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\textsuperscript{1}.
- But how does the brain structure-function coupling change in different tasks and individuals?
- Here\textsuperscript{2}, we quantify this relationship using a recent graph signal processing (GSP) framework\textsuperscript{1} and we investigate for the first time its task-decoding and individual fingerprinting performances.

**METHODS**

Graph Signal Processing (GSP) framework

![Graph Signal Processing](image)

Projection of fMRI signals into structural bases & filtering

**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 decoupling 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**

<table>
<thead>
<tr>
<th>Task decoding</th>
<th>Subject fingerprinting</th>
<th>Brain-Cognition</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDI</td>
<td>c-FC</td>
<td>d-FC</td>
</tr>
<tr>
<td>100%</td>
<td>99%</td>
<td>29%</td>
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Significant $F$-values, $p < .05$ Bonferroni corrected

**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.