

Functional networks and brain folds map different emotions to the brain hemispheres

Background

- At rest, our brain shows a periodic pattern of activity orchestrated by **networks**.
- The spatial layout of brain networks is highly associated with neuroanatomy – specifically the pattern of brain folds¹ (**sulci**, plural for sulcus), and influence individual differences in higher-order behavior, such as emotion and cognition².
- A diversity of emotion-related processing are associated with the dorsomedial frontal cortex (dmFC), an anatomical region situated at the midline of the brain.

- ❖ The relationship between networks and dmFC sulci, and its association to emotion and cognition are incompletely understood.
- ❖ Here, we investigate network organization about sulci of the dmFC, and its contribution to individual differences in emotion.

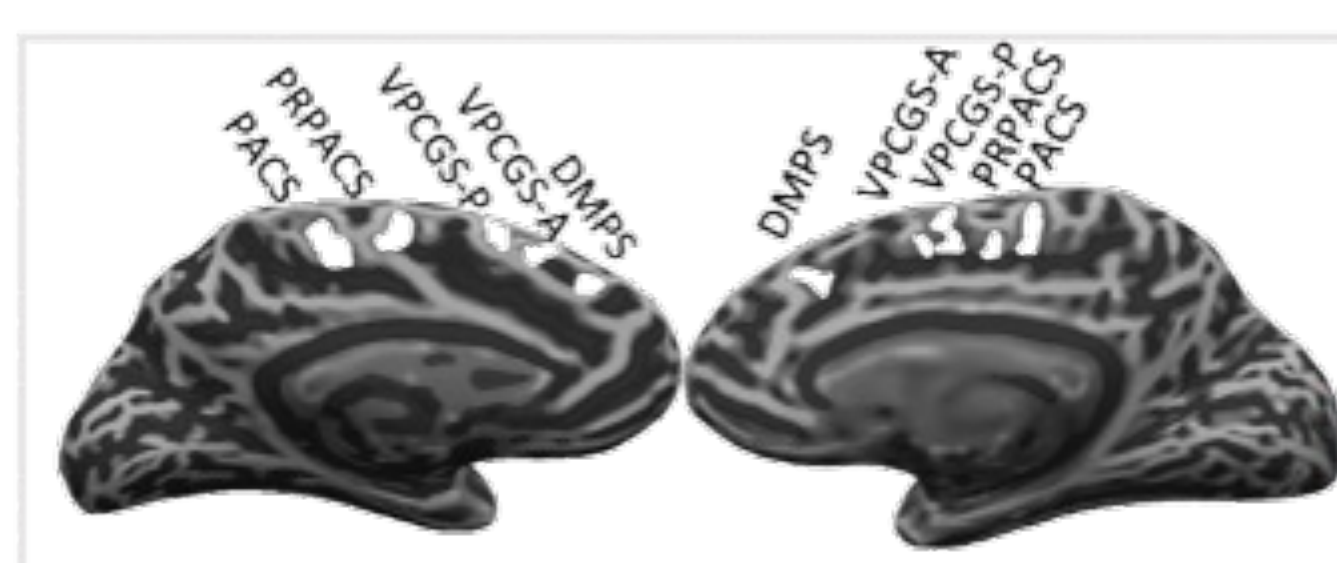
Methods

Neurocognitive aging open dataset³
(sample N = 60, healthy young adults, 50% female, 22.8 +/- 3.7 years)

Neuroimaging (magnetic resonance imaging)

Behavioral assessments (tests/questionnaires)

① Anatomical labels⁴



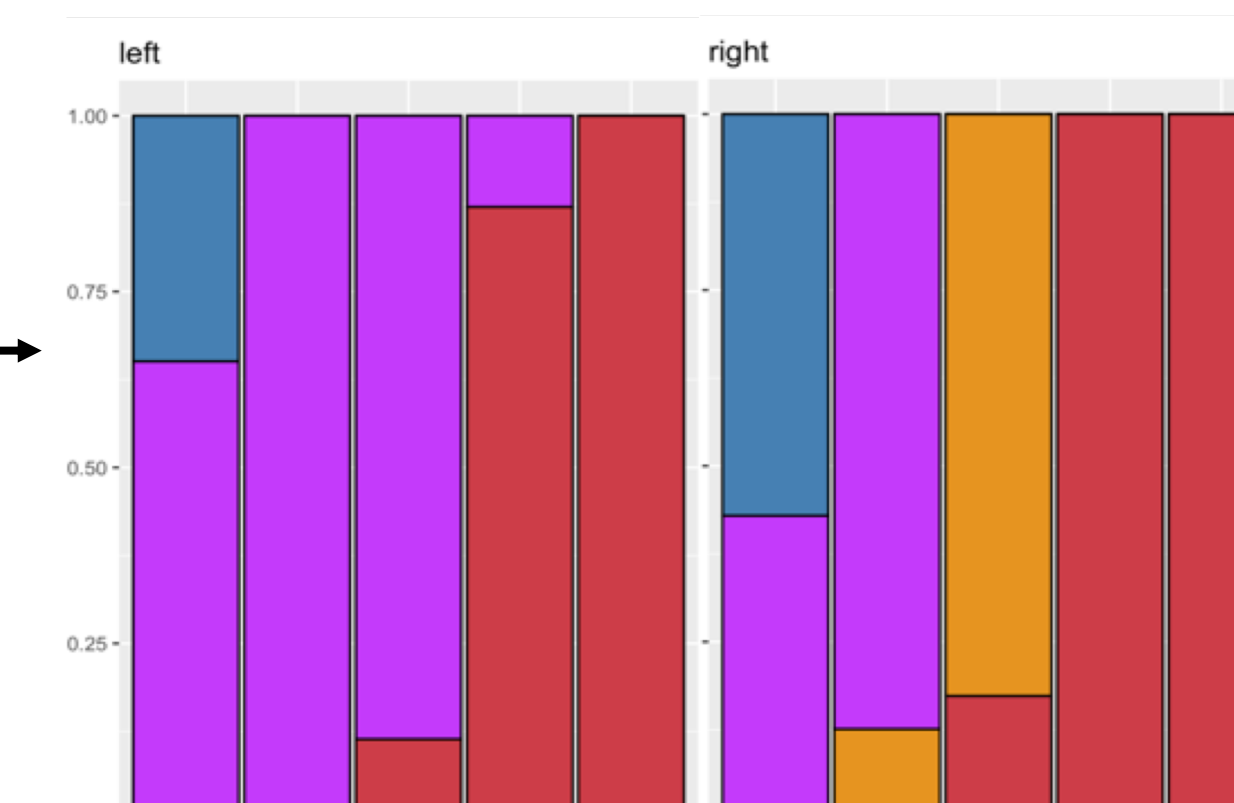
PACS (paracentral sulcus), PRPACS (preparacentral sulcus), VPCGS-P and VPCGS-A (vertical branch of the paracingulate sulcus, posterior and anterior segments) and DMPs (dorsomedial polar sulcus)

② Individualized network map⁵



Visual, Somatomotor, Dorsal Attention, Ventral Attention, Limbic, Frontoparietal, Default

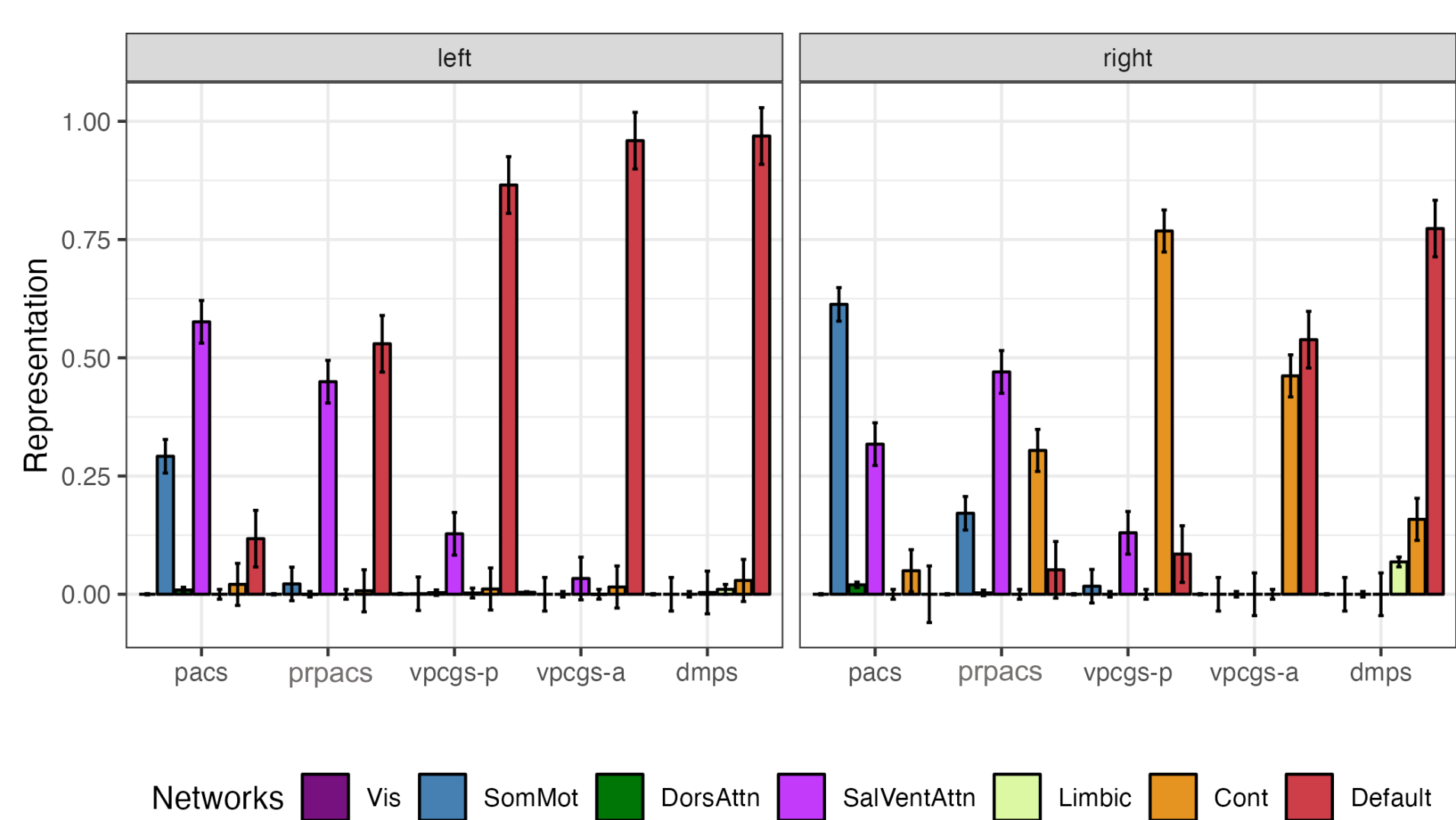
③ Network fingerprint of sulci



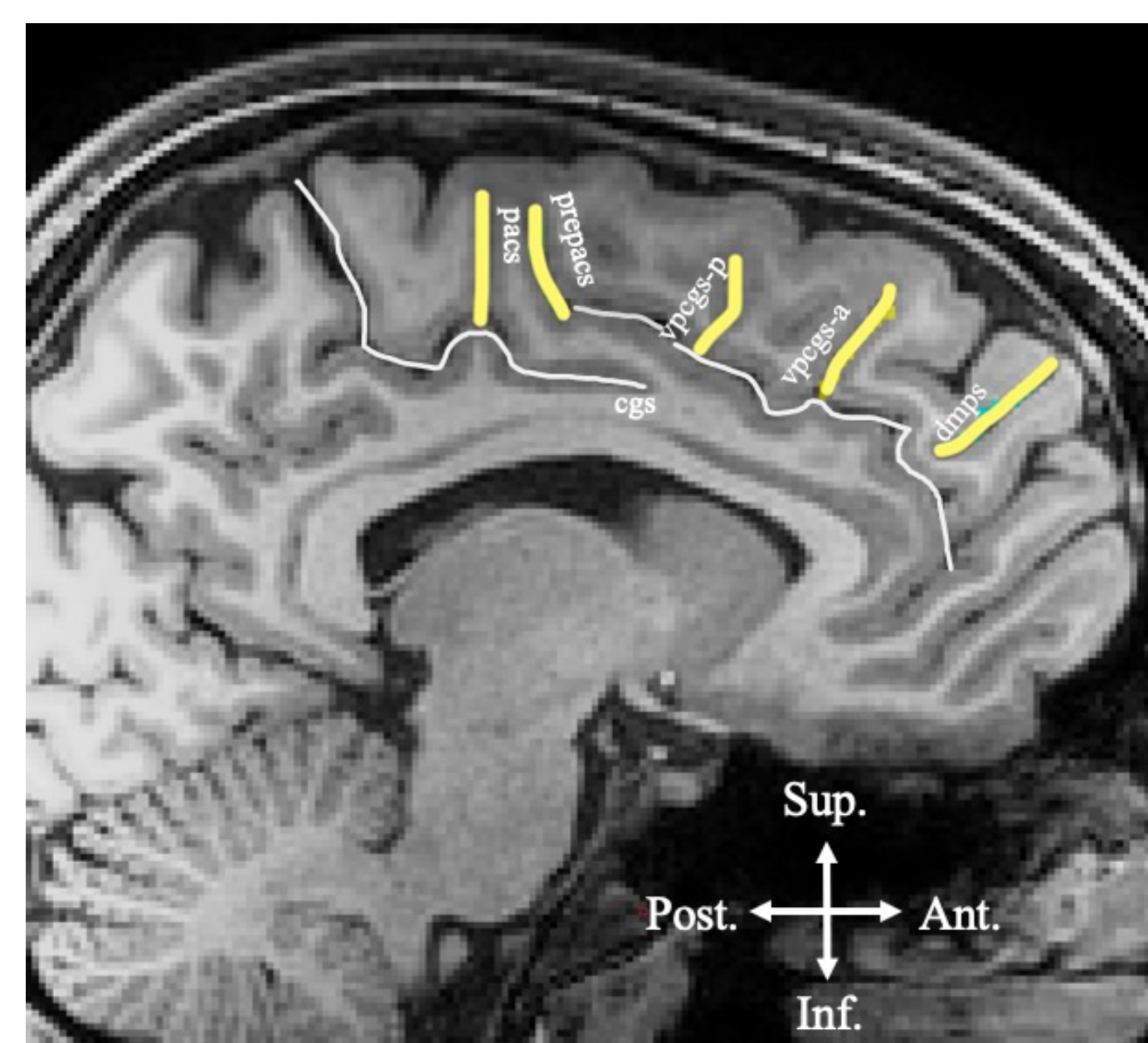
④ Statistical analysis using behavioral partial least squares (PLS)⁶

Results

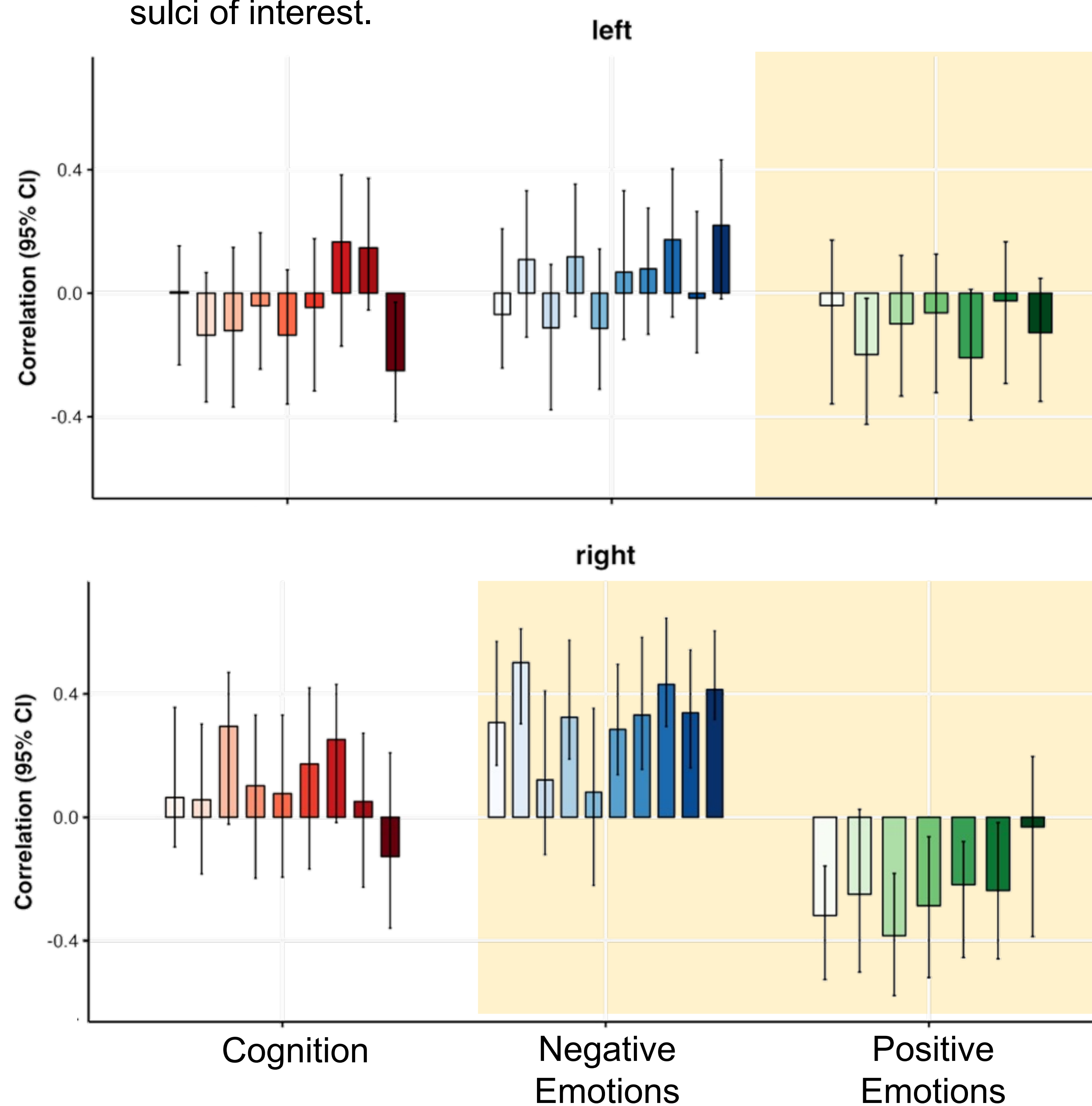
1. Networks are arranged along the posterior-anterior anatomical direction in the brain, from low to high along the functional hierarchy



Hierarchy of functional networks: Low-order to High-order. Anatomical direction: Posterior to Anterior.

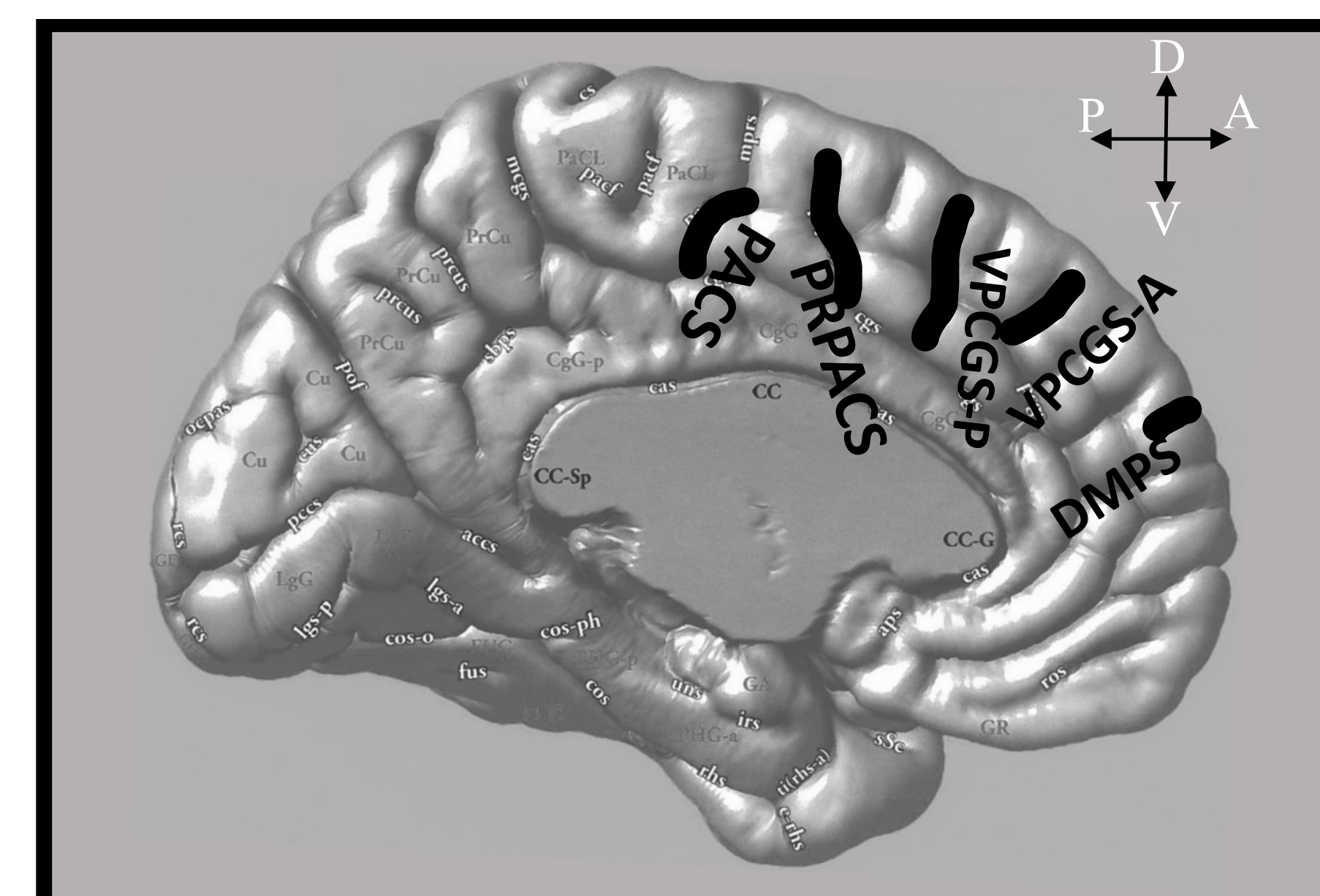
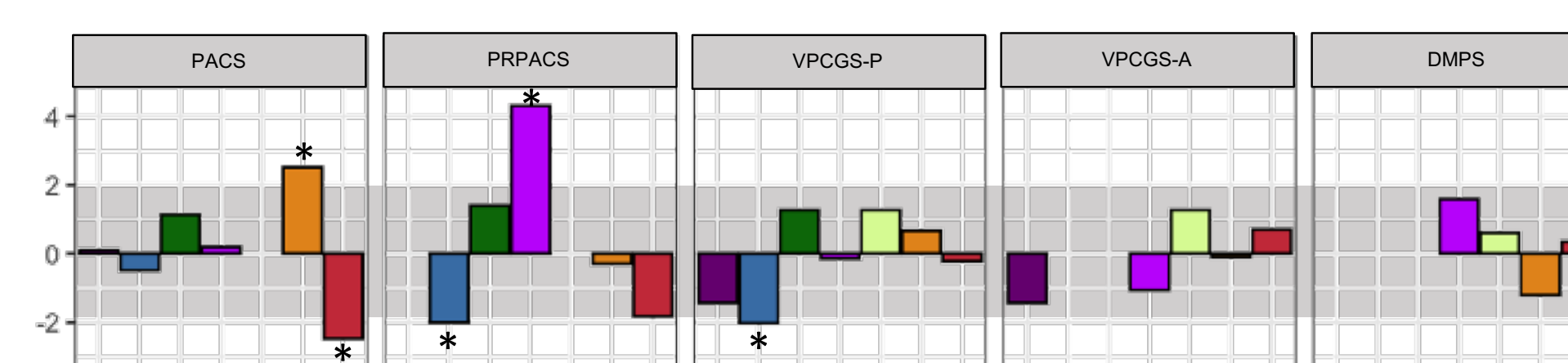


2. Negative and positive emotions are represented on different sides of the brain, and distinctively related to patterns of network layout with respect to sulci. Aspects of negative emotion are associated to the right brain only, positively correlated to the patterning of networks about the sulci of interest; aspects of positive emotion are independently represented in the right and left brain, negatively correlated to the patterning of networks about the sulci of interest.



Behavior PLS - Latent Variable 1

$p (<0.05) = 0.0419$, 22.96% covariance explained



The representation of higher order (Control, Default and Salience) networks in posterior parts of the dmFC are principal drivers of differences in emotion between people.

- | | | |
|-----------------|---|---|
| mmse | NIHEmo_Anger.Affect_CAT_TSCORE | NIHEmo_EmotionalSupport_SF_TSCORE |
| nihcog_cryst | NIHEmo_Anger.Hostility_SF_TSCORE | NIHEmo_Friendship_SF_TSCORE |
| nihcog_fluid | NIHEmo_Anger.PhysicalAggression_SF_TSCORE | NIHEmo_GeneralLifeSatisfaction_CAT_TSCORE |
| episodic_index | NIHEmo_Fear.Affect_CAT_TSCORE | NIHEmo_InstrumentalSupport_SF_TSCORE |
| semantic_index | NIHEmo_Fear.SomaticArousal_SF_TSCORE | NIHEmo_MeaningandPurpose_CAT_TSCORE |
| executive_index | NIHEmo_Loneliness_SF_TSCORE | NIHEmo_PositiveAffect_CAT_TSCORE |
| sdmt_oral_z | NIHEmo_PerceivedHostility_SF_TSCORE | NIHEmo_Self.Efficacy_CAT_TSCORE |
| ai_intdens_avg | NIHEmo_PerceivedRejection_SF_TSCORE | |
| ai_extdens_avg | NIHEmo_PerceivedStress_CAT_TSCORE | |
| | NIHEmo_Sadness_CAT_TSCORE | |

Conclusions

- The anatomy of the dmFC is highly influential on complex human behavior, such as the processing of emotions.
- Distinct patterns of relations between behavior, function and individual dmFC anatomy are revealed by this study. Behavior and network representation within sulci highlighted correlation patterns in the right brain between negative affect and network layout, explaining 22.96% of the differences in emotions between people.
- This study provided a thread weaving together how the two sides of the brain collaborate in shaping the way we handle emotions.
- Further understanding of the relationship between dmFC anatomy and function can help us predict behavior in the context of clinical psychology, or post-surgical, day-to-day managements of neurosurgical patients.

References

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