GRAPH THEORETICAL ANALYSIS OF BRAIN FUNCTIONAL CONNECTIVITY IN INITIATION AND INHIBITION TASKS

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INTRODUCTION

The brain is a complex network that transmits a large amount of information. Graph-based network analysis reveals meaningful information about the topological architecture of human brain networks, such as highly connected or centralized hubs (Farahani et al., 2019). Initiation and inhibition play an important role in our understanding of human behaviors and psychopathology. Several diseases have been found to be associated to deviations in the functional network topology (Stam & Reijneveld, 2007). By analyzing several core measures in graph theoretical analysis, the current study explores network properties of highly associated brain areas during initiation and inhibition tasks among healthy adults.

METHOD

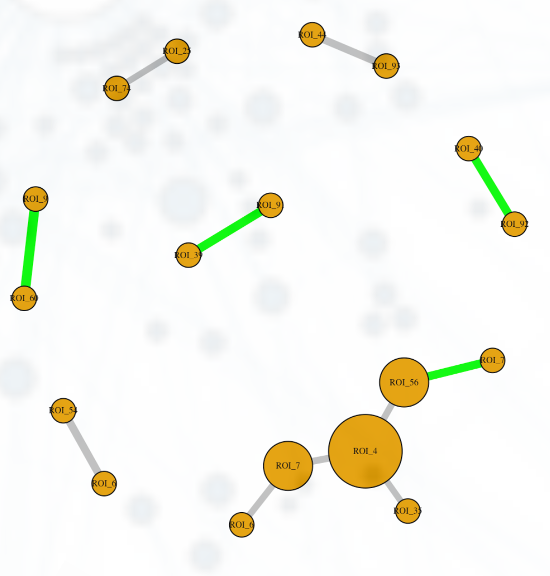
- We used publicly available dataset of functional connectivity matrices generated during initiation and inhibition (visual go/nogo paradigm) in 144 healthy adults (20 - 86yo) (Rieck et. al., 2021).
- We selected brain areas (ROIs) that showed high correlation (>0.75) from each participant's matrices.
- We input high incidents of functional connectivity among all participants into an incidental matrix.
- We generated a network graph with incidental matrix for each tasks with ROIs presenting as nodes (vertices) and their connections are edges.
- Core measures, such as degree distribution (the number of connections), mean distance (path length), within module degree z score (hub status), betweenness centrality (amount of influence a node has over the flow of information in a graph) and gateway coefficient (identify critical connections in modular networks) were analyzed.

ROI	Schaefer labels	Network
4	lh.VisCent.ExStr.4	VisCent
6	lh.VisPeri.ExStrInf.2	VisPeri
7	lh.VisPeri.ExStrInf.3	VisPeri
9	lh.SomMotA.2	SomMotA
25	lh.SalVAN.A.FrMed.1	SalVAN.A
35	lh.ContC.pCun.1	Cont.C
39	lh.DMN.A.PCC.1	DMN.A

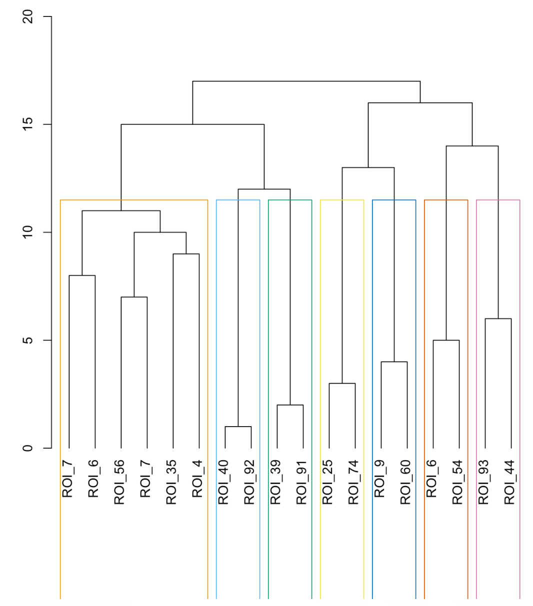
ROI	Schaefer labels	Network
40	lh.DMN.A.PFCm.1	DMN.A
44	lh.DMN.B.PFCd.1	DMN.B
54	rh.VisPeri.ExStrSup.1	VisPeri
56	rh.VisPeri.ExStrSup.3	VisPeri
60	rh.SomMotA.4	SomMotA
74	rh.SalVAN.A.FrMed.2	SalVAN.A
91	rh.DMN.A.PCC.1	DMN.A

GRAPH PLOTS

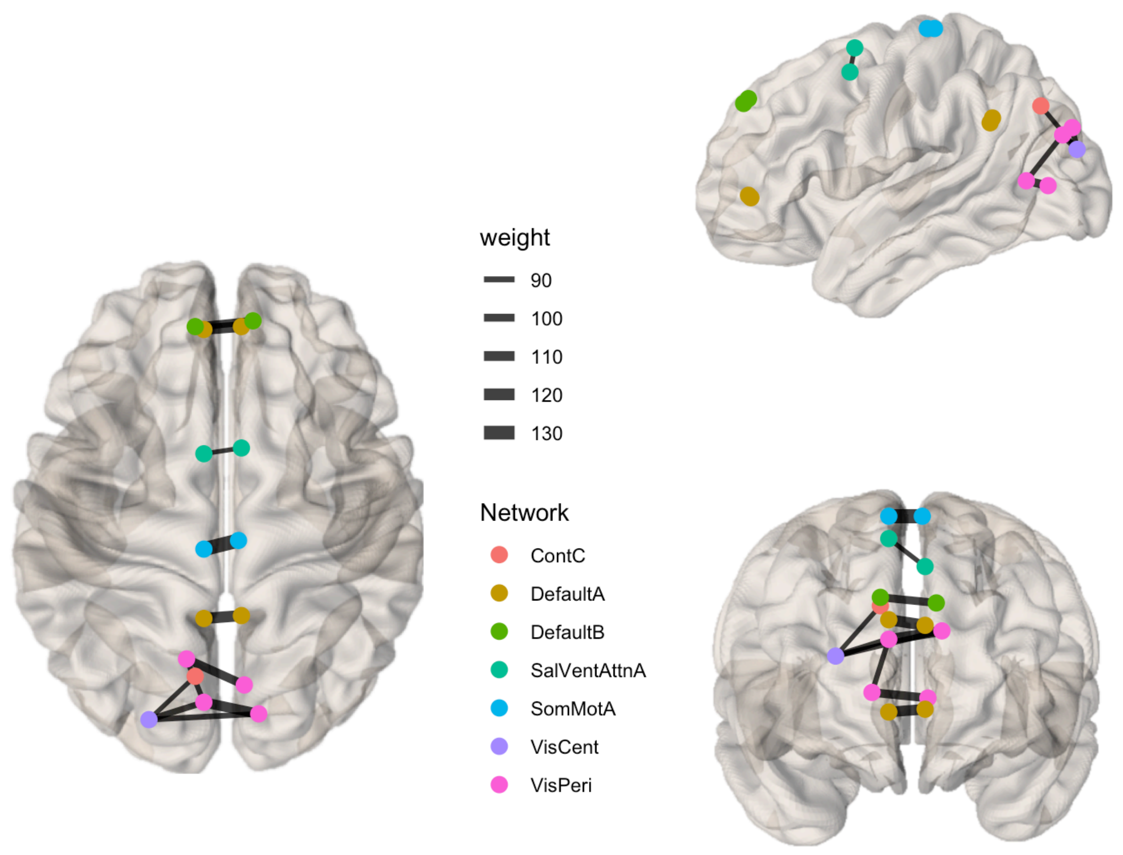
GRAPH



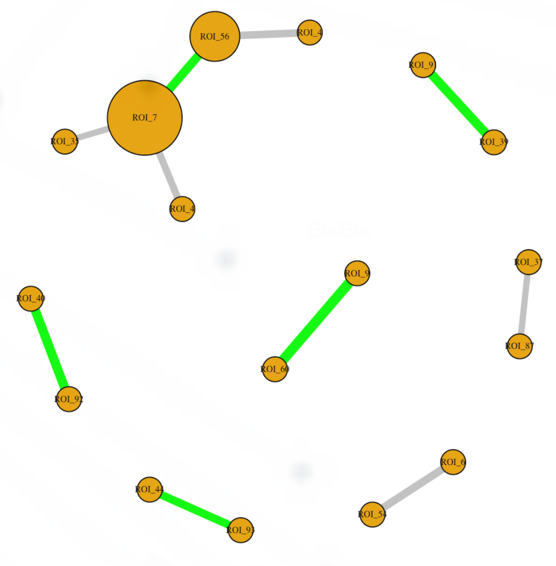
COMMUNITY



INITIATION



GRAPH



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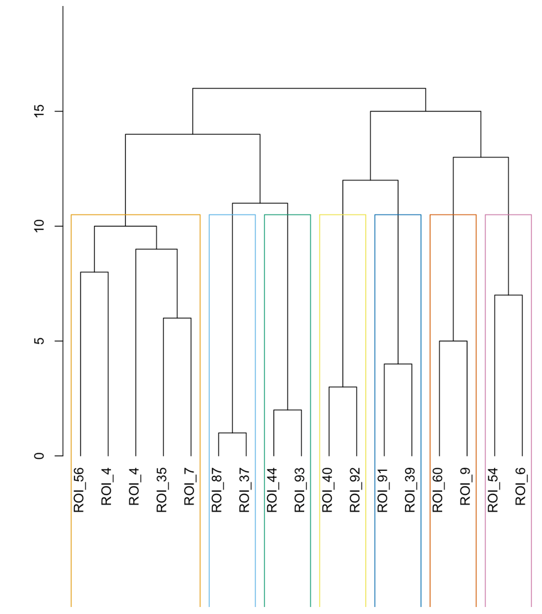
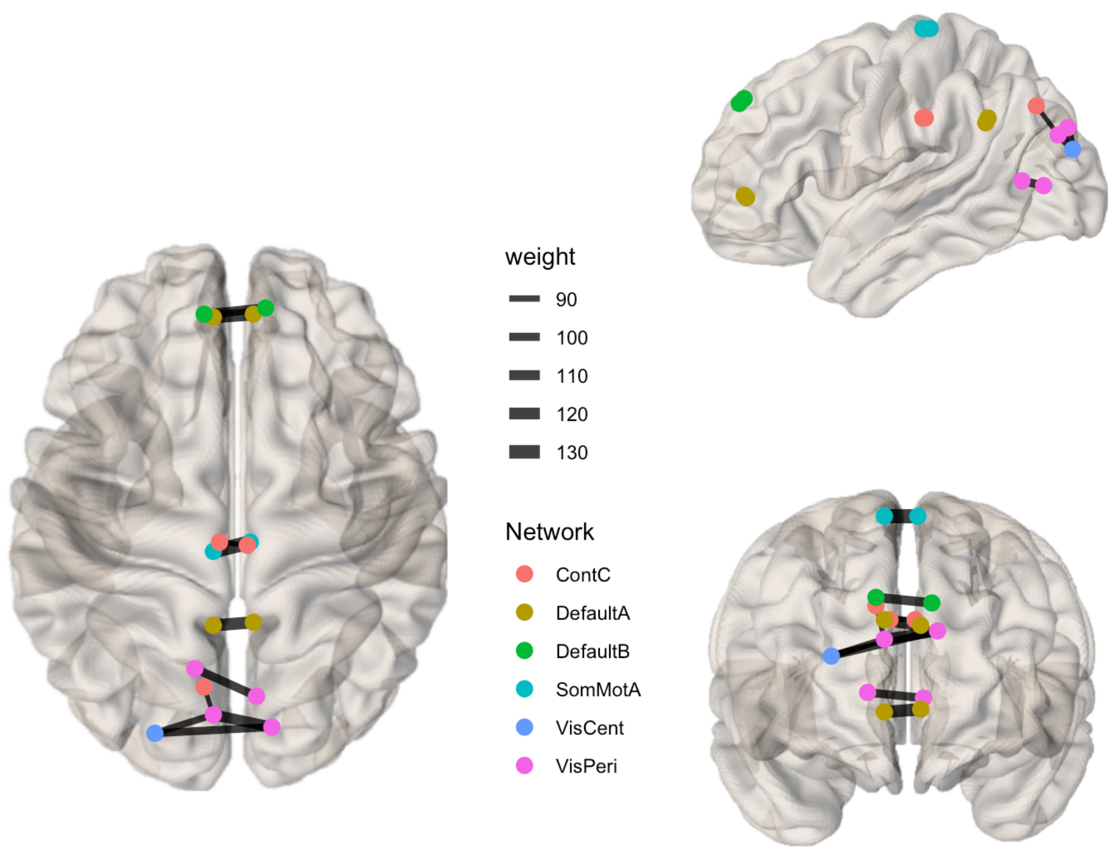


INHIBITION



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RESULTS & CONCLUSION

The present study revealed both tasks involved a disconnected network across several brain regions and several common brain areas activated during both initiation and inhibition. It highlighted differences in activation between the two tasks, and explored several areas that could be a "hub" during each task. Due to a small sample size, these results should be viewed as exploratory and need to be validated in future works.

- Both tasks shared common connections including somatomotor, default A, and peripheral visual networks.
- For the initiation task, the medial prefrontal cortex on both hemispheres were more frequently activated.
- Left hemisphere Control C network, specifically, left precuneus area was more connected to the visual networks when processing inhibition/initiation tasks.
- Comparing the two tasks, ROI 4, ROI 56 and ROI 7 showed high betweenness in the initiation task while only ROI 7 and ROI 56 showed high betweenness during the inhibition task.
- Due to visual cueing, ROI 4 or the Visual Central network appears to be the "hub" for initiation task.
- Similarly, ROI 7 or the Visual Peripheral network appears to be the "hub" for inhibition task.

CLINICAL IMPLICATIONS

Neurodevelopmental, neurocognitive and psychiatric disorders are associated with specific symptoms that may be partly a product of impaired initiation/inhibition such as ADHD, dementia and addiction. A disconnected network could be more vulnerable to cortical degeneration. Decreased task initiation and inhibition are often seen in patients with mild to moderate AD and bvFTD (Migliaccio et al., 2020; Cook et al., 2008). Measures involve visual cueing should consider the visual peripheral and visual central network's heavy involvements.