Diffusion property and functional connectivity of superior longitudinal fasciculus underpin human metacognition

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Is Metacognition Domain-general or Domain-specific?

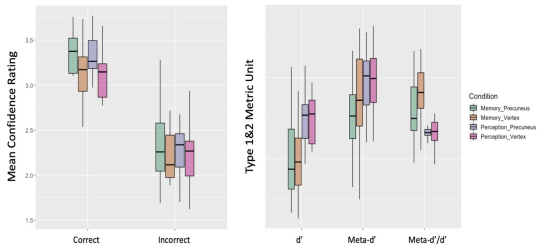
A large body of fMRI research has demonstrated that the neural mechanisms underlying perceptual and mnemonic metacognition :

- dlPFC and dACC involves in both perceptual and mnemonic metacognition (Kwok et al., 2019; Morales et al., 2018);
- Perceptual metacognition is additionally dependent on aPFC (Fleming et al., 2010);
- Mnemonic metacognition is additionally dependent on the precuneus (Ye et al., 2018).

This study examined how white-matter pathways contribute to metacognition in different domains.

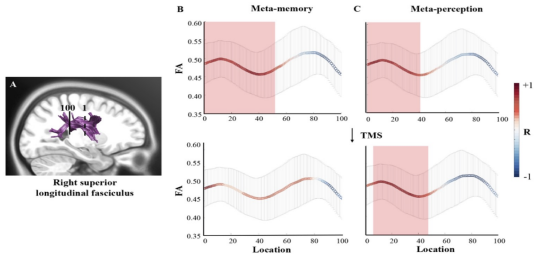
Methodology

Behavioural Results



- Metacognitive ability in each domain is quantified by the Hierarchical Bayesian Meta-d' Model (Fleming, 2017);
- TMS at the precuneus significantly reduced the mnemonic metacognitive ability.

DTI Results

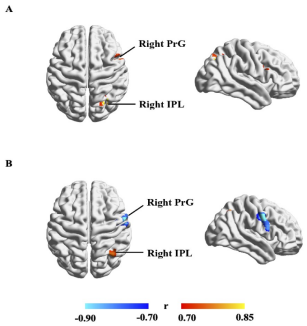


- Automated Fibre Quantification (AFQ) divided each white matter tracts into evenly 100 nodes, and measured the Fractional Anisotropy (FA) of each node;
- FA in the anterior portion of right superior longitudinal fasciculus (SLF), linking dlPFC and IPL, was associated with both perceptual and mnemonic metacognitive abilities;
- When mnemonic metacognition was disrupted by precunues-TMS, its correlation with the SLF did not exist

Resting-state fMRI Results

Choosing Precunues as a seed:

- the precuneus/right precentral gyrus (PrG) resting-state functional connectivity (FC) positively correlated with mnemonic metacognitive ability, while negatively correlated with overall memory decision confidence;
- the precuneus/right IPL FC positively correlated with both mnemonic metacognitive ability and overall memory decision confidence



Take-Home Message

- **Information transmission alongside the right SLF support both perceptual and mnemonic metacognition**
- **The efferent and afferent between the precuneus and the right SLF-connected regions support mnemonic metacognition**

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