The neural representation of stimulus information, of the stimulus location, and of the location-dependence of stimulus information in visual working memory

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This study applied multivariate inverted encoding modeling (IEM) to fMRI data to track the dynamics of stimulus representation across a visual working memory (VWM) task. Each trial began with the presentation of an oriented bar (“sample”) in one of four locations (one in each quadrant), followed by a blank 8-sec delay, followed by a recall dial requiring estimation of the sample orientation. The recall dial appeared in the same location as the sample. Across 11 subjects, mean estimation error our 6.7 deg., and a 2-factor mixture model estimated a mean guess rate of less than 5%. Sample-evoked BOLD signal intensity was elevated in occipital, parietal, and frontal regions; delay-period activity in parietal and frontal. Unilateral ROIs were defined in each of these lobes as the 400 voxels showing the greatest difference in sample-evoked activity for contralateral versus ipsilateral stimuli. When IEMs were trained and tested at each TR, in all three regions, stimulus orientation could be reconstructed with signal evoked by contralaterally presented samples as well as by signal evoked by ipsilaterally presented samples. In the occipital ROIs, the same was true for data from the delay and recall periods. In the parietal ROIs, orientation could be reconstructed during the delay period only when the sample had been presented contralaterally. These stimulus representations were dynamic, because reconstruction failed when sample-trained IEMs were fed data from later portions of the trial. To further investigate the temporal evolution of these memory representations, we also trained IEMs on signal from the occipital ROIs from the delay and the recall periods. Whereas recall-period output of sample-trained IEMs distinguished those that had been trained contralaterally from those that had been trained ipsilaterally, information about sample location was weaker in delay-trained IEMs, and weaker still in probe-trained IEMs, suggesting that the mnemonic representation of orientations became progressively less location-dependent over time. In contrast to this, multivariate pattern analysis (MVPA) of the same ROI indicated that occipital cortex retained a robust representation of sample location through the trial. These findings demonstrated that the neural representation of the location dependence of nonspatial stimulus features can be dissociated from the neural representation of stimulus location, per se.