Cerebello-Striatal Resting-State Network Efficiency and Cortical Network Coherence

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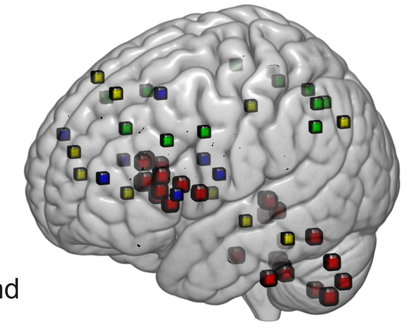
Subcortical network efficiency predicts task-positve network efficiency, but not default mode network efficiency.

Introduction

- Imaging studies have implicated disruptions in functional connectivity in subcortical and cortical resting-state networks in multiple pathologies[1] and healthy aging.[2]
- The cerebellum (CB) and basal ganglia (BG) each have distinct functional subregions that are functionally connected to cognitive and motor[3,4] cortical regions through discrete thalamic loops.[5]
- Previous work by Bostan & Strick (2018) suggests subcortical interconnectedness may be especially important for cognition and cortical connectivity.[6]
- We have previously shown CB-BG functional connectivity becomes asynchronous in older adulthood.[7] Compensatory cortical over-recruitment may be due to degradation of this network.
- It is unknown how subcortical functional connectivity relates to cortical functional connectivity; however, we hypothesize that subcortical regions provide a foundation for cortical processing.
- We predict subcortical resting-state network functional network coherence to correlate postively with task-positive networks and negatively with the default mode network.

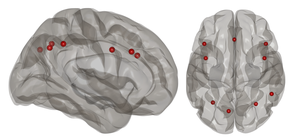
Method

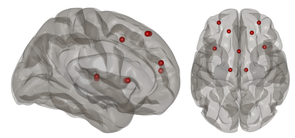
- Preprocessed resting-state fMRI Human Connectome Project[8] data (n = 233) were analyzed using Conn 19b.
- 60 ROIs were derived from previous results and included the cerebellum[9], basal ganglia[10], two task-postivite resting-state networks, and the DMN.[11]
- Network-level correlation coefficients (β > .15), were computed separately using multivariate regression for subcortical, DMN, and task-positive networks (fronto-parietal, and cingulo-operculum).
- Subcortical measures were correlated with DMN and task-positive network measures
  - *Global efficiency (GE), Local Efficiency (LE), Betweenness (B), Cost (C), Average Path Length (APL), Correlation Coefficient (CC), and Degree (D)*

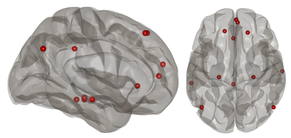


Visualization of the ROIs used for analysis. The color of the ROIs are as follows: Subcortical, red; Cingulo-operculum, blue; Fronto-parietal, green; DMN, yellow.

Results







	Fronto-parietal		*Cingulo-operculum*		*DMN*	
Subcortical *Cerebellum, Basal ganglia*	*GE*	***.22*****	*GE*	***.23*****	*GE*	*.08*
	LE	*-.06*	*LE*	*-*	*LE*	*-.05*
	B	*.08*	*B*	***.15*****	*B*	*-.00*
	C	***.21*****	*C*	***.21*****	*C*	*.11*
	APL	***.14*****	*APL*	***.17*****	*APL*	*.03*
	CC	*-.06*	*CC*	*-*	*CC*	*-.048*
	D	***.21*****	*D*	***.21*****	*D*	*.09*

*Note: Values presented are Pearson correlations coefficients (r). *p<.05 **p<.01 ***p<.001*

Discussion

- Multiple graph theoretical measures, including global network efficiency, show positive correlations with the task-positive networks and are generally in support of our hypothesis.
  - Subcortical network efficiency potentially supports task-positive networks as needed for processing.
- However, contrary to our hypothesis, no correlation with the DMN is found in these analyses.
  - Task-based fMRI may elicit different results with respect to the DMN and should be considered.
- This work has implications for understanding cortical network organization, as well as cortical-subcortical interactions in both health and disease.
- Planned future analyses with the same dataset will investigate age and cognitive performance as they relate to cortical-subcortical communication.

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