Understanding the Primary Visual Cortex (V1): Altered Resting State Functional Connectivity in the Congenitally Blind

A single chair can be viewed from a thousand different angles and still be recognized as the same chair. The human visual processing system is complex, technical, complicated, layered, involved, and multidimensional. Human visual processing is hardwired into the visual hierarchy of the brain, starting the eyes, through the optic nerves, into the lateral geniculate nuclei, to the primary visual cortex (V1), and finally through the dorsal and ventral processing streams.

V1 is a hub for visual processing and its role is widely understood in the average healthy sighted human. What is far less understood is the function of V1 in the blind brain. To elucidate the dynamic role of V1 in the blind, recent studies have used resting state functional magnetic resonance imaging (fMRI) to track hemodynamic response function as a correlate of brain activity over time. Resting state fMRI Studies have found significant differences of V1 connectivity between blind and sighted brains. Beyond probings of altered V1 connectivity to isolated brain regions, the relative connectivity of V1 to different ROIs remains unquantified, and the role of V1 in the blind remains elusive.

In this study, resting state fMRI scans are acquired from 12 congenitally blind subjects and 14 sighted controls. While previous studies have reported changes in blind V1 connectivity to many regions of interest (ROIs), this study quantifies V1 connectivity to many ROIs in a single dataset. Singular value decomposition (SVD) is used to decompose the activity of V1 and quantify how much variance in V1 activity is explained by the activity of other ROIs. Additionally, a groupwise, sliding-window analysis of V1 connectivity in the blind relative to the sighted may shed light on the new and emerging multiple demand network hypothesis of the visual hierarchy in the blind. Our V1 connectivity breakdown may reveal more insights about relative V1 connectivity to commonly cited ROIs such as temporal and frontal lobes.

Revealed V1 connectivity differences in the blind may be consistent with broader themes of neuroplasticity and functional repurposing of connectivity. The results of this study represent a small, quantitatively-driven piece of a larger puzzle in understanding the role of V1 in the blind brain.

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