

Neurophysiology of Domain Specific Execution Costs of Grasping in Working Memory Phases

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Abstract : Previous behavioral studies have shown that working memory (WM) and manual actions share limited capacity cognitive resources, which in turn results in execution costs of manual actions in WM. However, to the best of our knowledge, there is no study investigating the neurophysiology of execution costs. The current study aims to fill this research gap investigating the neurophysiology of execution costs of grasping in WM phases (encoding, maintenance, retrieval) considering verbal and visuospatial domains of WM. A WM-grasping dual task paradigm was implemented to examine execution costs. Baseline single task required performing verbal or visuospatial version of a WM task. Dual task required performing the WM task embedded in a high precision grasp to place task. 30 participants were tested in a 2 (single vs. dual task) x 2 (visuo-spatial vs. verbal WM) within subject design. Event related potentials (ERPs) were extracted for each WM phase separately in the single and dual tasks. Memory performance for visuospatial WM, but not for verbal WM, was significantly lower in the dual task compared to the single task. Encoding related ERPs in the single task revealed different ERPs of verbal WM and visuospatial WM at bilateral anterior sites and right posterior site. In the dual task, bilateral anterior difference disappeared due to bilaterally increased anterior negativities for visuospatial WM. Maintenance related ERPs in the dual task revealed different ERPs of verbal WM and visuospatial WM at bilateral posterior sites. There was also anterior negativity for visuospatial WM. Retrieval related ERPs in the single task revealed different ERPs of verbal WM and visuospatial WM at bilateral posterior sites. In the dual task, there was no difference between verbal WM and visuospatial WM. Behavioral and ERP findings suggest that execution of grasping shares cognitive resources only with visuospatial WM, which in turn results in domain specific execution costs. Moreover, ERP findings suggest unique patterns of costs in each WM phase, which supports the idea that each WM phase reflects a separate cognitive process. This study not only contributes to the understanding of cognitive principles of manual action control, but also contributes to the understanding of WM as an entity consisting of separate modalities and cognitive processes.

Keywords : dual task, grasping execution, neurophysiology, working memory domains, working memory phases

Conference Title : ICCN 2016 : International Conference on Cognitive Neuroscience

Conference Location : Paris, France

Conference Dates : January 21-22, 2016