An RDoC framework integrating structural MRI with cognitive Control and Working Memory.

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- **Methodological Question Being Addressed**

We address the integration of structural MRI and neurocognitive measurements across multiple domains using Bayesian networks, without restriction to bivariate inference.

- **Introduction (Aims)**

The growth of biological psychiatry over the last 50 years has increased accessibility of measures at multiple levels from the genomic through neuroimaging of brain circuit structure and function to sophisticated assessment of cognitive and behavioral processes. The RDoC initiative aims to leverage our capacity to assess these underlying dimensions with the aim to provide stronger bases for biological psychiatry. Here, we identify structural MRI correlates of working memory (visual and spatial) and cognitive control (response inhibition) using Bayesian networks in 57 subjects without a DSM diagnoses.

- **Methods**

Composite measurements of visual working memory, spatial working memory, and response inhibition (Cognitive Control) were compiled by using exploratory structural equation modeling and bifactor analyses using the measurement instruments described in Table 1.

Screening/Diagnosis/Clinical Rating Scales	**WM**	**CC**
Neurocognitive Measures		
Verbal Memory and Manipulation Task	X	
Spatial Memory and Manipulation Task	X	
Verbal Working Memory Capacity Tasks	X	
Spatial Working Memory Capacity Tasks	X	
WMS-IV Symbol Span	X	
WMS-IV Digit Span	X	
WMS-IV Letter Number Sequencing (LNS)	X	
Stop-Signal Task		X
CNP CPT		X
Reversal Learning		X
Color Trails Test		X
Task Set Switching		X
Stroop Test		X
Attention Networks Task (Exec Center)		X
Delay Discounting		X
Balloon Analog Risk Task		X
NeuroImaging Measures		
Structural MRI volumes: (total brain, total cortical, DLPFC, VLPFC, PPC, total grey/white cortical and subcortical, Ventrofronto-striatal, hippocampal, thalamic, globus pallidus)	X	X

Table 1: Neurocognitive and neuroimaging measures used to assess working memory (WM) and cognitive control (CC).

Hierarchical cluster analyses was used to identify redundant variables with numerous outcome measures generated by each neurocognitive task. Next, exploratory bifactor analysis would be used to develop measurement models for each construct of interest, wherein the bifactor approach allows us to examine what a set of tasks share in common (general factor) and data-driven models for specific variance would allow us to examine relationships among neurocognitive variables that remain after accounting for the general factor.

Structural MRI data from 57 subjects was processed using FreeSurfer. Measurements were extracted for Left Cerebellum White Matter, Left Cerebellum Cortex, Left Thalamus Proper, Left Caudate, Left Putamen, Left Pallidum, Left Hippocampus, Left Amygdala, Left Accumbens area, Right Cerebellum White Matter, Right Cerebellum Cortex, Right Thalamus Proper, Right Caudate, Right Putamen, Right Pallidum, Right Hippocampus, Right Amygdala, Right Accumbens area, CortexVol, lhCorticalWhiteMatterVol, rhCorticalWhiteMatterVol, CorticalWhiteMatterVol, SubCortGrayVol, TotalGrayVol.

Finally, these measurements were integrated using a Bayesian network, where the most likely relationship spanning all dimensions were assessed without assuming given hierarchy or causality. This network was learned using the score-based method, connecting 29 nodes with 73 arcs, fit using the BIC for conditional Gaussian.

- **Results**

The optimized model connected many structural regions, and mapped the relationships among structural and functional regions, which we present below. Notably, we found that Impulsivity Self Report in the Cognitive Control domain is dependent upon gender, and Visual Working Memory is dependent on the left accumbens, gender, and response inhibition neurocognitive measures. The right putamen was conditioned on the Impulsivity Self Report.

- **Conclusions**

Our results suggest that Bayesian networks can be used to identify the dependencies between structural MRI measurements and brain regions.