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Brain signatures: the relationship between brain function and structure is unique to individuals and tasks

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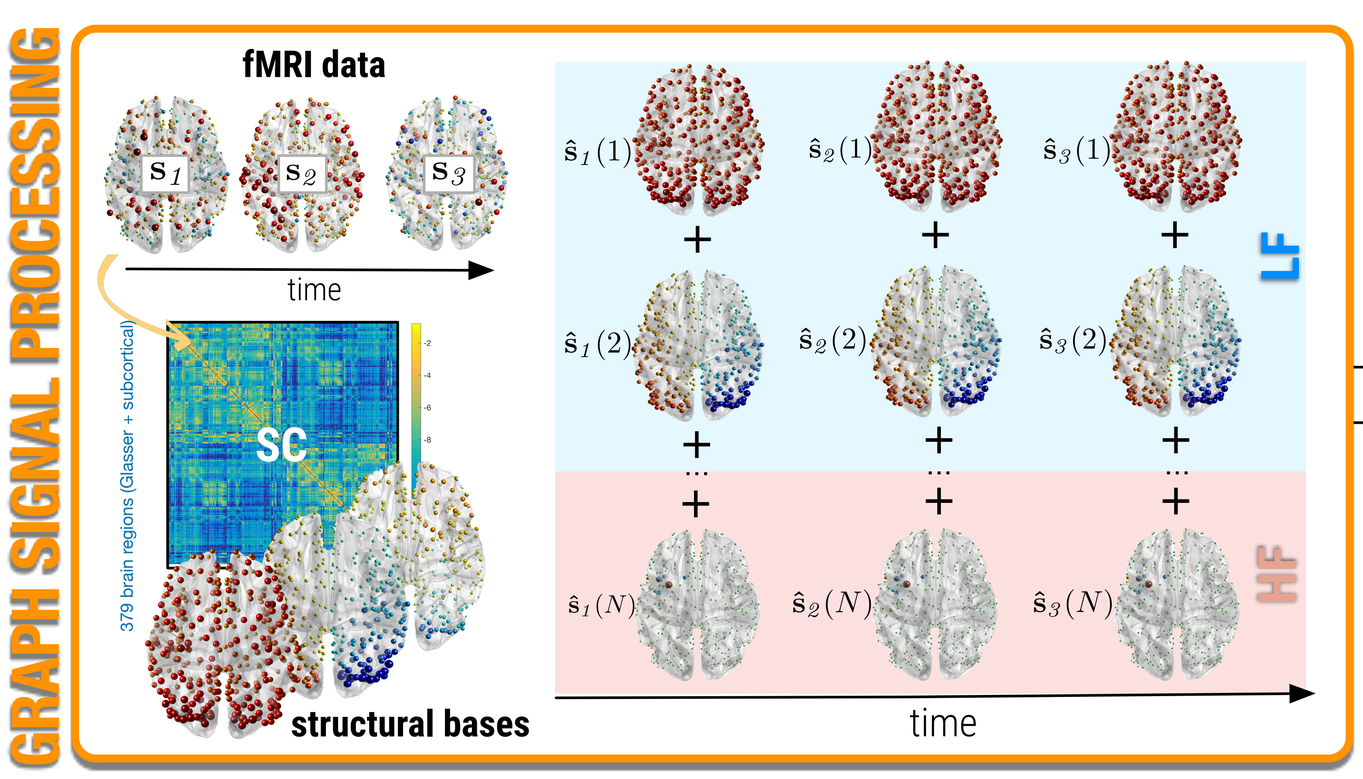
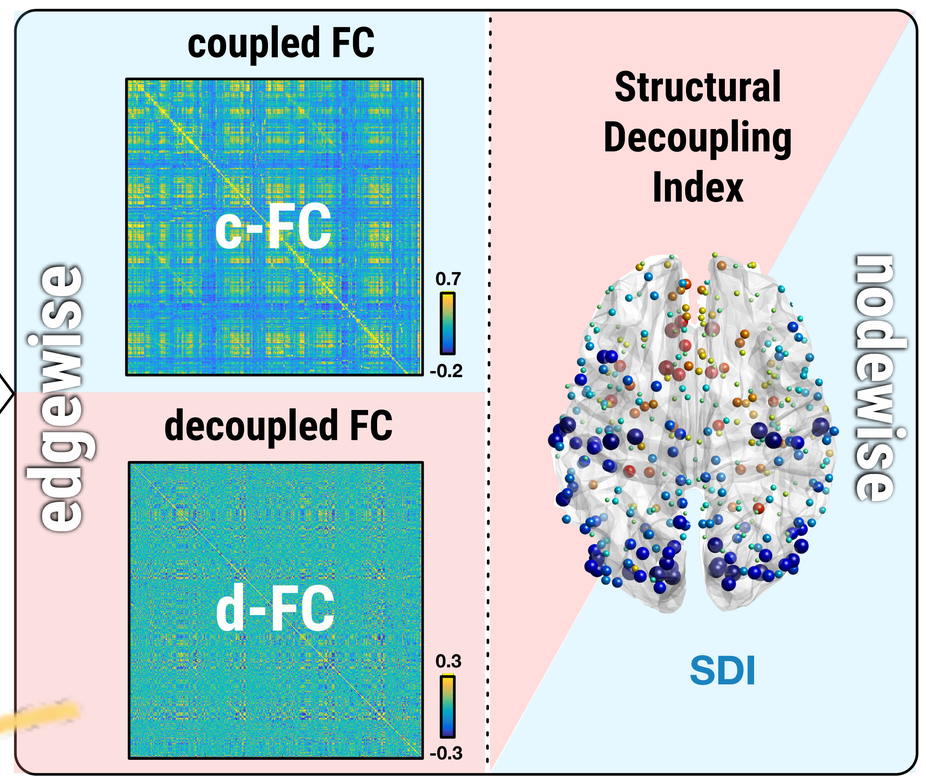
BACKGROUND & AIM

- The **relationship** between **functional activity** and the **underlying structural wiring** has been shown to vary along a specific behaviorally relevant cortical gradient during resting-state[1].
- But how does the brain **structure-function coupling** change in different **tasks** and **individuals**?
- Here[2], we quantify this relationship using a recent **graph signal processing** (GSP) framework[1] and we investigate for the first time its **task-decoding** and individual **fingerprinting** performances.

METHODS

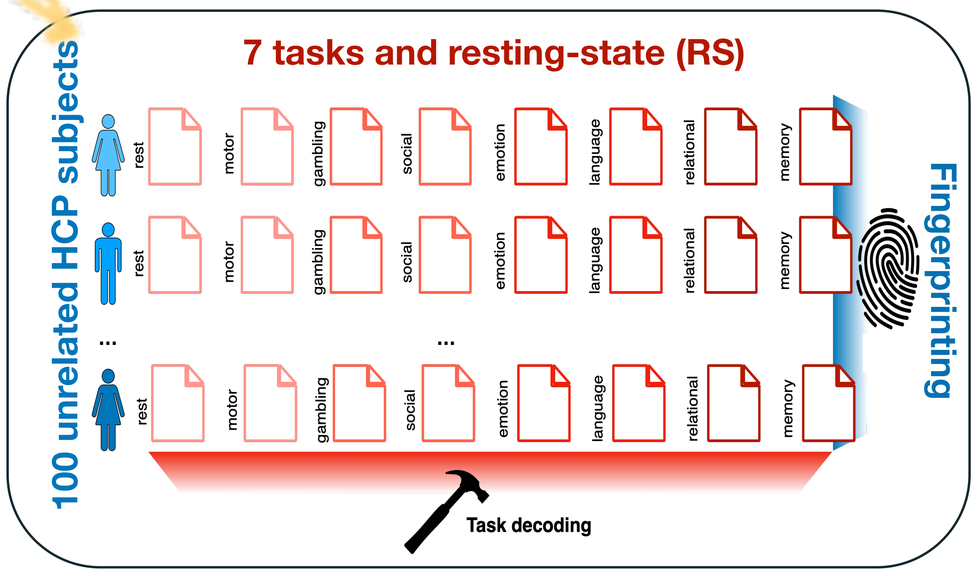


Projection of fMRI signals into structural bases & filtering



GSP measures of structure-function coupling

SVM classification



RESULTS

- Structure-function coupling predicts task-related **brain states** (SVM 100-fold CV) and represents an **individual fingerprint** of brain organization (near-perfect accuracy in subject classification, SVM 8-fold CV, Table 1).
- Structure-function ***de*coupling** explains inter-individual variations of **cognitive traits**, particularly sustained attention and fluid intelligence scores (Partial Least Square analysis, brain-cognition r^2 higher for decoupled FC, Table 1).
- **Brain networks** associated with decoding and fingerprinting are spatially distinct, involving unimodal vs transmodal regions, respectively (2-factor ANOVAs of SDI, c-FC and d-FC in different tasks or subjects respectively).

Two-factor ANOVA

Significant *F*-values, $p < .05$ Bonferroni corrected

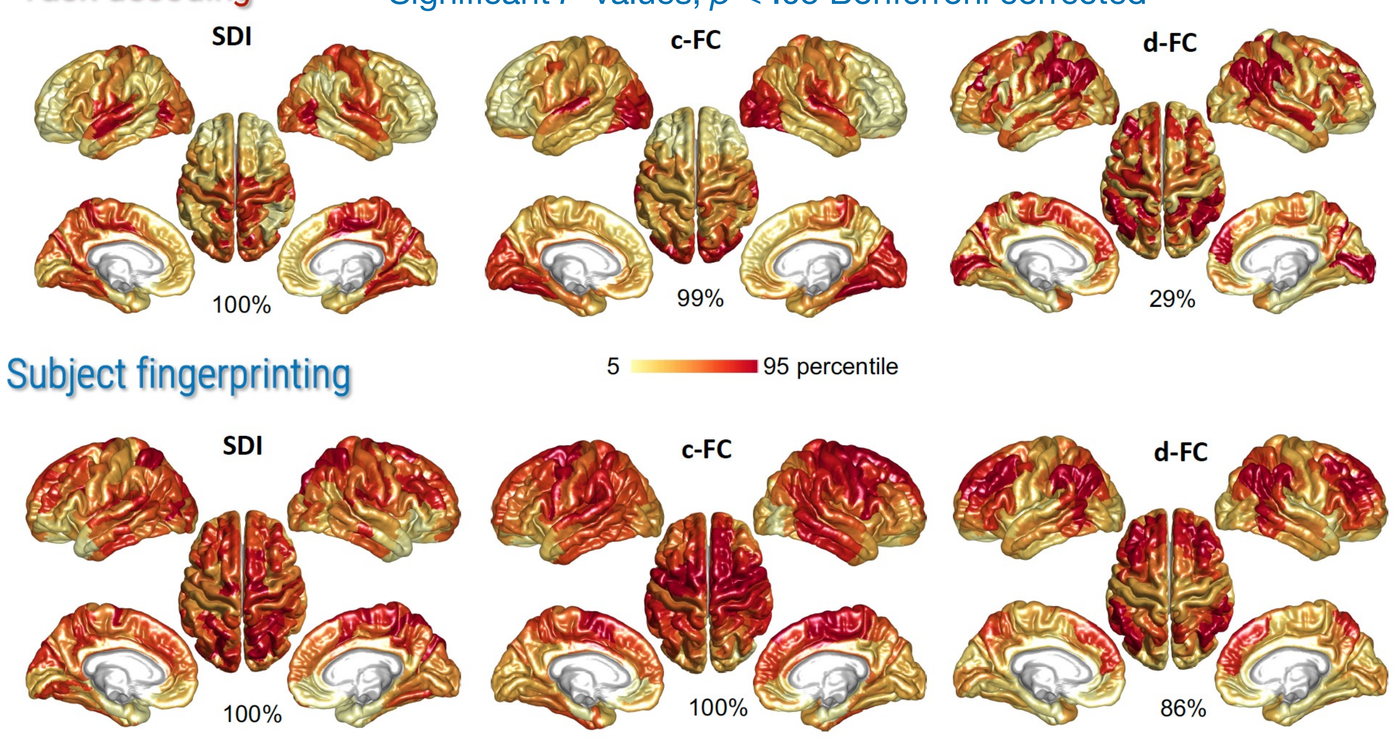


Table 1	**Task Decoding *accuracy***	**Subject Fingerprinting *accuracy***	**Brain-Cognition r^2**
FC nodal strength	0.544	0.984	0.211
nodal SDI	**0.756**	**0.997**	**0.180**
FC	0.919	0.964	0.224
c-FC	**0.893**	**0.972**	**0.209**
d-FC	**0.873**	**1.000**	**0.654**

CONCLUSIONS

- **Structure-function coupling** quantified with GSP is a prominent signature of both **individuals** and **tasks**.
- **Decoupled** pathways contain key information for **fingerprinting** and correlate with individual **cognitive traits**.

(1) Preti & Van De Ville (2019), 'Decoupling of brain structure from function reveals regional behavioral specialization in humans', *Nature Communications* 10:4747. **(2)** Griffa A, Amico E, Liégeois R, Van De Ville D, Preti MG (2022), 'Brain structure-function coupling provides signatures for task decoding and individual fingerprinting', *Neuroimage,* 250:118970.