Title: Visual field mapping of visuomotor adaptation to reversing prisms

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Abstract:

Background. A number of studies (e.g., Stratton, Psych. Rev., 1897, Miyauchi et al., J. Physio., 2004) have investigated visuomotor adaptation to altered visual input by wearing inverting or reversing prism spectacles. The behavioral results were consistent across studies. However, the neuronal results have been controversial. In addition, no study has examined the visuomotor cortical regions behind this process. Recently, several human visual field maps have been described in parietal cortex that are thought to be involved in visuomotor integration (Swisher et al., J. Neurosci., 2007). Here we investigate the adaptation of parieto-occipital cortical maps to an extreme alteration of visuomotor processing through long-term use of left-right reversing prism spectacles.

Methods. In our study, subjects wore left-right reversing prism spectacles continuously for 14 days. Throughout the experimental period (including pre-adaptation, adaptation, post-adaptation), subjects practiced a daily battery of visual and visuomotor behavioral tasks and were scanned every three days in fMRI. We first measured the BOLD responses to retinotopic stimuli comprised of wedges and rings, and we defined the baseline organization of the occipital and parietal visual field maps using phase-encoded traveling wave analysis of these data. Then we measured receptive field alterations within these maps across time points, using the population receptive field (pRF) method (Dumoulin and Wandell, Neuroimage, 2008).

Results. The results highlight a systematic and gradual shift of visual field coverage from the normal coverage in the contralateral space to expanding into the ipsilateral space, in both primary visual cortex (V1) and intra-parietal sulcus region (IPS), throughout the adaptation period of prism wearing. The visual field coverage also exhibits gradual area expansion in V1 and contraction in IPS throughout the experiment, which corresponds nicely with the population Receptive Field (pRF) size change in the voxels within the above regions-of-interests (ROIs), where more voxels gain larger pRF sizes in V1 and more voxels contract to smaller pRF sizes in IPS.

Conclusions. These findings clearly allow us to identify the cortical regions subserving the dynamic remapping of cortical representations in response to altered visual perception. Furthermore, these measurements differentiate between early and later stages of the dorsal pathways for visual and visuomotor processing.

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