**McGill Ophthalmology Research Day Abstract Submission Form**

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**Abstract Details**

Research Title Dimensionality of Neural Activity During 3D and 2D Movie Viewing Authors (ALL) Linshan(Sunny) Wang, Reza Farivar

Abstract Understanding the dimensionality of neural activity is crucial for deciphering how the brain processes visual information. The primary aim of this study is to investigate how neural dimensionality differs during 3D versus 2D movie viewing, shedding light on how the brain processes more immersive visual experiences. While previous studies have utilized principal component analysis (PCA) and other dimensionality reduction techniques to estimate neural complexity from fMRI data, these approaches lack a standardized statistical framework for determining the number of meaningful principal components (PCs). Additionally, reliance on predefined regions of interest (ROIs) may obscure finer-scale spatial heterogeneity, particularly relevant when comparing dimensionality across different visual experiences.

To address these limitations, we introduce a novel searchlight-based PCA framework, with a primary focus on comparing neural responses to 3D and 2D movie viewing. Unlike predefined parcellation-based analyses, the searchlight approach dynamically adapts to cortical variability, enabling unbiased detection of regional differences critical for visual processing under varying perceptual demands. For each ROI, we extracted time series from its constituent nodes and applied PCA to decompose neural activity into orthogonal components. A Fourier phase scrambling procedure was employed to generate a null distribution of eigenvalues, providing robust statistical control for identifying significant PCs. Additionally, we developed a novel eigenvalue ratio metric to quantify the relative dominance of the first principal component (PC1) in each ROI.

Our findings revealed distinct patterns of neural dimensionality between 3D naturalistic and 2D movie viewing. Specifically, 3D movie viewing was associated with increased neural dimensionality in the visual networks, suggesting more complex processing to support depth perception and spatial awareness. Conversely, 2D movie viewing exhibited a higher scaled PC1 variance in the visual network, reflecting low-dimensional neural representations optimized for rapid scene recognition without depth-related processing. These results suggest that 3D viewing engages a more distributed neural code, accommodating the additional perceptual demands of immersive visual experiences. When comparing 2D naturalistic movies with 2D narrative movies, we found that the visual network exhibited a higher scaled PC1 variance during naturalistic movie viewing, reflecting dominant low-dimensional neural representations for rapid perceptual processing. In contrast, narrative movie viewing revealed higher-dimensional regions within the default mode network (DMN), indicating integrative and long-range temporal processing necessary for understanding storylines.

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Competing Interest Disclosure / Other N/A