# Network competition and reconfiguration during working memory processing

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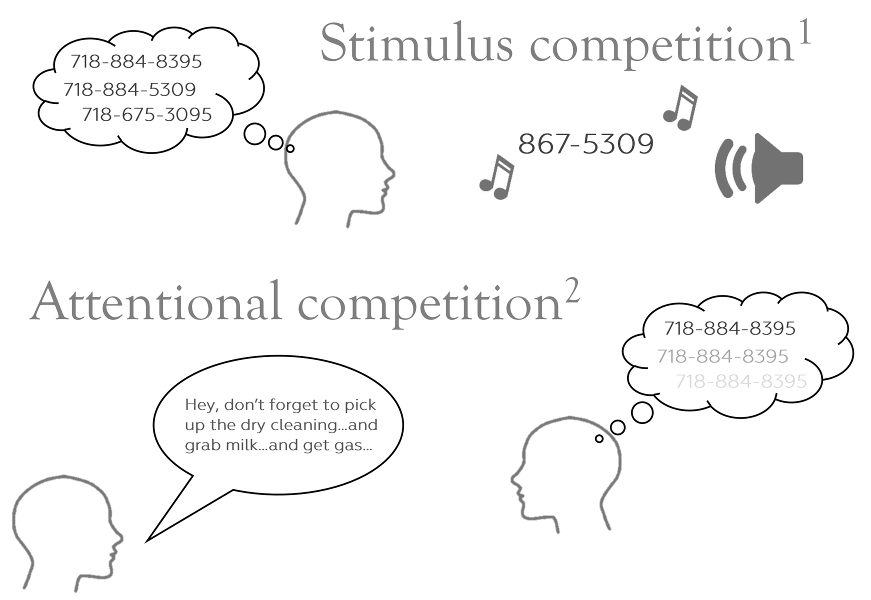
## Background

### WM and dual-task demand

Concurrent demands can impair working memory (WM) performance

WM disruption may come from several sources




### Network connectivity and reconfiguration

Measures of correlated fluctuations in fMRI BOLD signal (i.e., functional connectivity) can be used to describe large scale brain organization

Network connectivity structure (and it's reconfiguration with task demands) relates to behavior[3]

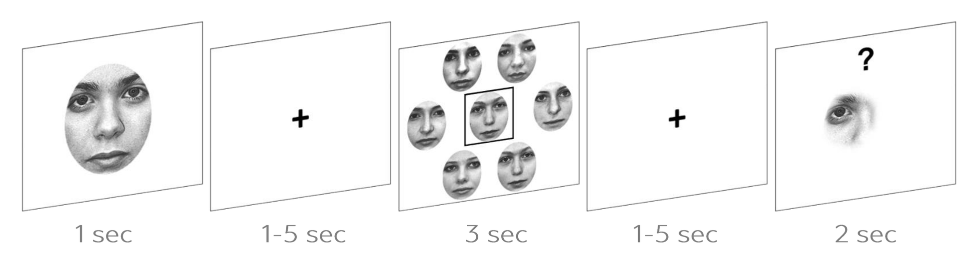
Segregated networks | Integrated networks

(higher modularity) | (lower modularity)

*Do distinct WM processing demands have unique or interacting influences on network segregation and integration?*

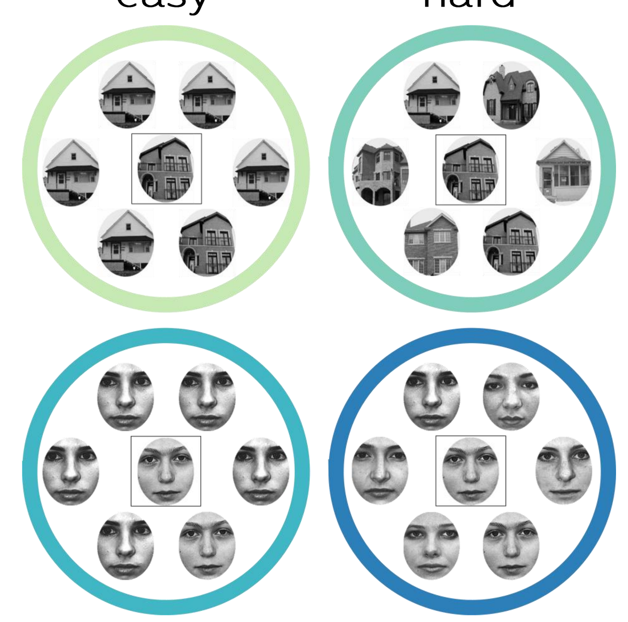
## Behavioral Task

During fMRI scanning:

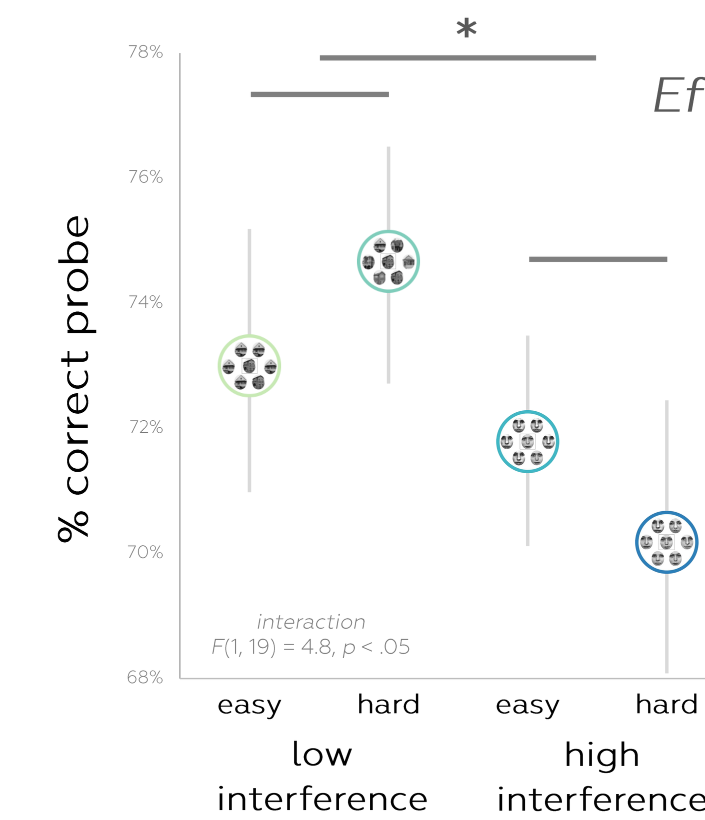



Manipulate attentional demand with and easier or harder intervening visual search

Manipulate stimulus interference with same or different category distractors




## WM accuracy




*Effect of search difficulty depends on stimulus interference*

*Worse memory when visual search stimuli are the same category*

***Click for other behavioral measures***

## Summary

Dual-task attentional demands can hurt or help WM performance depending on stimulus interference level

Whole brain networks become more integrated (i.e., connected) during greatest combined task demand

*Rostral frontal* nodes increase *between-network* connectivity, while ***parietal*** nodes increase ***within-network*** connectivity, with high dual-task demand

## fMRI Analysis

10 mins rest

10 task runs (× 24 dual-task trials per run)

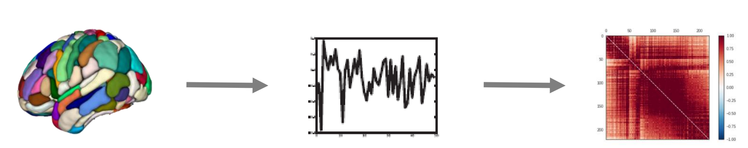
n = 18 (after exclusions for missing data)

***Click for univariate contrasts of:***

- High Interference > Low Interference
- Hard Search > Easy Search
- Interference x Search Difficulty Interaction

### Beta series connectivity[4]

Model individual trials, sort betas by condition



Parcellate into 264 nodes (Brainnetome atlas) → Extract beta-series from each node → Cross-correlate all nodes

### Graph metrics

Calculated using the Louvain algorithm (gamma=1), and community detection using consensus clustering (250 iterations) run on the un-thresholded, weighted, signed connectivity matrices

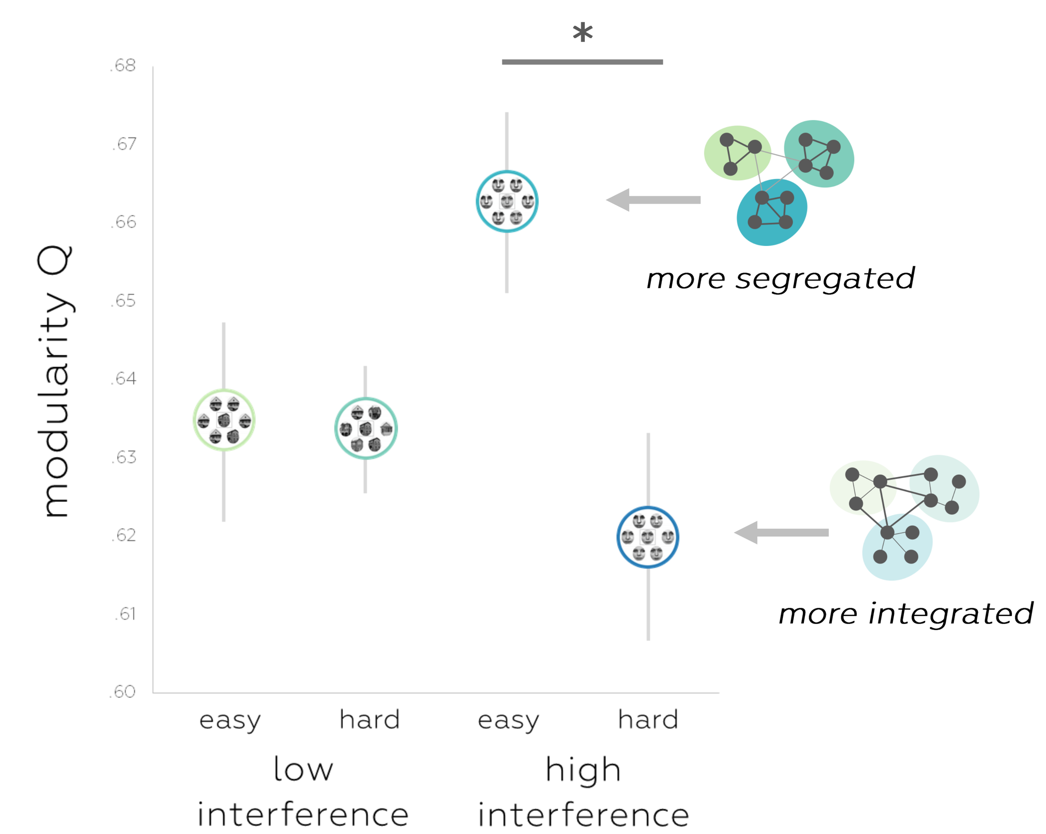
Q = modularity, strength of ***segregation*** into communities

PC = participation coefficient, strength of connectivity with ***other*** sub-networks

WMDz = within-module degree, strength of connectivity ***within*** node's own sub-network

## Whole brain network connectivity structure changes with task condition

***Click for community structure***




*Greater global network integration for hard search only when stimulus interference is also high*

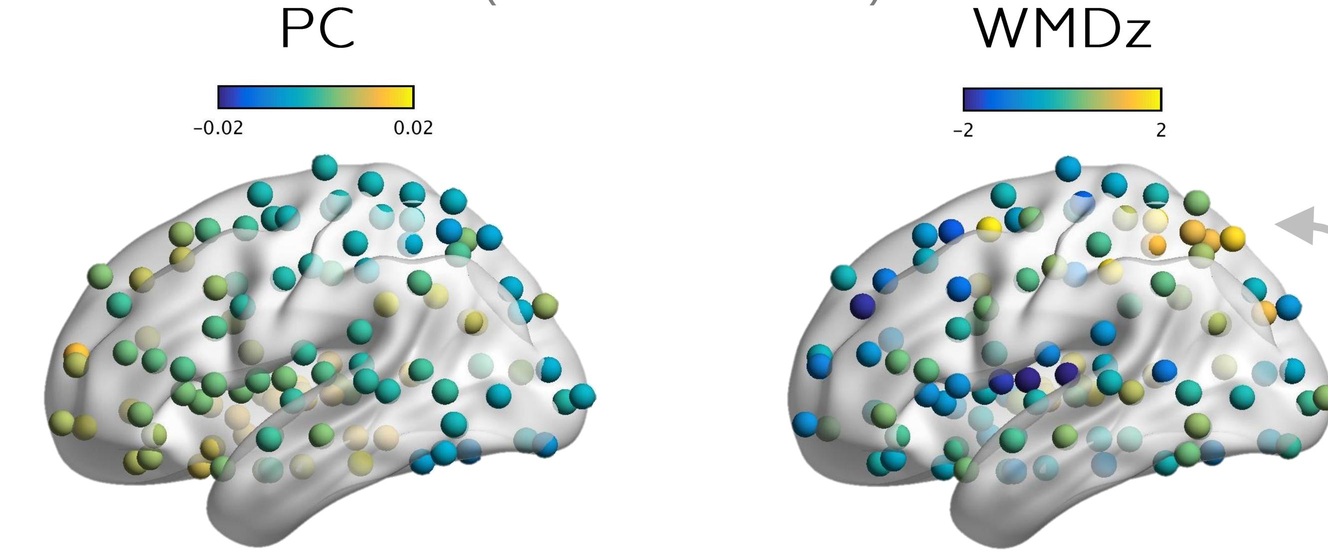
***Click for individual plots***

## Individual nodes change connectivity properties with task

Difference *between rest and task*

(raw time series)

***Click on brains for expanded views***

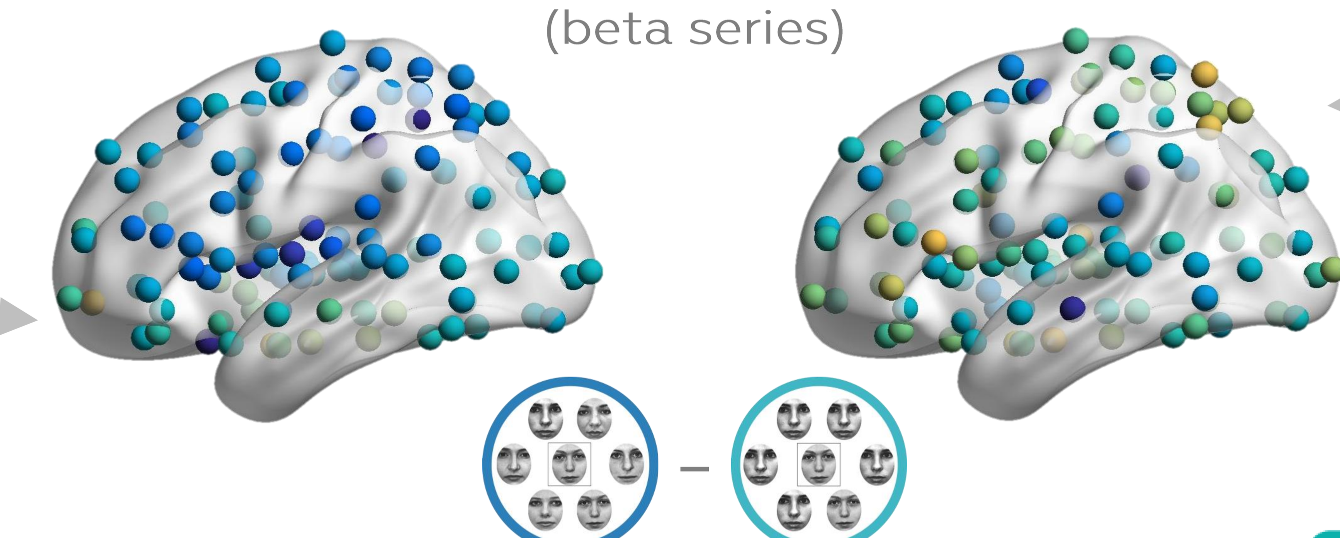



*Rostral frontal nodes show stronger connectivity across sub-networks, both from rest to task, and from easier to harder task*

Difference *across task conditions*

(beta series)

*Posterior parietal nodes show stronger connectivity within their network, both from rest to task, and from easier to harder task*



## References

1. Yoon, J. H., Curtis, C. E., & D'Esposito, M. (2006). Differential effects of distraction during working memory on delay-period activity in the prefrontal cortex and the visual association cortex. *Neuroimage*, *29*(4), 1117-1126.

2. Cohen, J. R., & D'Esposito, M. (2016). The segregation and integration of distinct brain networks and their relationship to cognition. *Journal of Neuroscience*, *36*(48), 12083-12094.

3. Barrouillet, P., Portrat, S., & Camos, V. (2011). On the law relating processing to storage in working memory. *Psychological review*, *118*(2), 175.

4. Rissman, J., Gazzaley, A., & D'esposito, M. (2004). Measuring functional connectivity during distinct stages of a cognitive task. *Neuroimage*, *23*(2), 752-763.

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