Evaluating Accuracy and Reliability of Brain-Behavior Models Using Diffusion MRI

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Background

- Diffusion MRI (dMRI) measures tissue properties of white matter, which contains long-range connections between different brain regions.
- Brain-behavior models can be used link neuroimaging features and phenotypes.
- Researchers have several options to process dMRI data into input features for brain-behavior modeling.
- Characteristics of feature sets determine which regularization methods are suitable for modeling fitting.
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Question: How do sets of features derived from different dMRI processing methods compare in model accuracy and variability?
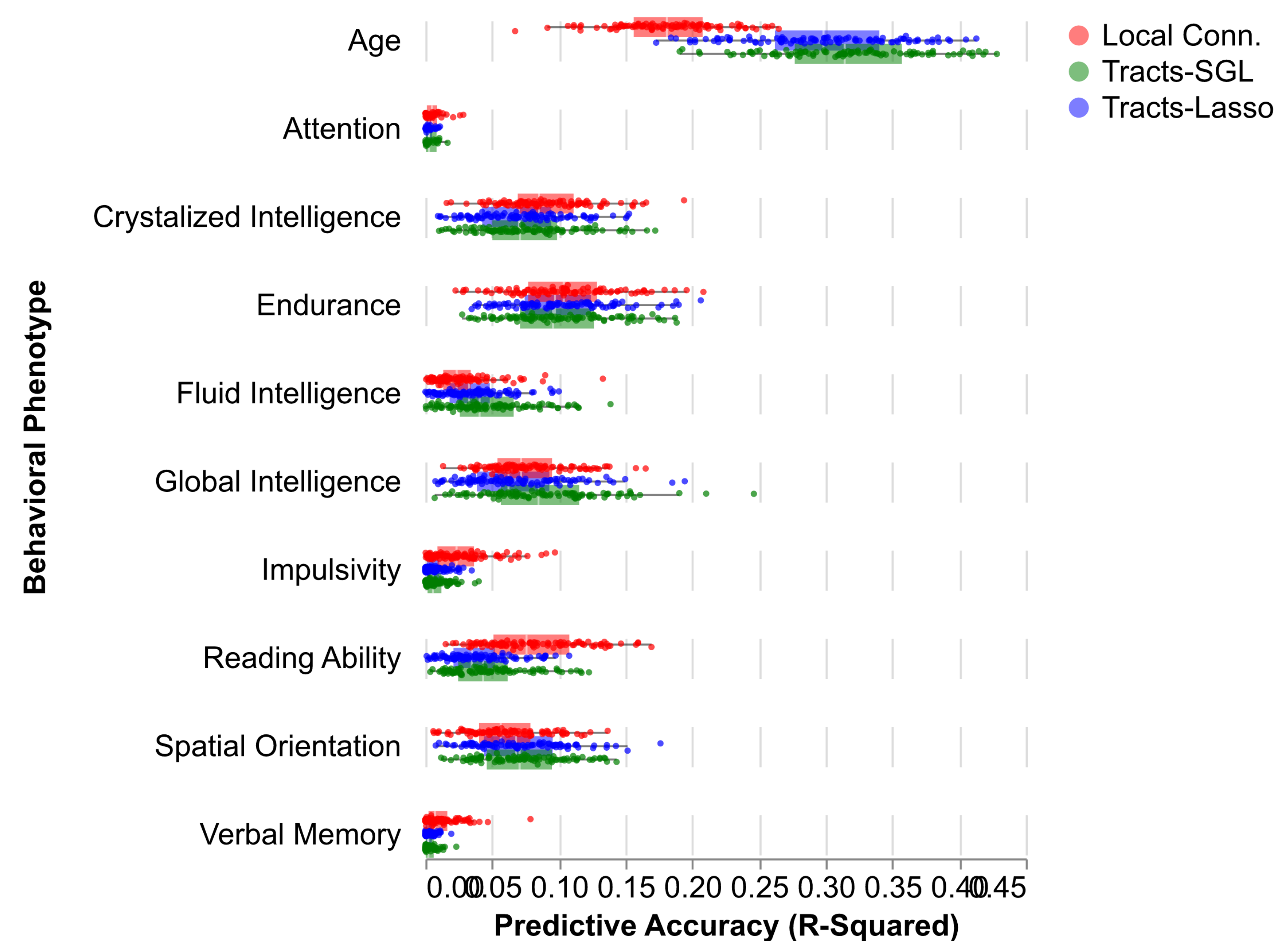
Methods

- Diffusion MRI from 1,041 Human Connectome Project participants.
- Processed into "tract profiles"(1) (9,600 features) using pyAFQ and "local connectome fingerprint" (100,000 features) using DSI-Studio (2).
- LASSO regularizated models fit to tract profiles and local connectomes seperately.
- Sparse Group LASSO (SGL) models fit to tract profiles, grouped by tract.
- Prediction targets were various cognitive phenotypes drawn from prior predictive modeling investigations(3).
- Models implemented in R and trained using nested group cross-validation and boostrap resampling by family.
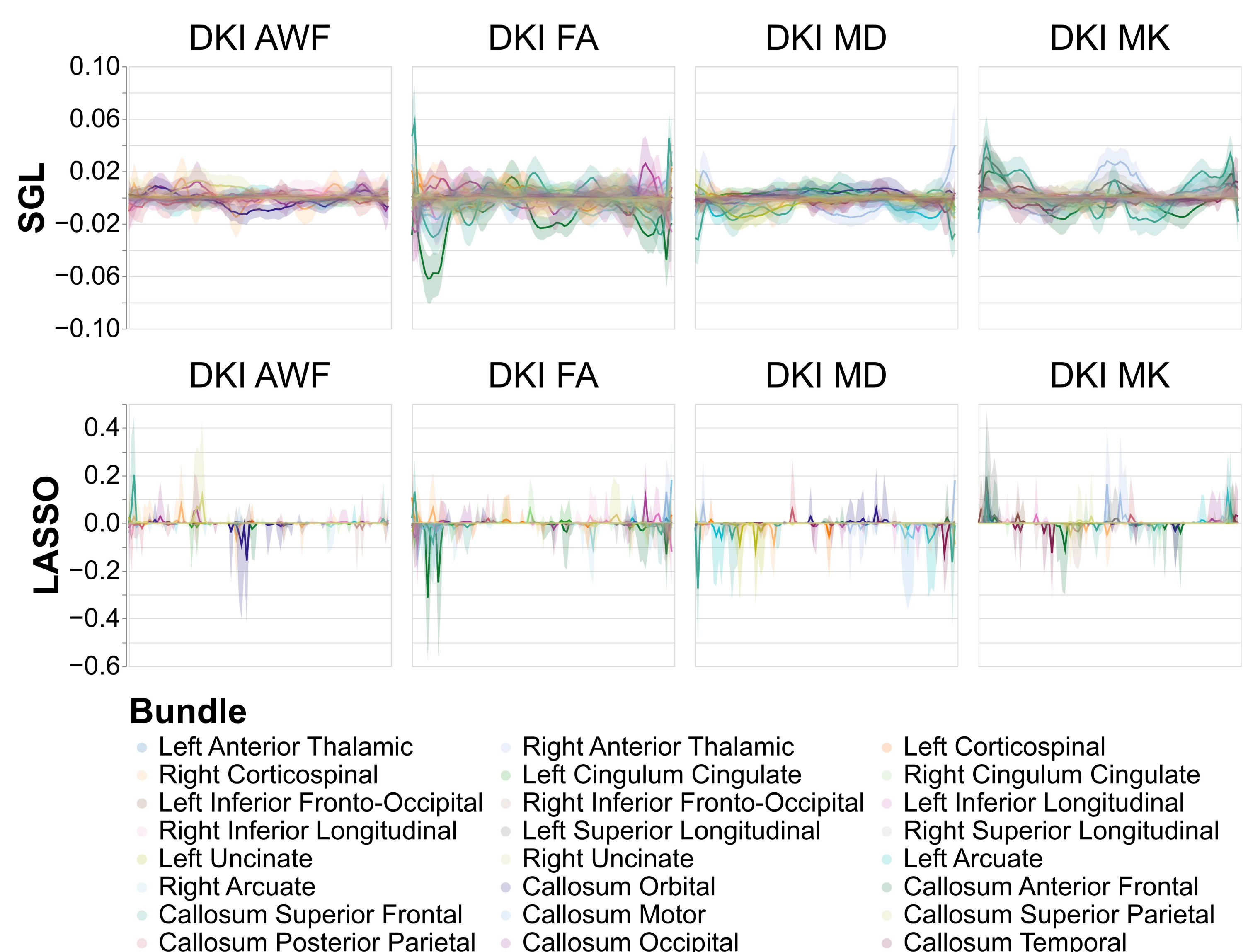-
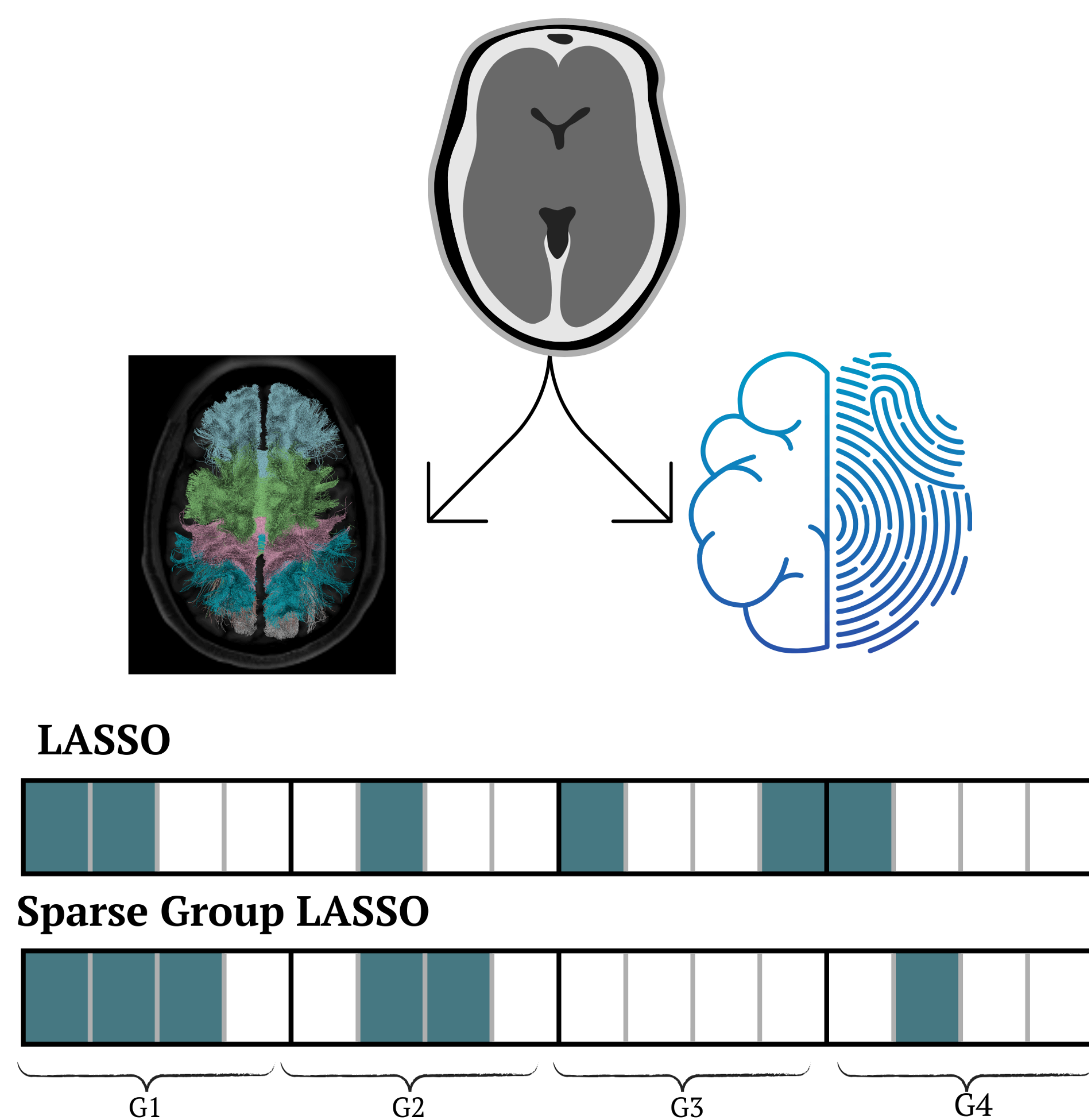
Conclusions

- Tractometry contains equivalent predictive information as compared to local connectome, with much fewer features.
- Utilizing a variety of regularization methods and feature engineering can maximize interpretability of models.
- this is more conclusions
- testing page limits
- This will be replaced with an insightful comment about the results
- Lots of space for conclusions
- Placeholder

Results

Model accuracies for behavioral phenotypes. All models, regardless of regularization method or feature set performed statistically equivalently.

Bundle
- Left Anterior Thalamic
- Right Anterior Thalamic
- Left Corticospinal
- Right Corticospinal
- Left Cingulum Cingulate
- Right Cingulum Cingulate
- Left Inferior Fronto-Occipital
- Right Inferior Fronto-Occipital
- Left Inferior Longitudinal
- Right Inferior Longitudinal
- Left Superior Longitudinal
- Right Superior Longitudinal
- Left Uncinate
- Right Uncinate
- Left Arcuate
- Right Arcuate
- Callosum Orbital
- Callosum Anterior Frontal
- Callosum Superior Frontal
- Callosum Motor
- Callosum Superior Parietal
- Callosum Posterior Parietal
- Callosum Occipital
- Callosum Temporal

"Age" prediction model weights across tracts for SGL and LASSO. Solid lines show the mean model weight across bootstraps for every tract, across every node, and the shaded areas show the 95% confidence intervals of the model weights. Note the reduced y-axis range for SGL.

Acknowledgements and Funding

References

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2. F.-C. Yeh *et al.*, *PLoS Comput. Biol.* **12** (2016).
3. J. Rasero, A. I. Sentis, F.-C. Yeh, T. Verstynen, *PLoS Comput. Biol.* **17** (2021).