Integrating Multimodal Neuroimaging Features to Predict Working Memory and Psychiatric Disability

#1124

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Background

- Working memory capacity (WMC) is positively correlated with higher order cognitive ability[1,2] and negatively correlated with psychiatric disability[3,4]
- A variety of structural and functional neuroimaging measures have been shown to correlate with individual differences in WMC
  - Most studies that investigate WMC only look at one type of neuroimaging measure, or within one psychiatric population
- Using a large sample (N=169) and an ensemble machine learning framework aimed at harnessing the informativeness of different neuroimaging feature classes[5,6], we predicted individual differences in working memory task performance, trait WMC, and psychiatric disability

Experimental Design

Research Domains Criteria (RDoC) inspired sampling

Care-Seeking (CS; N=116)

Non-Care Seeking (NCS; N=53)

N=169 participants
106 F, ages 21-45
(M=27.79, SD=5.19)

*All analyses conducted pooling across CS and NCS samples

Self-reported clinical symptomatology

Battery of 10 behavioral tests indexing working memory

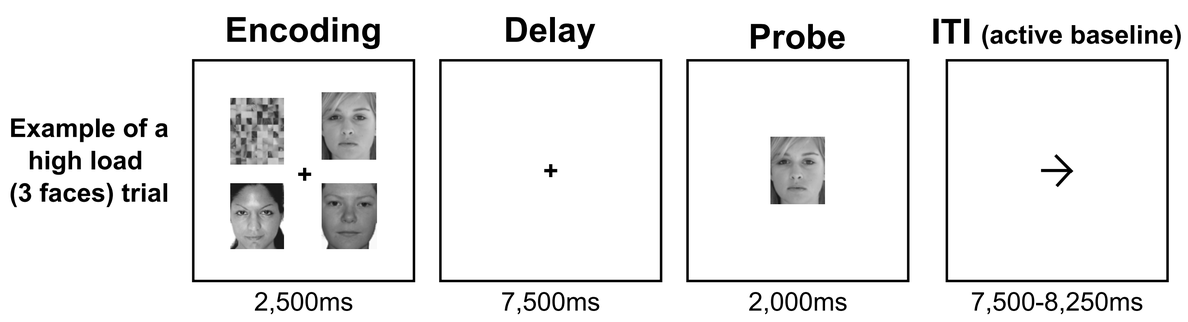
6 min resting state fMRI, Delayed Face Recognition Task, Structural MRI (MPRAGE, DTI)

Scanned on 3.0T Siemens Prisma (n=97) or Trio (n=72)
EPI Params: TR=1.5s,TE=34.2ms, voxel size = $2mm^3$, multiband acceleration factor = 4

Behavioral Measures

Delayed Face Recognition (DFR) Task Performance

- Delayed-match-to-sample working memory task requiring maintenance of either **1 face (low load)** or **3 faces (high load)**.
- 32 high load and 32 low load trials total (across 4 scanner runs); accuracy averaged into a single *DFR Task Performance score*



Working Memory Capacity (WMC)

- Exploratory Factor Analysis using *oblimin* rotation on 10 independent working memory tests identified latent factors capturing Visual and Verbal WMC

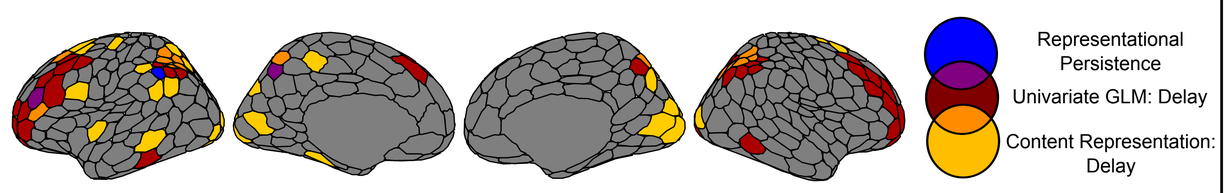
World Health Organization Diability Assessment Scale 2.0

- Scores summed across WHODAS used as index of psychiatric disability

Analytic Approach: Stacked Models

Analytic Approach: Feature Space

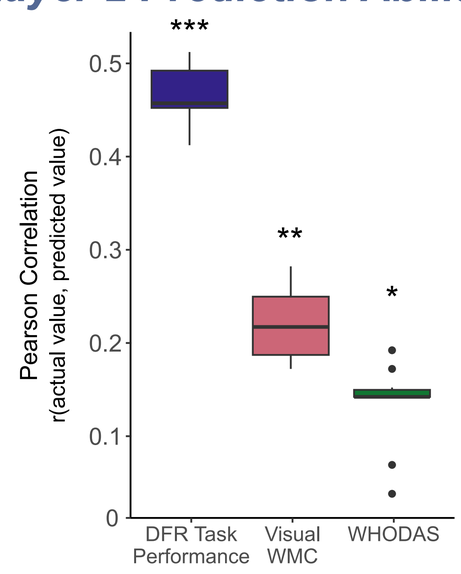
- Functional data parcellated into 400 region Schaefer atlas and restricted to regions that show **high > low** load effects in any task measure (FDR corrected)



- 84 regions across Control (37), Visual (15), Dorsal Attention (15), Default (9), Salience/Ventral Attention (8) and Somatomotor (1) networks identified
- Despite a high degree of spatial overlap in load effects across task fMRI measures, no single region showed load effects in all three measures

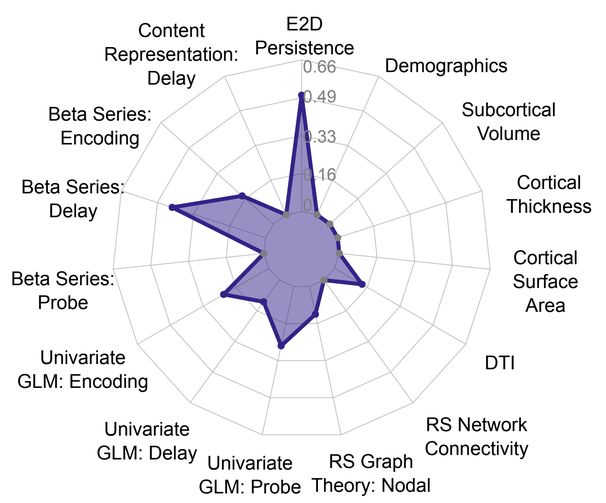
Results

Layer 2 Prediction Ability



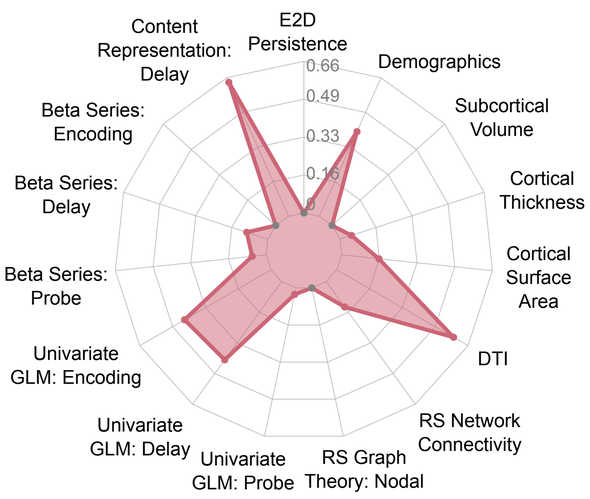
****p<0.001, **p<0.01, *p<0.05*

DFR Task Performance

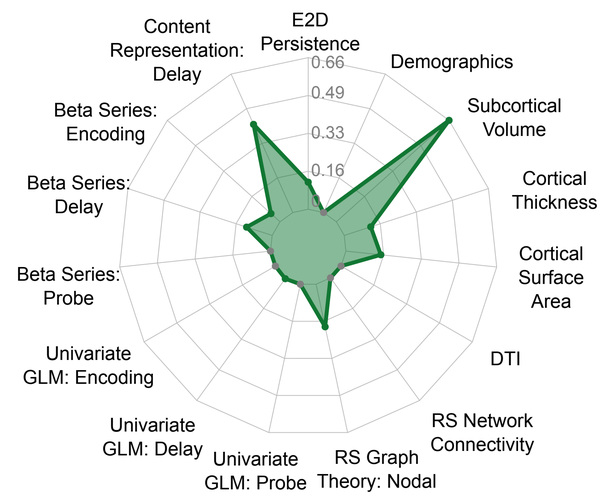


**Radar plots reflect Level 2 LASSO weights*

Visual WMC



WHODAS



- Pearson correlation between actual behavioral outcomes and predicted values from held-out test sets revealed that while stacked models could predict all behavioral outcomes, different neuroimaging features were retained for each model
  - DFR Task Performance mostly predicted by measures from task fMRI; Visual WMC was also predicted by structural MRI and resting state FC
  - fMRI features from DFR task that reflect maintenance of content over the delay period were retained in the model predicting WHODAS

Conclusions and Future Directions

- Machine learning models with multimodal feature stacking were able to significantly predict across-subject variance in all three behavioral outcomes
  - Diverse measures (including fMRI pattern similarity and task-based functional connectivity), not just delay period univariate GLM contrasts, are important for understanding individual differences in working memory
- Measures from the scanned DFR fMRI task are retained in models predicting psychiatric disability, suggesting potential utility as transdiagnostic biomarkers
- Future work will examine prediction of specific psychiatric symptom classes

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Funding: NIMH R01-MH101478, NSF DGE-2034835

Talk: Wed. 6/26 11:30-12:45
ASEM Ballroom 202