

Is a whole insect brain connectome bilaterally symmetric?

A case study on comparing two networks

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Aimed to define bilateral symmetry for a pair of networks, and formally test this hypothesis.	Left and right hemispheres are significantly different under even the simplest model of a pair of networks	Left and right differ significantly in cell type connection probabilities, even when adjusting for the difference in density	Difference between hemispheres can be explained as combination of a network-wide and cell-type specific effects	Provided a definition of bilateral symmetry exhibited by this connectome, tools for future connectome comparisons
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Motivation

- Connectomes are rich sources of inspiration for architectures in artificial intelligence
- Comparing connectomes can help elucidate which structural features are necessary for yielding incredible capabilities animal intelligences

Larval *Drosophila* brain connectome

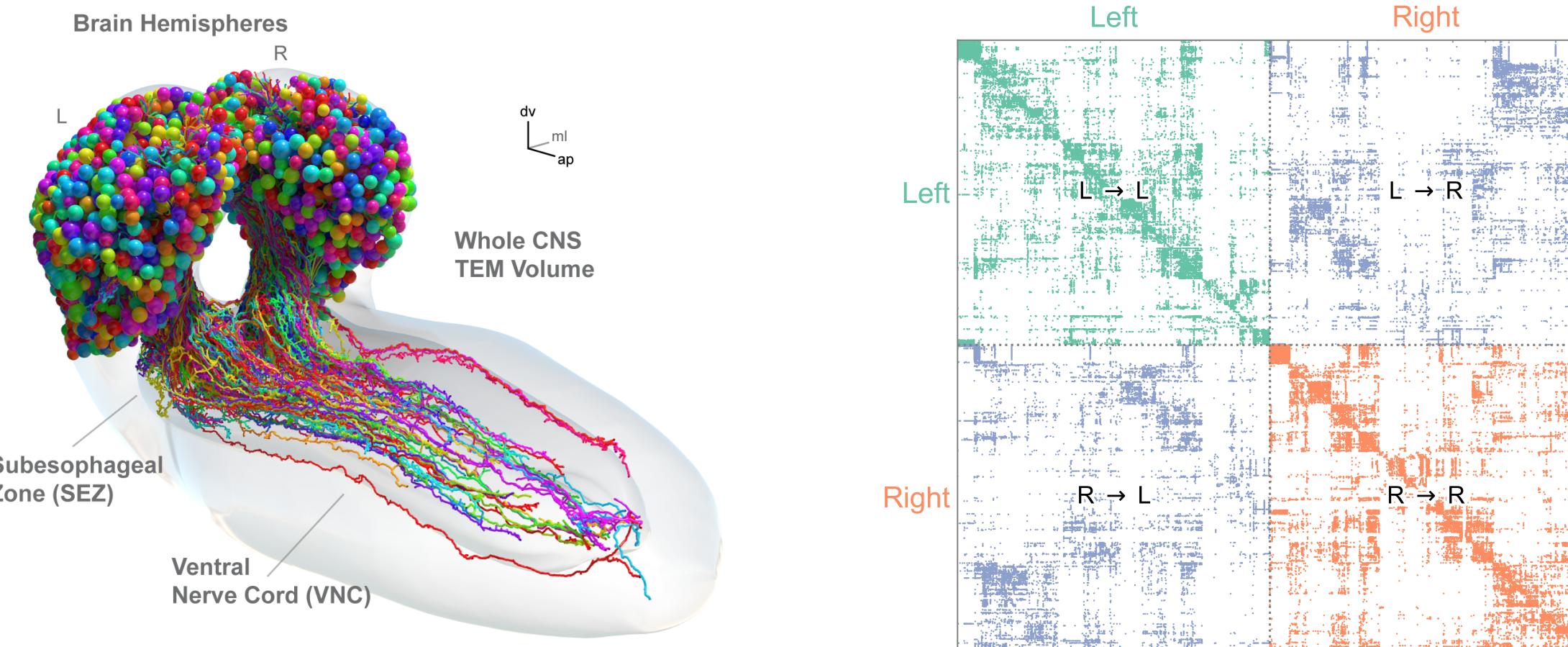


Fig 1A: 3D rendering of larval *Drosophila* brain connectome [1]. Dataset comprised of xxx neurons and yyy synapses.

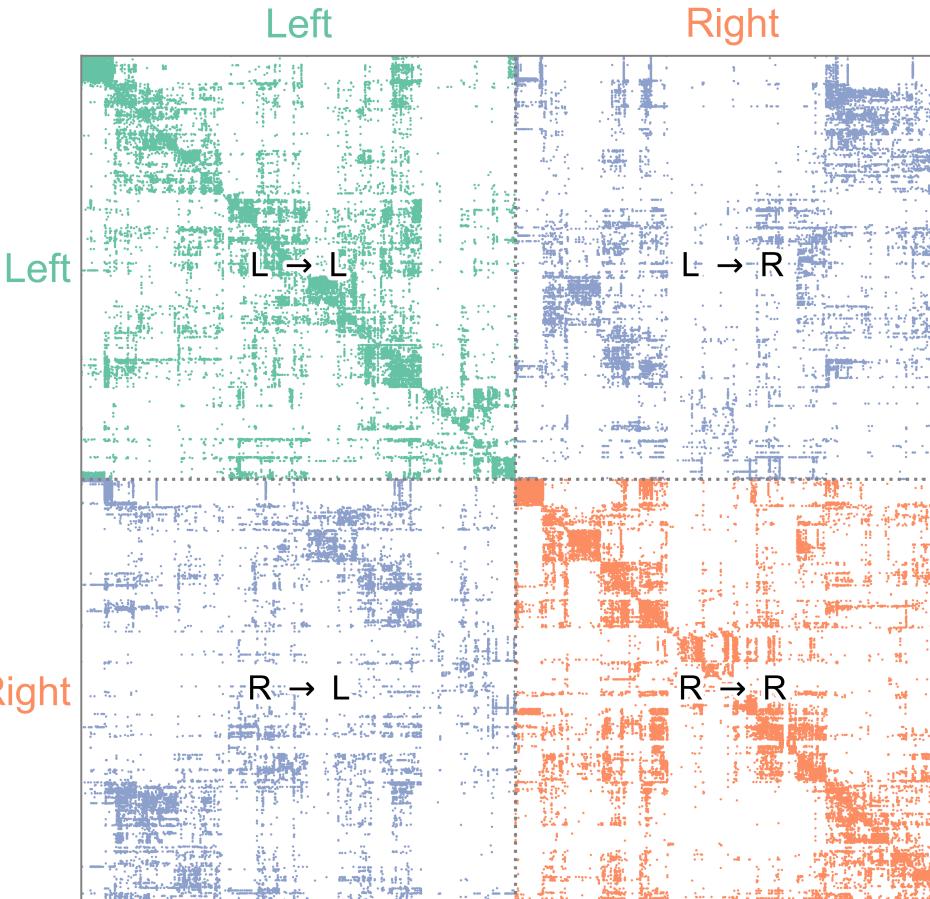


Fig 1B: Adjacency matrix sorted by brain hemisphere. We focus on comparing $L \rightarrow L$ vs. $R \rightarrow R$ subgraphs.

Are left and the right networks "different"?

Requires that we define what we mean by "different" for a network, and develop a test procedure for any definition.

Density testing

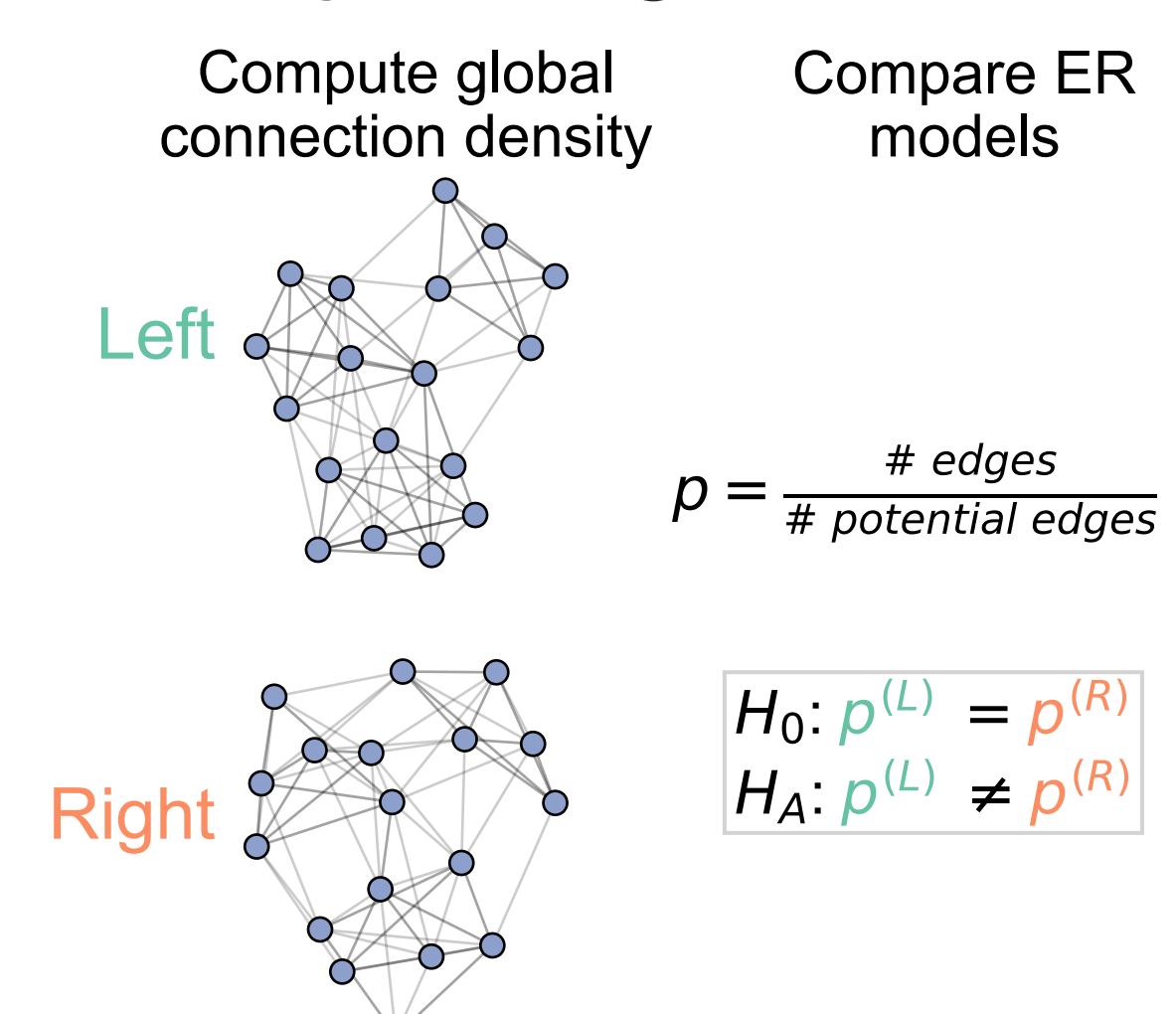


Fig 2A: Comparison of densities via Fisher's exact test

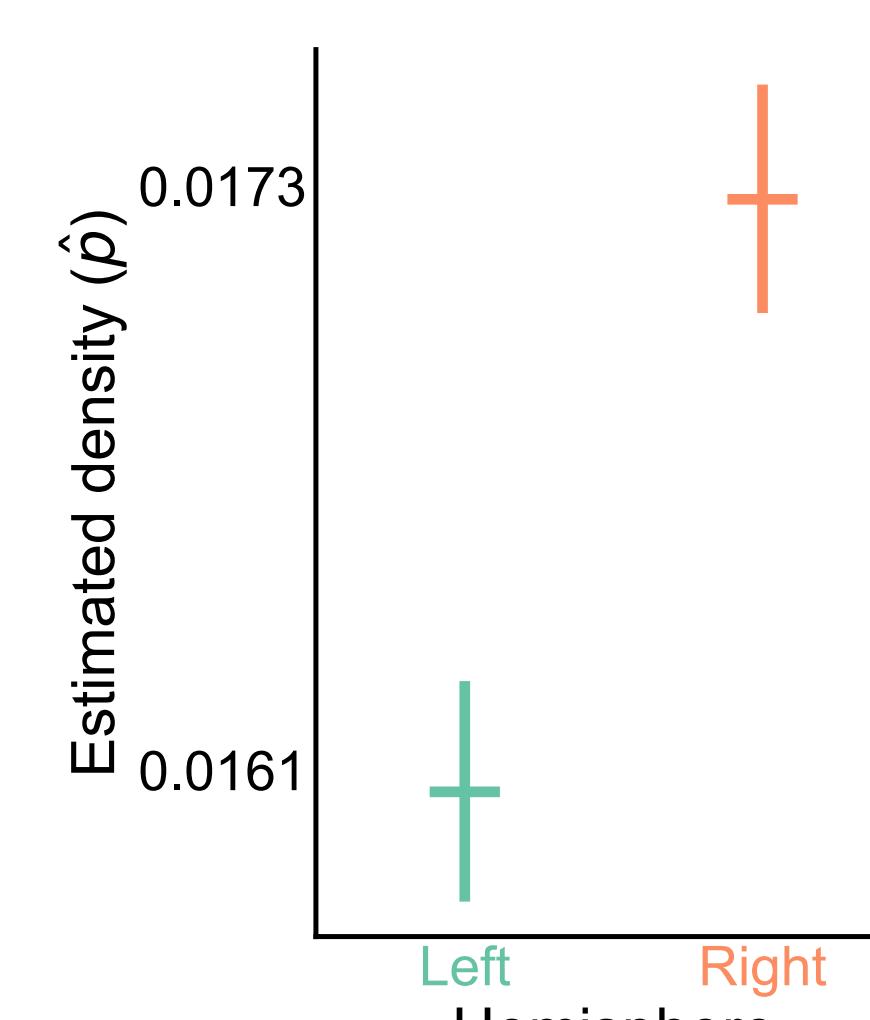


Fig 2B: Densities are significantly different between hemispheres ($p < 10^{-23}$)

Group connection testing

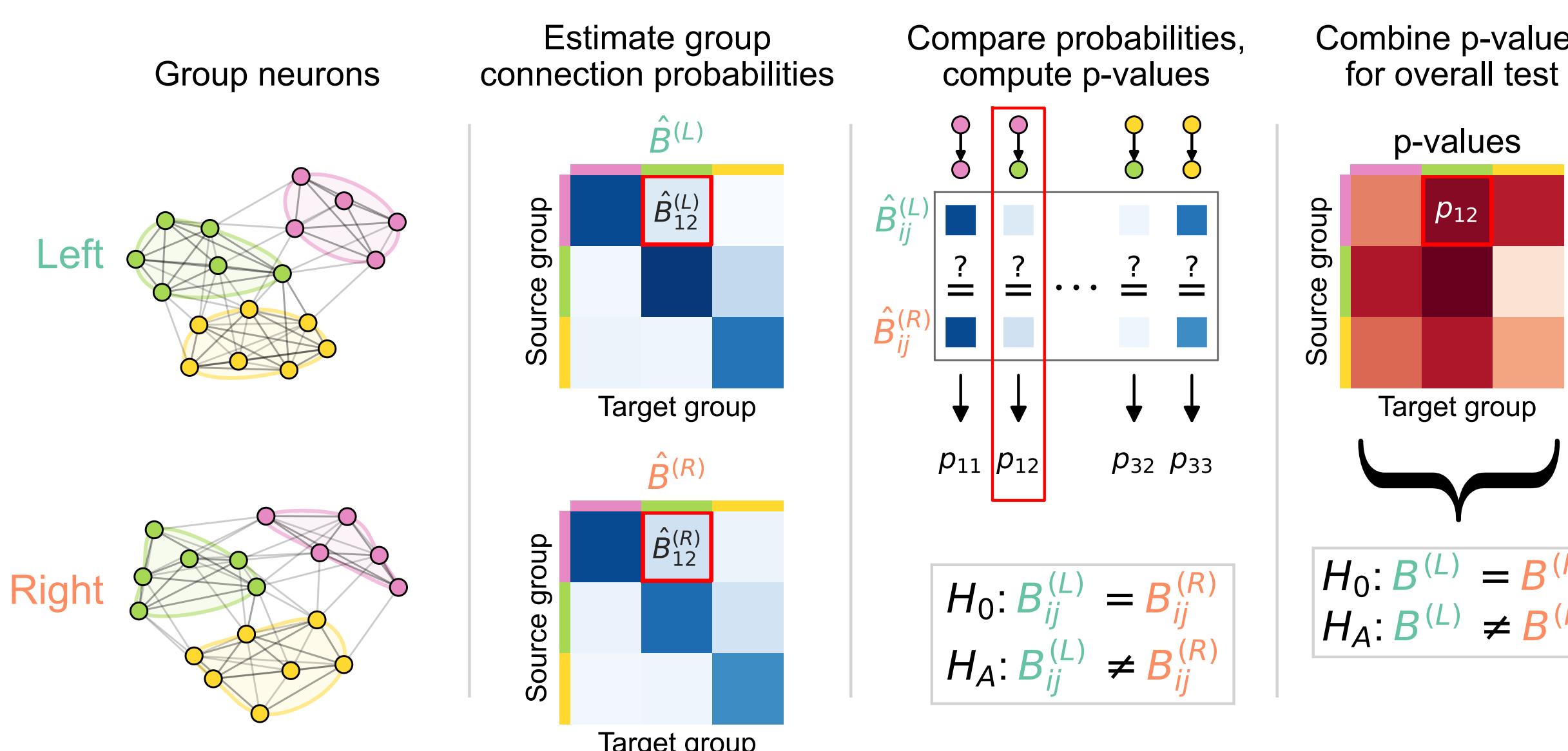


Fig 3A: Group connection testing fits SBMs using cell type partition. Group-to-group connection probabilities are compared (Fisher's exact test), p-values are combined (Tippett's method).

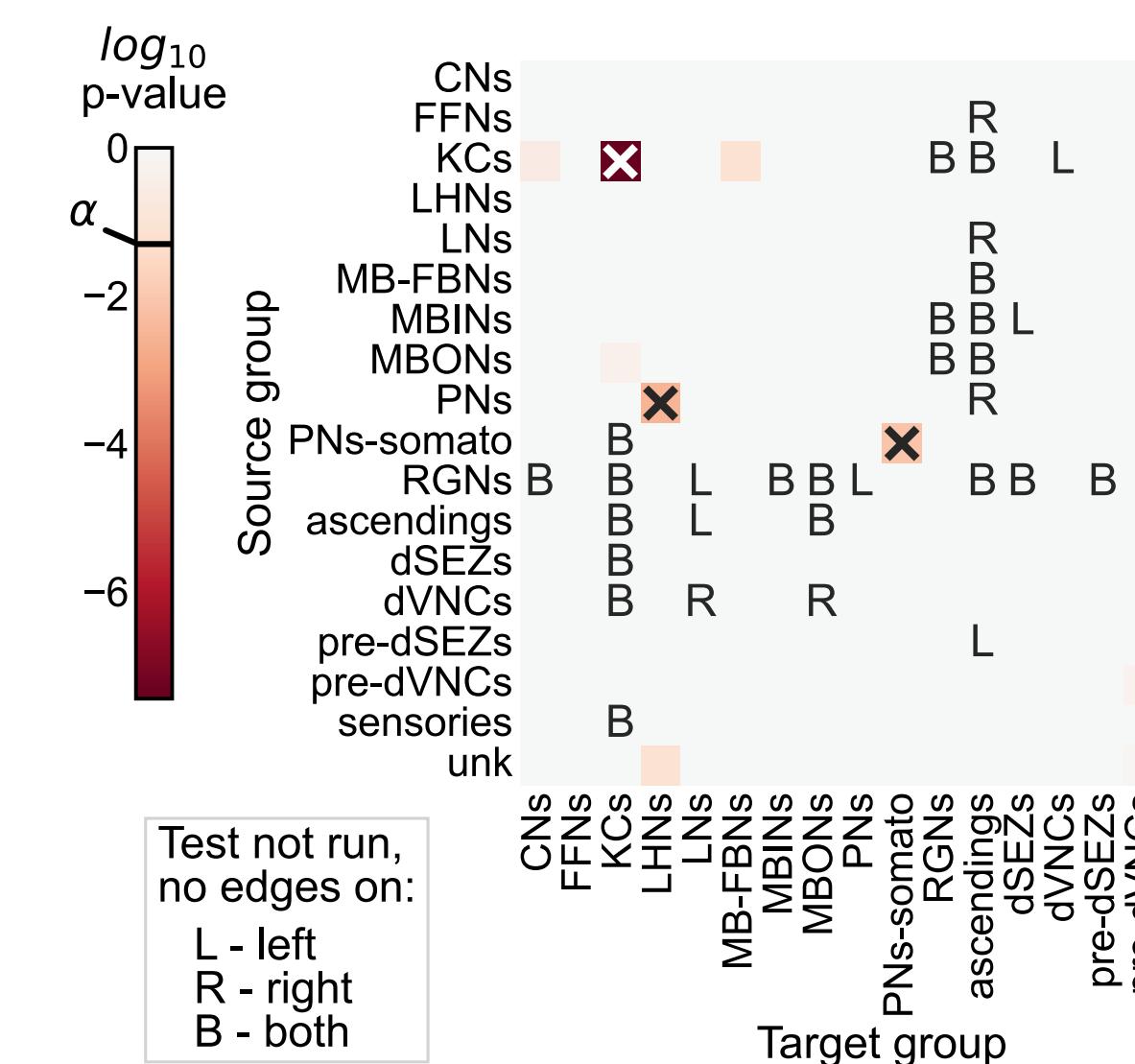


Fig 3B: p-values (multiple comparison corrected) for each group connection. 5 connections are < 0.05 , shown with "X"s.

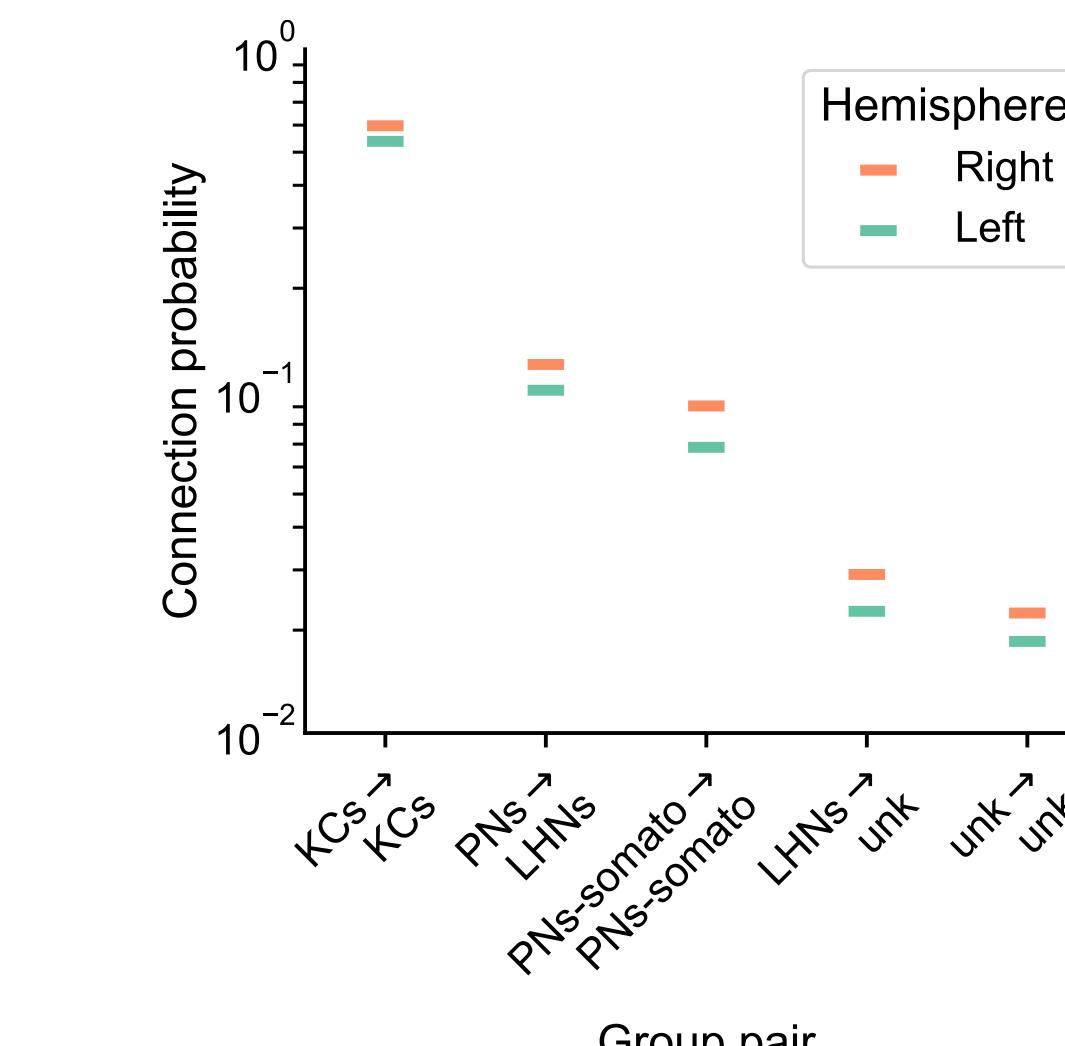


Fig 3C: Comparison of probabilities for significant connections. Probability is always higher on right side.

Density-adjusted group connection testing

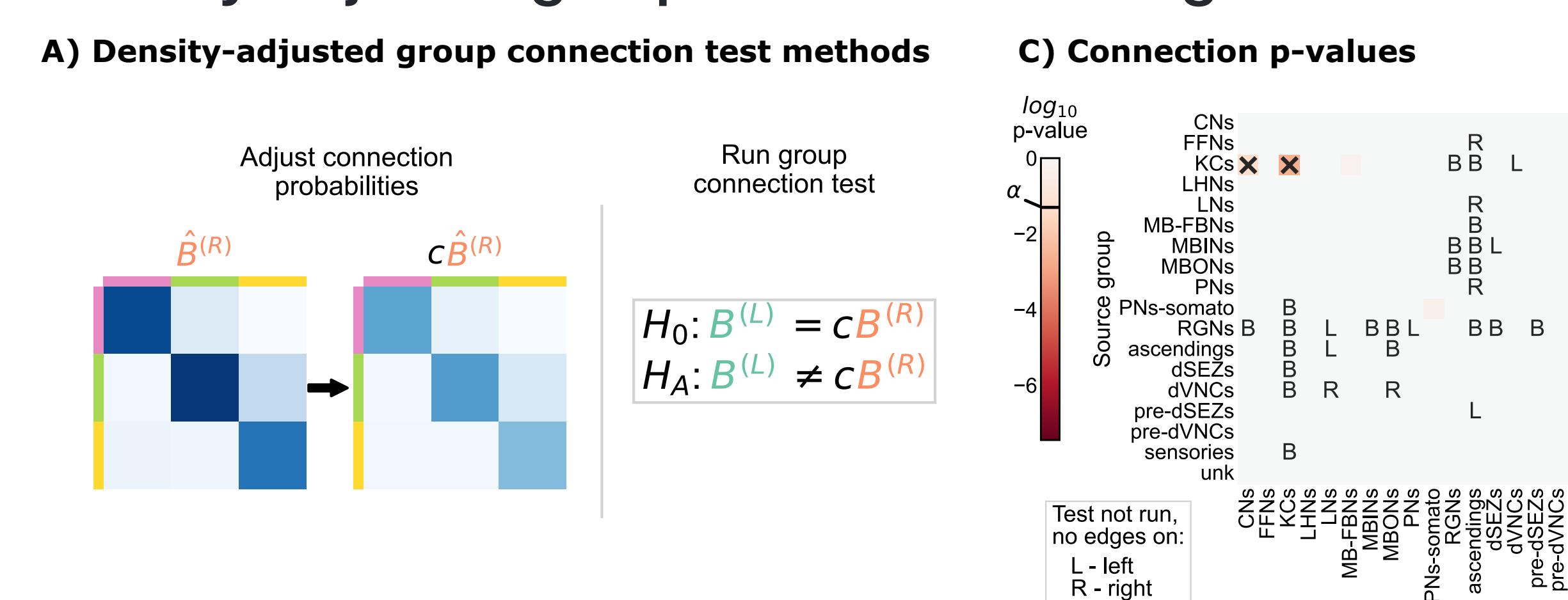
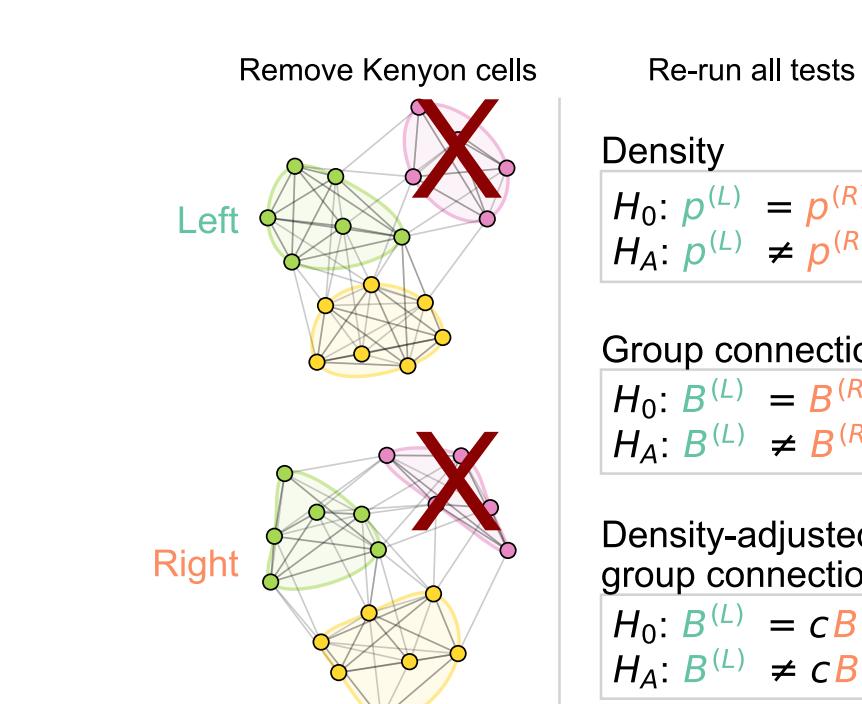


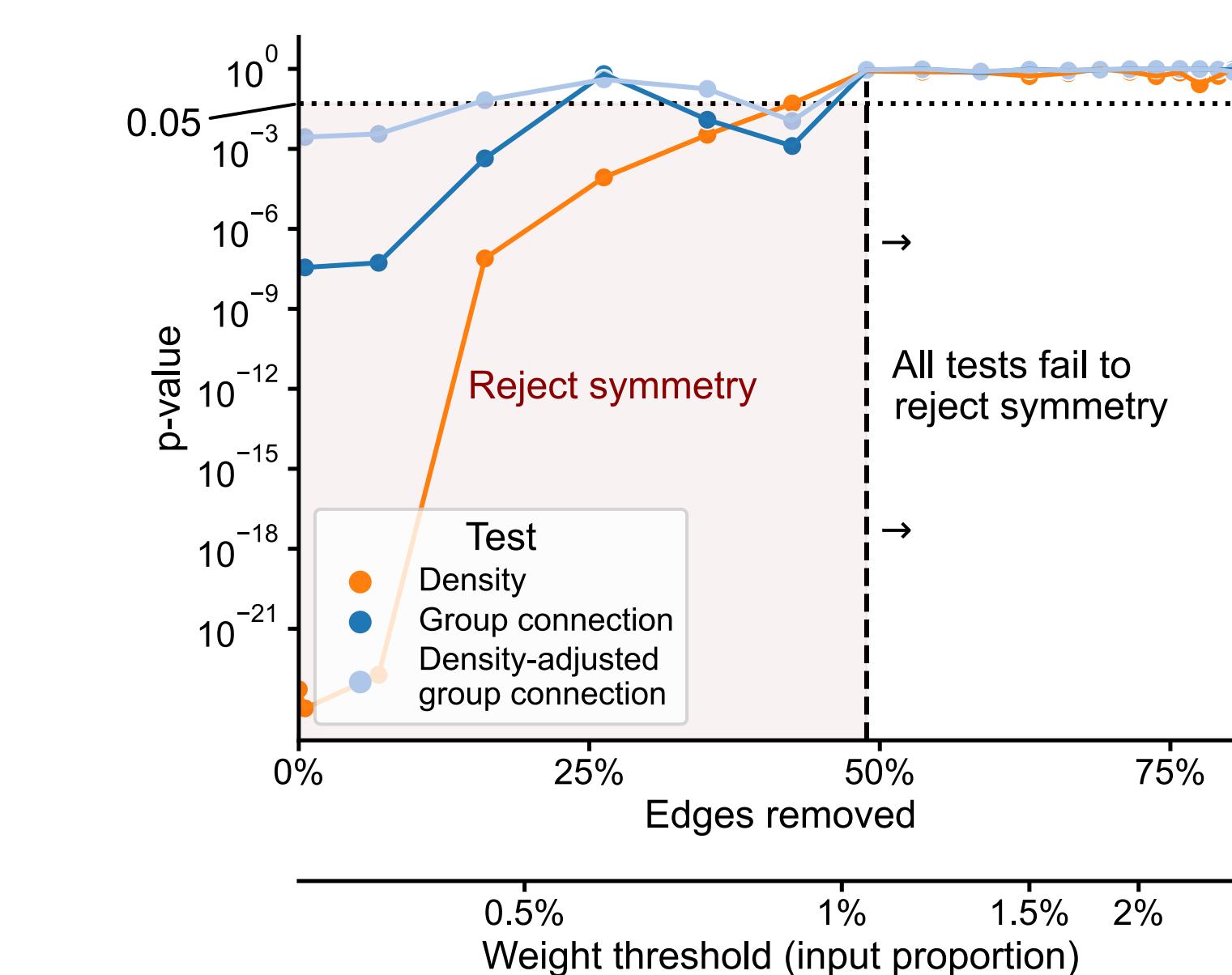
Figure x: Adjusted the hypothesis from figure

Removing Kenyon cells



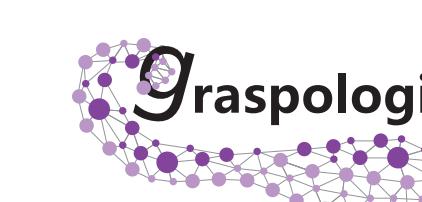
- Density test: $p < 10^{-26}$
- Group connection test: $p < 10^{-2}$
- Density-adjusted group connection test: $p \approx 0.5$

Edge weight thresholds



- some stuff about it
blah blah

Code



github.com/neurodata/bilateral-connectome

github.com/microsoft/graspologic

References

[1]: Winding, Pedigo et al. *The complete connectome of an insect brain* In prep. (2022)