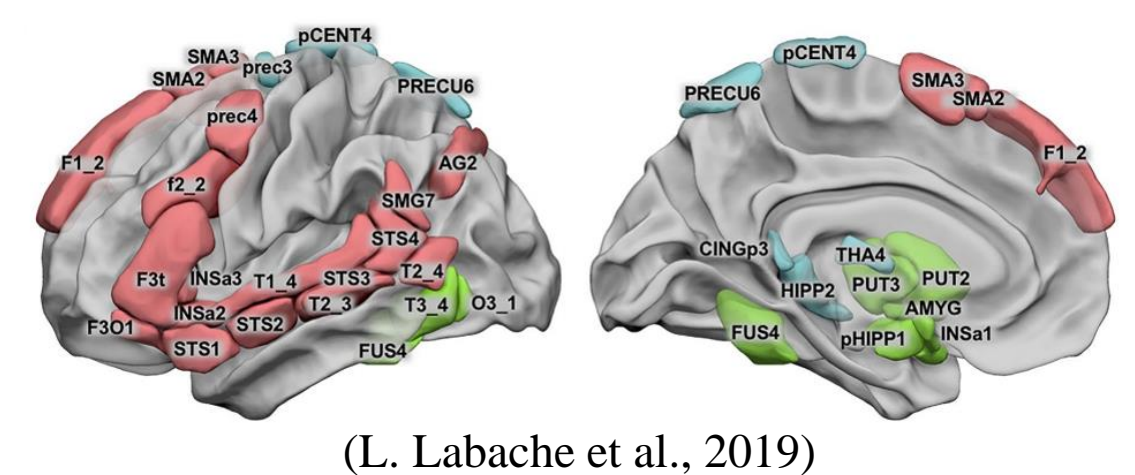# Lateralization of Language Brain Networks: A Graph Theory Study

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Introduction

◆ Previous work has revealed multiple distributed brain regions associated with language and they are typically located in the left hemisphere, showing a left-brain predominance.

◆ *L. Labache et al.* proposed an atlas of 32 language-related areas and divided them into three clusters.

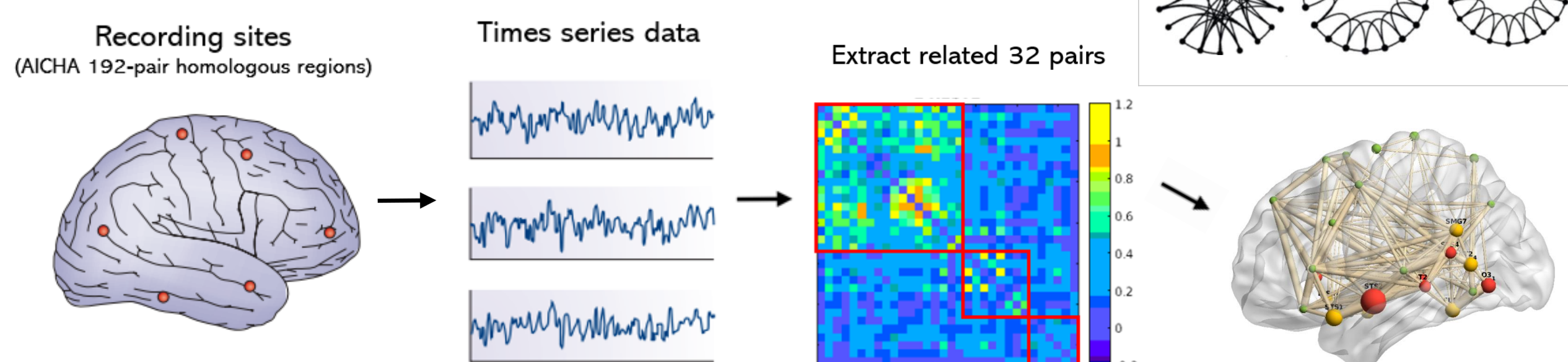◆ Graph theory can be applied in examining how these regions work together as a network.

(L. Labache et al., 2019)

➡ **Question:** Is there any substantial lateralization in the topological properties of language networks and how they related to behaviors?

Network Construction

Data
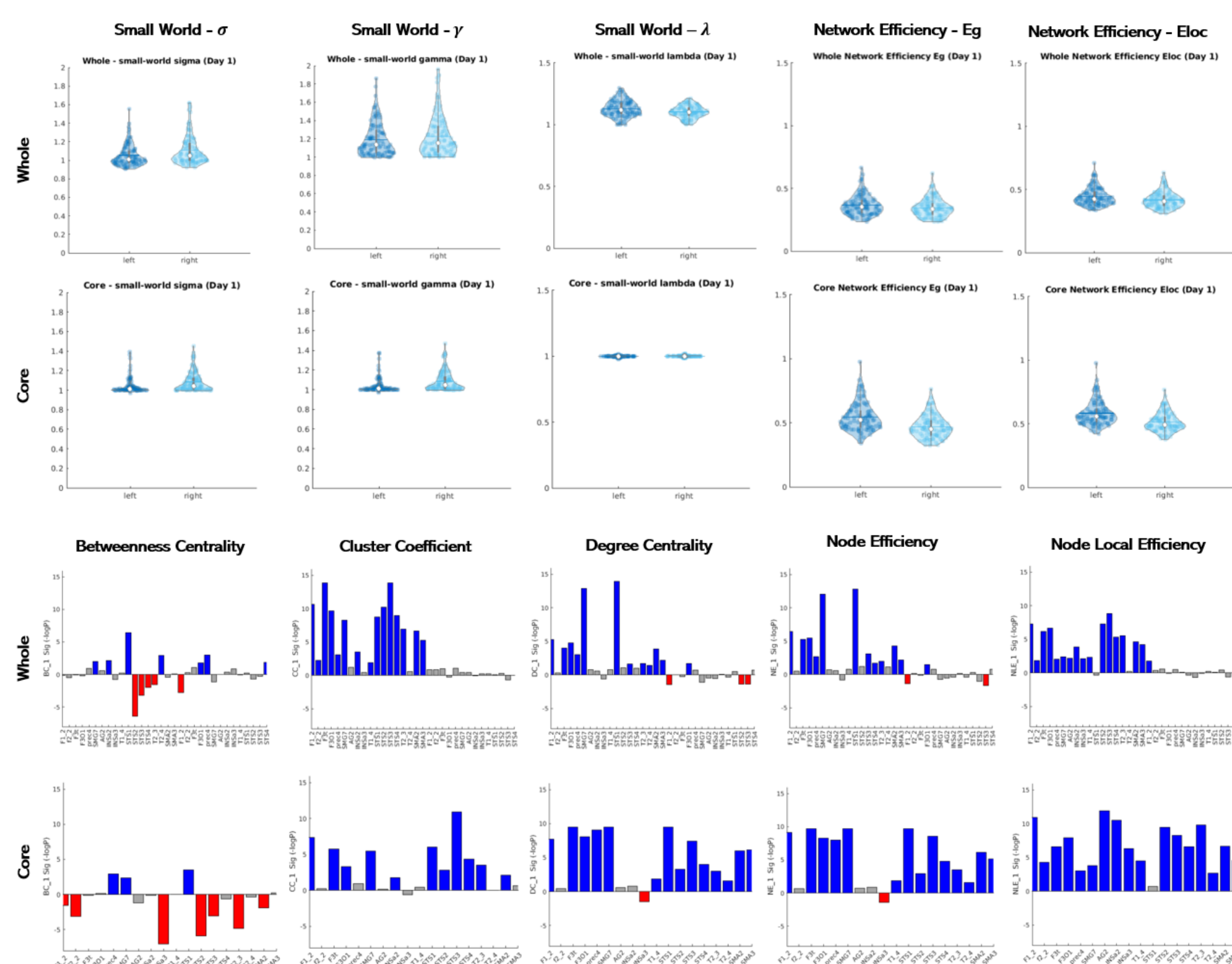
◆ 100 unrelated subjects from the Human Connectome Project (54 females; age: 29±3.7 years)

◆ Resting-state fMRI, preprocessed by HCP

◆ Additional preprocessing: remove first 10 images; spatially smooth; temporally detrend; regress out covariates; filter (0.071Hz~0.125Hz)

Process

Recording sites (AICHA 192-pair homologous regions) → Times series data → Pearson Correlation, Fisher z Transformation, Extract related 32 pairs
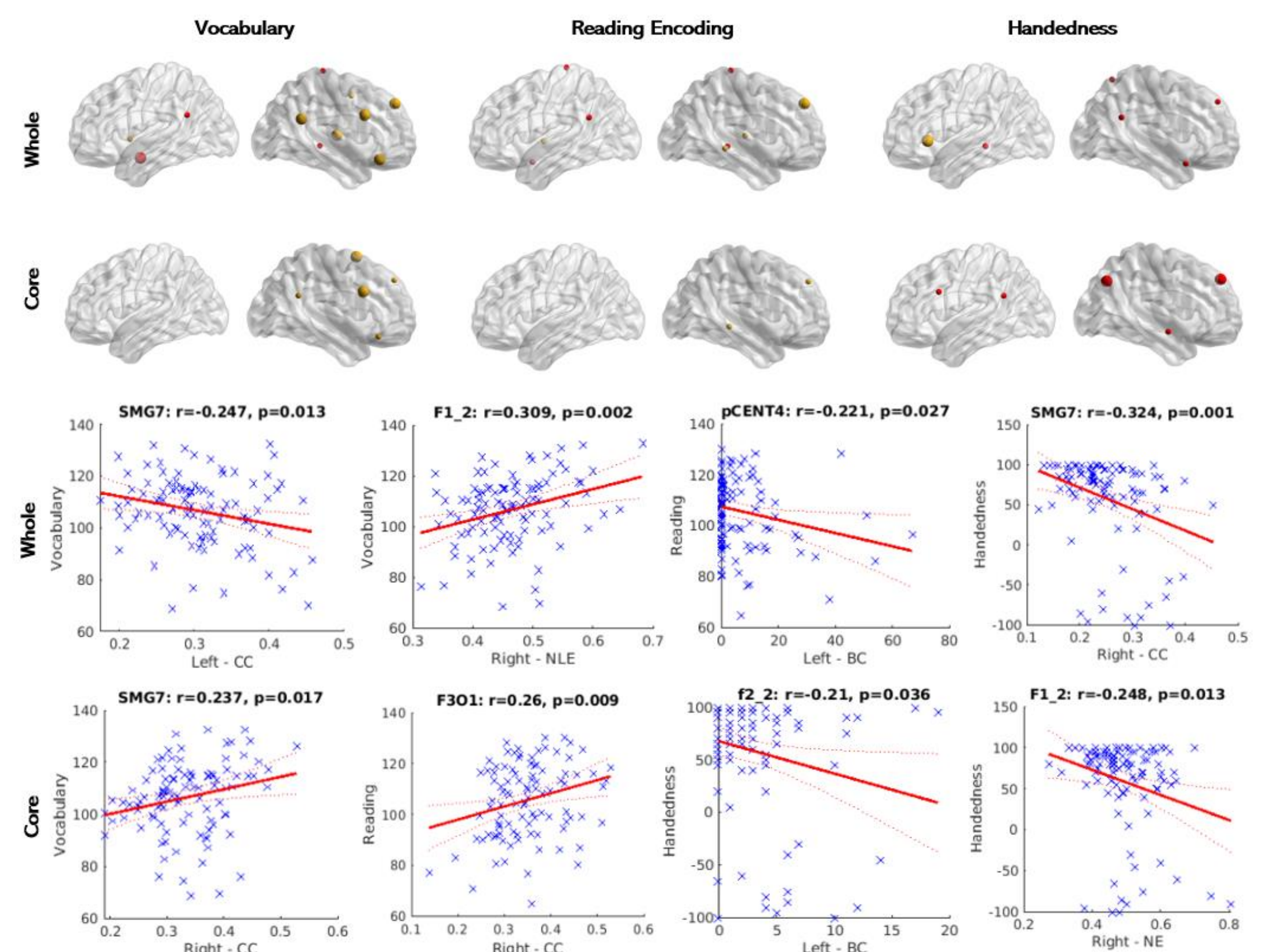
Random — Small-world — Regular

## Graph Theory Analysis

Network-/Nodal-level Differences

◆ Correlation threshold = 0.20 (to remove spurious correlations).

◆ Small-worldness σ was smaller in left general/core network but driven by larger λ ($p=0.002$) or smaller γ ($p<0.001$) separately.

◆ Repeated the analysis under various sparsity thresholds from 20% to 40% and results were similar.

Behavioral Correlations

Vocabulary — Reading Encoding — Handedness

SMG7: r=-0.247, p=0.013 | F1_2: r=0.309, p=0.002 | pCENT4: r=-0.221, p=0.027 | SMG7: r=-0.324, p=0.001

SMG7: r=0.237, p=0.017 | F3O1: r=0.26, p=0.009 | f2_2: r=-0.21, p=0.036 | F1_2: r=-0.248, p=0.013

◆ Network-level correlations: right core network λ & reading decoding ($r=-0.358$, $p<0.001$), left core γ & handedness ($r=-0.228$, $p=0.025$), left core small-worldness σ & handedness ($r=-0.216$, $p=0.031$).

◆ Nodal-level correlations: attributes showed various correlations with behavioral measures, mainly in the right hemisphere.

General language network — *Core language network*
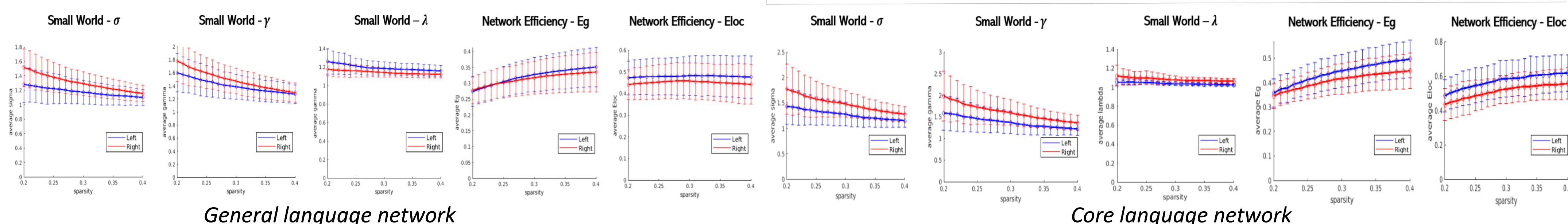
Conclusion

Language network in left hemisphere has smaller small-worldness and higher efficiency, and the left nodes are also more efficient and clustered with higher degree centrality. Interestingly, we found that more nodes in right network show significant correlations with language-related behaviors.

Reference

➢ L. Labache, M. Joliot, J. Saracco et al., ASENtence Supramodal Areas AtlaS (SENSAAS) based on multiple task-induced activation mapping and graph analysis of intrinsic connectivity in 144 healthy right-handers[J], 2019, Brain Structure and Function, 224: 859-882.

Future Work

Further replication of the behavioral correlations is needed.

Contact

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