Load-dependent and capacity-limited response in the posterior parietal cortex during visual working memory retention: MEG evidence

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It has been established behaviorally that humans can only hold ~ 3 items in visual working memory (VWM; Luck & Vogel, 1997; Vogel & Machizawa, 2004). However, the biological basis of the VWM capacity is elusive. Prior fMRI studies have suggested that the posterior parietal cortex hosts load-dependent (increase as memory load increases) and capacity-limited (plateaus beyond the ~ 3 capacity) representations during VWM retention (Todd & Marois, 2004; Xu & Chun, 2006; Mitchell & Cusack, 2008; Robitaille et al., 2010). However, the slow modulation in blood signals makes it hard to disentangle perceptual encoding and VWM retention processes in fMRI. Only one existing MEG study examined this question (Robitaille et al., 2010), but a different paradigm from the fMRI studies was used. While the fMRI studies employed a central presentation paradigm (where the memorandum was presented around the center of the screen), the MEG study employed a bilateral presentation paradigm (where the memorandum was presented bilaterally and only one side was to be memorized based on a cue beforehand). In order to close the gap in the literature, we aim at testing if there are load-dependent, capacity-limited responses in the posterior parietal cortex with the central presentation paradigm, using MEG (Figure 1).

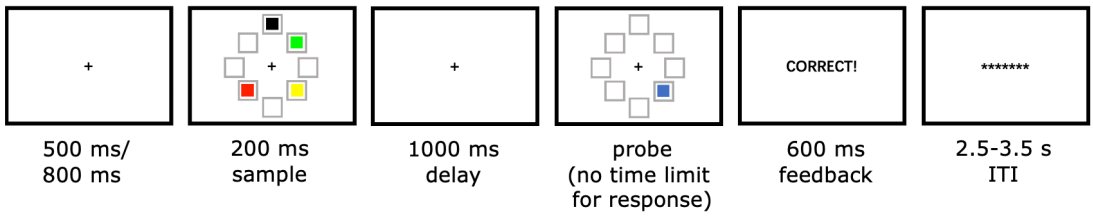

Figure 1. Illustration of a trial in our current experiment.

20 subjects entered data analysis. We performed source-space analysis using the dSPM method, and examined the mean response during encoding (0-400 ms) and VWM retention (400-1200 ms) periods in the posterior parietal cortex, the occipital cortex, and the anterior cingulate cortex (as a “sanity check”, cf. Todd & Marois, 2004). Indeed, the posterior parietal cortex hosted a load-dependent, capacity-limited response during VWM retention, but such effect was absent for encoding. In contrast, the occipital cortex demonstrated a load-dependent, capacity-limited response for encoding, but not during VWM retention. The anterior cingulate cortex did not show significant effects in either time windows. In all, we confirmed that the posterior parietal cortex is hosting load-dependent, capacity-limited responses during VWM retention. The observations in the occipital cortex also suggested that the visual cortex may not be compulsory for VWM retention, despite its importance in perceptual encoding.