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The role of the hippocampus and dorsolateral prefrontal cortex in implicit learning of contextual information

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Decades of research into the neurocognitive mechanisms of attention have revealed that visual attention can be controlled by perceptually salient information (bottom-up) or by internal goals and expectations (top-down). However, recent findings have shown that implicit contextual memory (ICM) also plays an important role in guiding attention. Despite the importance of implicit contextual memory in cognition, it is unclear how the brain encodes and retrieves implicit contextual memories, translates them into an attentional control signal, and how the ventral and dorsal frontoparietal attention networks control deployment of visual attention. In this thesis, a number of questions about the role of the hippocampus and the dorsolateral prefrontal cortex (DLPFC) in implicit contextual memory-guided attention are addressed. First, automated segmentation of structural MRI was combined with neurobehavioral assessment of implicit contextual memory-guided attention to test the hypothesis that hippocampal volume would predict the magnitude of implicit contextual learning. Forty healthy adults underwent brain scanning with 3T magnetic resonance imaging with subsequent automatic measurement of total brain and hippocampal (right and left) volumes. Implicit learning of contextual information was measured using the contextual cueing task. It was shown that both, left and right hippocampal volumes positively predict implicit contextual memory performance. This result provides new evidence for hippocampal involvement in implicit contextual memory-guided attention. Next, continuous theta burst stimulation (cTBS) combined with electroencephalography (EEG) was used in twenty-one healthy adults to test whether transient disruption of the DLPFC would interfere with implicit learning performance and related electrical brain activity. Neuronavigation-guided cTBS to the DLPFC or to the vertex as a control region was employed prior to the performance of an implicit contextual learning task. It was shown that a transient disruption of the function of the left DLPFC leads to significant enhancement of implicit contextual memory performance. This finding provides novel causal evidence for the interfering role of DLPFC-mediated top-down control on implicit memory-guided attention. Additionally, it was shown that cTBS applied over the left DLPFC significantly decreased task-related beta-band oscillatory activity, suggesting that beta-band oscillatory activity is an index of DLPFC-mediated top-down cognitive control. Together, these results shed light on how implicit memory-guided attention is implemented in the brain.