

# Hybrid structure-function connectome predicts crystallised and fluid cognition

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## Introduction

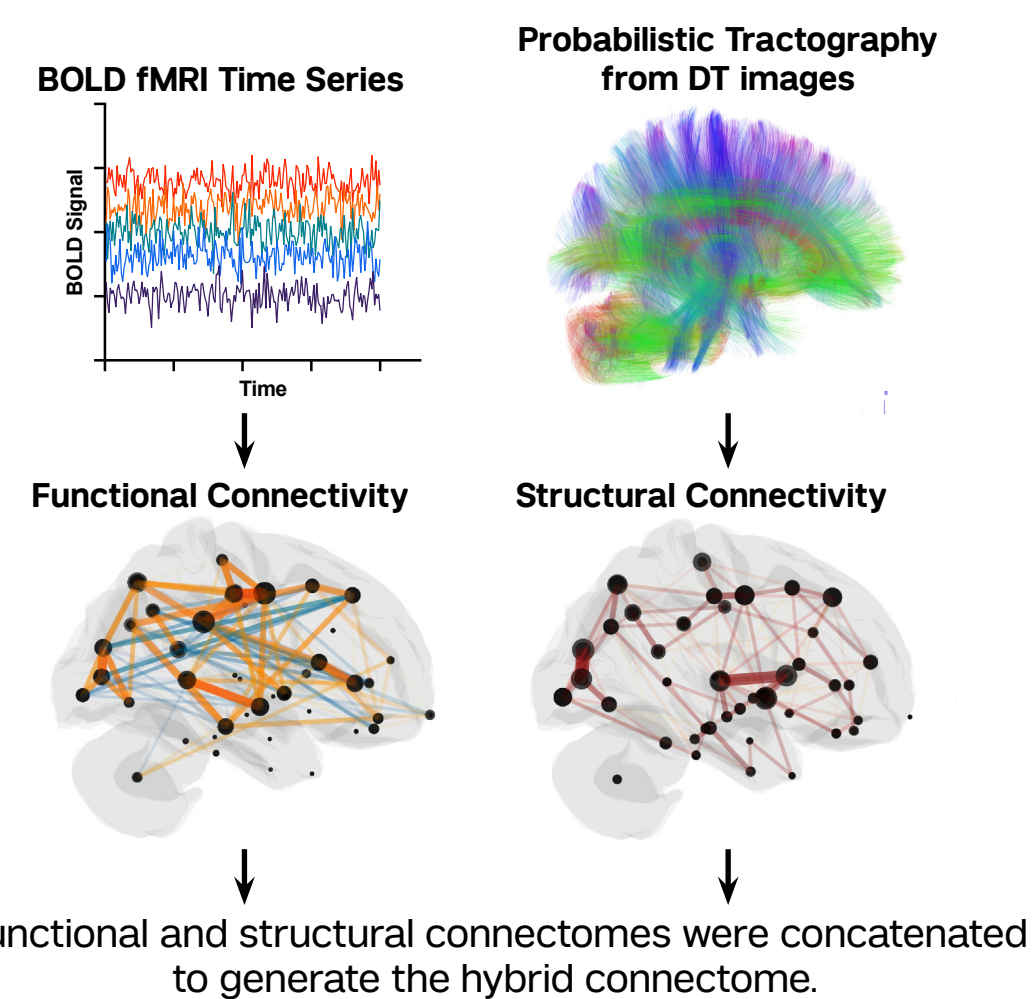
Functional connectivity (FC) represents temporal dependency patterns between regional blood-oxygenation-level dependent activity in functional MRI time series, and structural connectivity (SC) represents the inter-regional white matter pathways estimated from diffusion-weighted MRI. Both FC<sup>1-3</sup> and SC<sup>4-7</sup> can be independently used to predict cognition<sup>8-11</sup>, and show distinct patterns of variance in relation to cognition. No work identified has yet investigated whether SC and FC can be combined to better predict cognitive abilities.

Here, we use data from 785 healthy young adults (Human Connectome Project; ages 22-37) to:

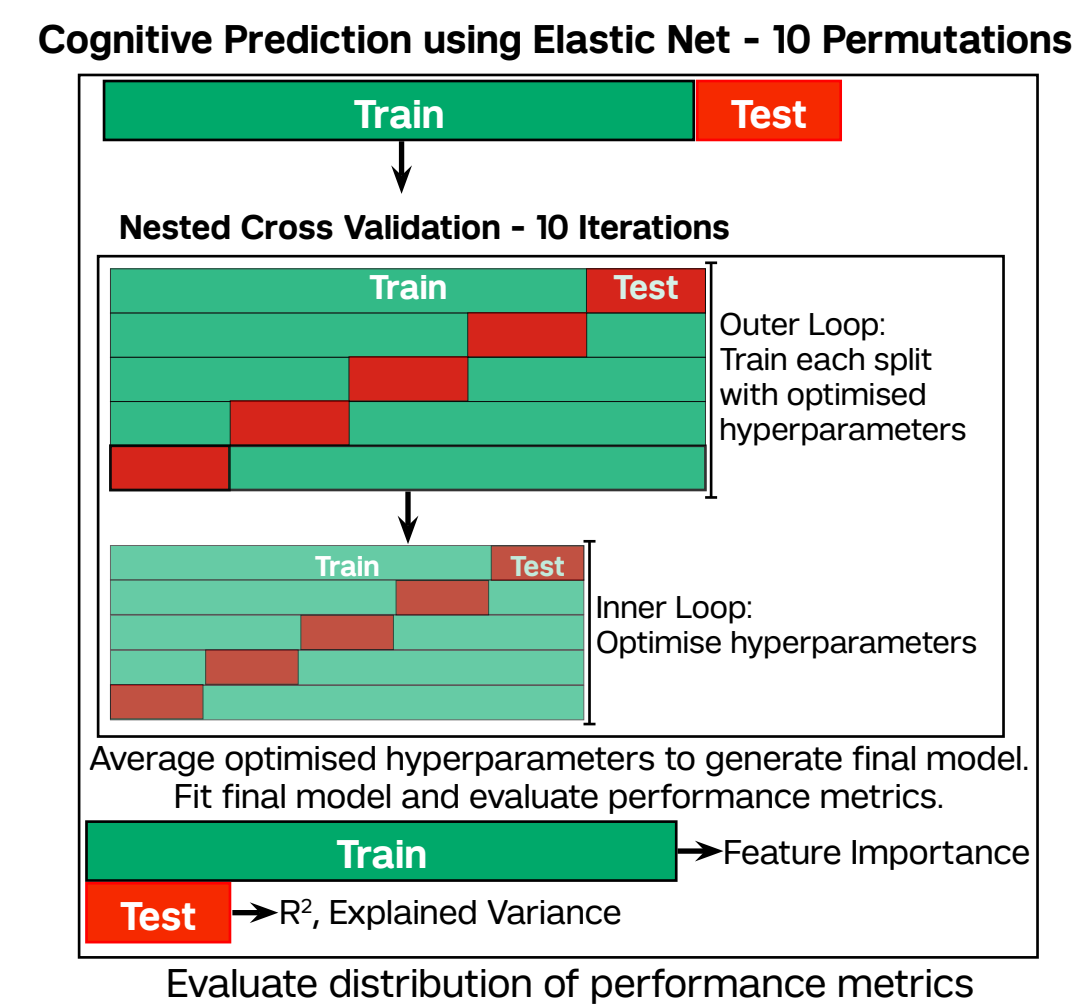
- 1) Predict cognition from SC, FC, & a hybrid connectome (HC)
- 2) Quantify the most important connections for the prediction.

## Workflow

### 1. Connectome Extraction



### 2. Regression

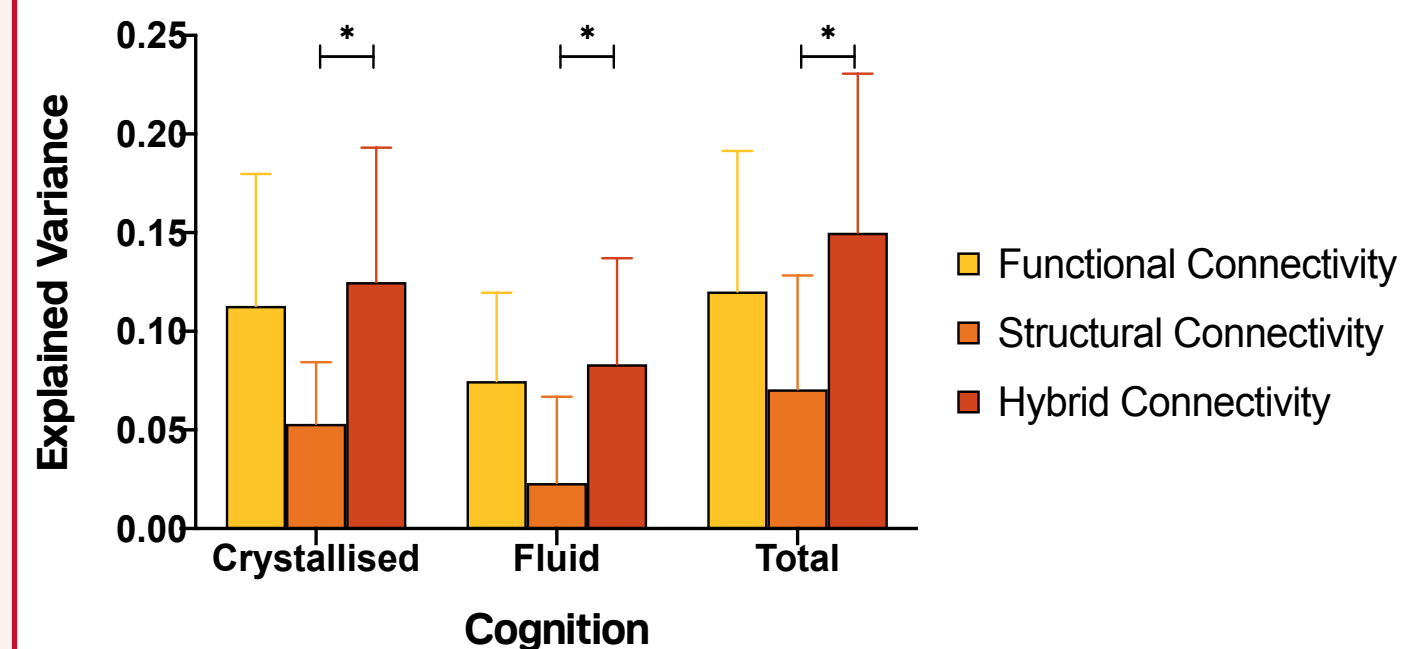


## Prediction Performance

FC explains 11.3%, 7.5%, and 12.0% of the variance in crystallised, fluid, and total cognition, respectively.

SC explains 5.3%, 2.3%, and 7.1% of the variance in crystallised, fluid, and total cognition, respectively.

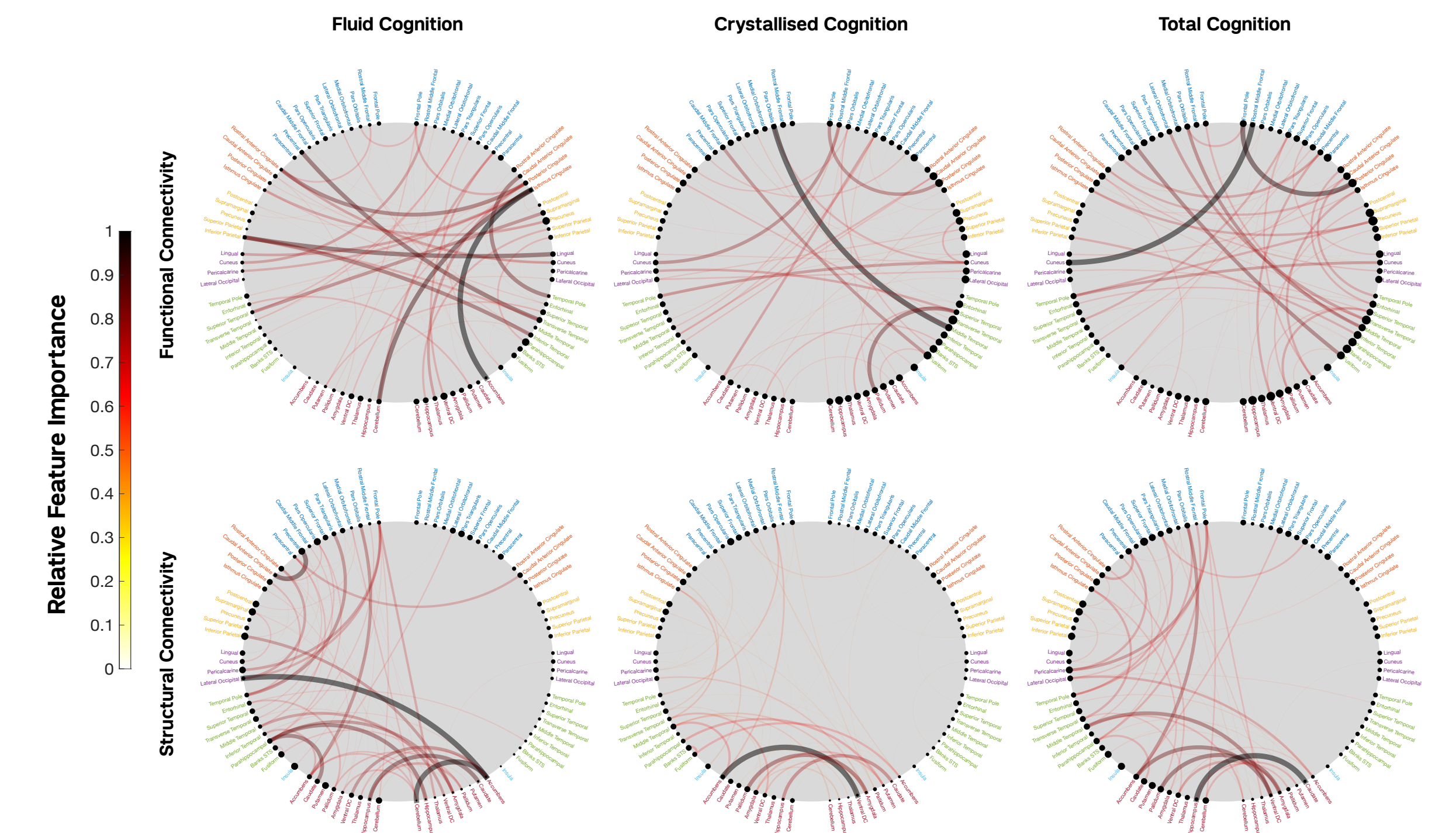
HC explains 12.5%, 8.3%, and 15.0% of the variance in crystallised, fluid, and total cognition, respectively. For all three cognitive measures, HC explains significantly more variance ( $p < 0.05$ ) than SC alone.



Explained variance using FC (yellow), SC (orange), and HC (red) for crystallised (left), fluid (middle), and total (right) cognition. \* denotes significant differences ( $p < 0.05$ ).

## Feature Importance

The most important FC features for cognitive prediction are primarily long-range, inter-hemispheric, cortico-cortical connections, while the most important SC features are primarily short-range and long-range cortico-subcortical and subcortico-subcortical connections in the left hemisphere. There is no correlation between the feature importance for FC and SC features.



The top 2% most important functional (top) and structural (bottom) connections for prediction of crystallised (left), fluid (middle), and total (right) are shown above. Hotter colours indicate greater relative feature importance. Nodes are organised by lobe and node size represents node degree of the feature importance.

The hybrid connectome outperforms the independent use of SC for the prediction of crystallised and fluid cognition. Distinct structural and functional connections are important for the cognitive prediction. Taken together, this suggests that **the integration of multi-modal connectivity data is crucial to understand the neurophysiological correlates of cognitive performance.**

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