Behavioral and Neural Investigation of Updating and Gating in Working Memory

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Working memory is required for storing and manipulating information as part of many "high-level" cognitive tasks. However, it is limited in capacity, being about 3 to 4 items. Controlling the content that enters WM enables the efficient use of this limited resource. The prefrontal-cortex-basal-ganglia (PFC-BG) working memory model, a central computational model in the field, suggests that input selection is carried out by gating mechanism at the BG that separates between perceptual input and representations maintained in WM. The gate is closed by default, enabling robust maintenance of information within WM, whereas transient opening of the gate enables WM to be updated with new information. The goal of my thesis was to identify the neural mechanisms underlying gating and updating. To this end, we employed the "reference back" paradigm, which is a modified version of the n-back task that allows to identify the sub-processes involved in WM updating (including opening the "gate" to WM, substitution of information, and gate-closing). In two fMRI studies, one using declarative items and the other using procedural information, we found that gate-opening was associated with activation of the BG-thalamus-PFC loop, supporting the BG-PFC model. On the other hand, we observed strong evidence against an active involvement of the basal ganglia and thalamus in the gate-closing process. A third, behavioral project aimed to investigate how the above processes are coordinated when updating WM with both declarative and procedural information. We found that gate-opening is content-specific, whereas closing the gates is general, supporting the idea of a closed-by-default gate. Implications regarding the BG-PFC model and future directions will be discussed.