1:45 - 3:15pm
Friday, 3rd February, 2023
Pacific Ballroom E

Moderated by: Derin Cobia

1 Task-Based Functional Connectivity and Network Segregation of the Useful Field of View (UFOV) fMRI task

Jessica N Kraft[1], Hanna K Hausman[1], Cheshire Hardcastle[1], Alejandro Albizu[1], Andrew O'Shea[1], Nicole D Evangelista[1], Emanuel M Boutzoukas[1], Emily J Van Etten[2], Pradyumna K Bharadwaj[2], Hyun Song[2], Samantha G Smith[2], Steven T DeKosky[1], Georg A Hishaw[2], Samuel Wu[1], Michael Marsiske[1], Ronald Cohen[1], Eric Porges[1], Adam J Woods[1]
[1]University of Florida, Gainesville, FL, USA. [2]University of Arizona, Tucson, AZ, USA

Objective: Interventions using a cognitive training paradigm called the Useful Field of View (UFOV) task have shown to be efficacious in slowing cognitive decline. However, no studies have looked at the engagement of functional networks during UFOV task completion. The current study aimed to (a) assess if regions activated during the UFOV fMRI task were functionally connected and related to task performance (henceforth called the UFOV network), (b) compare connectivity of the UFOV network to 7 resting-state functional connectivity networks in predicting proximal (UFOV) and near-transfer (Double Decision) performance, and (c) explore the impact of network segregation between higher-order networks and UFOV performance.

Participants and Methods: 336 healthy older adults (mean age=71.6) completed the UFOV fMRI task in a Siemens 3T scanner. UFOV fMRI accuracy was calculated as the number of correct responses divided by 56 total trials. Double Decision performance was calculated as the average presentation time of correct responses in log ms, with lower scores equating to better processing speed. Structural and functional MRI images were processed using the default pre-processing pipeline within the CONN toolbox. The Artifact Rejection Toolbox was set at a motion threshold of 0.9mm and participants were excluded if more than 50% of volumes were flagged as outliers. To assess connectivity of regions associated with the UFOV task, we created 10 spherical regions of interest (ROIs) *a priori* using the WFU PickAtlas in SPM12. These include the bilateral pars triangularis, supplementary motor area, and inferior temporal gyri, as well as the left pars opercularis, left middle occipital gyrus, right precentral gyrus and right superior parietal lobule. We used a weighted ROI-to-ROI connectivity analysis to model task-based within-network functional connectivity of the UFOV network, and its relationship to UFOV accuracy. We then used weighted ROI-to-ROI connectivity analysis to compare the efficacy of the UFOV network versus 7 resting-state networks in predicting UFOV fMRI task performance and Double Decision performance. Finally, we calculated network segregation among higher order resting state networks to assess its relationship with UFOV accuracy. All functional connectivity analyses were corrected at a false discovery threshold (FDR) at $p<0.05$.

Results: ROI-to-ROI analysis showed significant within-network functional connectivity among the 10 a priori ROIs (UFOV network) during task completion (all pFDR<.05). After controlling for covariates, greater within-network connectivity of the UFOV network associated with better UFOV fMRI performance (pFDR=.008). Regarding the 7 resting-state networks, greater within-network connectivity of the CON (pFDR<.001) and FPCN (pFDR=.014) were associated with higher accuracy on the UFOV fMRI task. Furthermore, greater within-network connectivity of only the UFOV network associated with performance on the Double Decision task (pFDR=.034). Finally, we assessed the relationship between higher-order network segregation and UFOV accuracy. After controlling for covariates, no significant relationships between network segregation and UFOV performance remained (all p-uncorrected>0.05).

Conclusions: To date, this is the first study to assess task-based functional connectivity during completion of the UFOV task. We observed that coherence within 10 a priori ROIs significantly predicted UFOV performance. Additionally, enhanced within-network connectivity of the UFOV network predicted better performance on the Double Decision task, while conventional resting-state networks did not. These findings provide potential targets to optimize efficacy of UFOV interventions.

https://doi.org/10.1017/S1355617723007701 Published online by Cambridge University Press

Categories: Aging
Keyword 1: neuroimaging: functional connectivity
Keyword 2: aging (normal)
Keyword 3: information processing speed
Correspondence: Jessica N. Kraft, University of Florida, Gainesville, FL, jkraft@ufl.edu

2 Rethinking the Neuropsychology of g: Structural and Functional Lesion Network Mapping of General Cognitive Ability

Mark Bowren[1], Joel Bruss[1], Kenneth Manzel[1], Maurizio Corbetta[2,3], Daniel Tranel[1], Aaron D Boes[1]
[1]University of Iowa, Iowa City, IA, USA. [2]Venetian Institute of Molecular Medicine, Padova, PD, Italy. [3]University of Padua, Padova, PD, Italy

Objective: General cognitive ability (g) is central to our understanding of human cognition, as it accounts for nearly half of individual differences in performances on diverse cognitive tests. There is growing interest in the brain networks necessary for g because such knowledge could elucidate neural mechanisms of g. Prior work highlighted the association between g and frontoparietal functional networks. However, the specificity of this relationship has been questioned. Moreover, no studies have compared the relative importance of structural and functional networks for g, and most studies have relied on data from neurologically healthy individuals, which limits causal brain-behavior inference. Lesion network mapping (LNM) can overcome such limitations. LNM integrates lesion location and structural and functional brain network data, and allows for inference upon networks necessary for cognitive functions. Here, we used data from three cohorts of patients with focal brain lesions to perform a large-scale LNM study of g. We also compared the relative value of lesion-behavior mapping, and structural and functional LNM, for predicting g across cohorts.
Participants and Methods:
Using data from 402 individuals with chronic, focal brain lesions from the Iowa Neurological Patient Registry, we created a bifactor model to estimate g from the shared variance across neuropsychological tests. To create "cognitive comparisons," we also estimated the unique aspects of domain-specific abilities (visuospatial processing, memory, and processing speed) by removing domain-general variance from each. Next, we used multivariate lesion-behavior mapping to create statistically weighted maps linking deficits in g and domain-specific abilities to regions of focal brain damage. To perform LNM, the local maxima of the lesion-behavior maps were used as seeds for structural and functional connectivity analyses based on normative diffusion-weighted imaging and resting-state functional connectivity data, respectively. The resulting maps were collapsed using principal components analysis (PCA). We quantified the overlap between each map and the lesion volumes of patients from two validation cohorts (n = 101, n = 100). We used these scores to predict observed g in the validation cohorts while controlling for lesion volume. We also compared the relative predictive value of the lesion-behavior maps, and the structural and functional LNMs.
Results: Lesion-behavior mapping indicated that lesions of left frontal white matter, bilateral frontal operculum/insula, and a region of white matter in the posterior left hemisphere were associated with impairments in g. Across all lesion-behavior mapping and LNM results, only two of the structural LNM maps linked to g were statistically significantly predictive of g in both validation cohorts: a map corresponding to the anterior thalamic radiation, and another corresponding to left frontal pyramidal projections. Both added value beyond lesion-behavior mapping and functional LNM.
Conclusions: The results are notable in several respects: they highlight the importance of structural networks for g, de-emphasize the relevance of functional networks for g, and suggest novel brain circuitry involved in g. Our findings are consistent with animal studies implicating anterior thalamic nuclei in working memory, a cognitive function central to g. Clinically, our study highlights the importance of considering domain-general deficits and the effects of focal lesions on distributed cognitive networks.

Categories: Cognitive Neuroscience
Keyword 1: focal lesion
Keyword 2: connectomics
Keyword 3: intelligence
Correspondence: Mark Bowren Jr., University of Iowa, mark-bowren@uiowa.edu

https://doi.org/10.1017/S1355617723007701 Published online by Cambridge University Press