Primary Visual Cortex is Active in Response to Stimulation of Phenomenally Blind Areas of the Visual Field in Patients with Cortical Blindness

Colleen Schneider, Emily K. Prentiss, Ania Busza, Kelly Matmati, Nabil Matmati, Zoë R. Williams, Bogachan Sahin, Bradford Z. Mahon

First author address: University of Rochester , Rochester, USA.
First author email: colleen_schneider@urmc.rochester.edu

Introduction: *Geniculostriate pathway lesions disrupt vision in the contralesional visual hemifield. Loss of tissue may not be the only cause of cortical blindness from these lesions. Careful inspection of previous functional MRI (fMRI) studies of patients with visual field defects reveals numerous cases of blind areas of the visual field with a preserved V1 response to visual stimulation ('blind voxels'; Ho et al., 2009, Baseler et al., 1999, Papanikolaou et al., 2014). Here we describe the characteristics of blind voxels in chronic stroke patients with homonymous visual field defects.*

Methods: *We recruited 13 chronic stroke patients with homonymous visual field defects. Retinotopic mapping (fMRI) was conducted with a random presentation scheme of 12 non-overlapping flickering wedges. Humphrey perimetry was performed in order to determine which of the wedges presented in the fMRI experiment were located in blind areas of the visual field. Eye tracking was employed during all testing. Functional MRI data was analyzed with a generalized linear model and thresholded at an alpha of 0.001. The number of significantly active voxels for sighted areas of the visual field were compared with those for blind areas of the visual field. Statistical analysis included summary statistics and t-tests.*

Results: *The average number of blind voxels in visual cortex was significantly greater than zero (mean = 27.7, 95% CI = 15.1-40.4 voxels) and was about one third of the average number of voxels activated for wedges presented in sighted areas of the visual field ('sighted voxels', mean = 96.7, 95% CI = 81.3–112.2 voxels). These blind voxels were retinotopically organized. In 6 of the 13 patients we found that the number of blind voxels fell within the range of the number of sighted voxels. For example, in one subject, the number of voxels that responded to stimulation of a wedge presented in a blind area of the visual field ranged from 26-69 voxels, whereas this range was 20-274 voxels for wedges presented in sighted areas of the visual field.*

Discussion:*Our results document a consistent dissociation between visual perception and visual cortex activity. Almost half of our chronic stroke patients with visual field defects exhibited some degree of preserved visual cortex activity in response to stimulation of the perceptual blind field. This dissociation may be due to disordered information content in the stimulus-driven neural activity of peri-lesional voxels such that the signal can no longer be read out as a visual percept. If the visual signal in blind voxels is merely disordered, it is possible that that vision recovery occurs through learning a new read-out strategy. These findings suggest a potential mechanism for some types of blindsight and offer hope for the development of better vision rehabilitation strategies in the future.*

References: *Baseler, H et al. J Neurosci (1999) 19:2619–27*
Ho, Y, et al. Ann Acad Med Singapore (2009) 38:827–31
Papanikolaou, A et al. PNAS (2014) 111:E1656–65

Keywords: Perception & imagery; patients; group study; adults; cerebrovascular; functional imaging, behavioural.