae, R., & Costa, P. (1996). [2] Potenza et al. (2012). [3] Rodriguez et al. (2019). [4] Leshem et al. (2019). [5] Pang et al. (2019). [6] Talaei, N., & Ghaderi, A. (2022). [7] Van Essen et al. (2013). [8] Cai et al. (2020). [9] Nostroet al. (2018). [10] Dubois et al. (2018).

Acknowledgments: This work was funded by the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) – grant number 269953372/GRK2150. The authors gratefully acknowledge computing time on the supercomputer JURECA at Forschungszentrum Jülich under grant no. 'cjinm71'.