# Making Working Memory Work: Computational Models of Learning in the Frontal Cortex and Basal Ganglia

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The prefrontal cortex has long been thought to subserve both working memory (the holding of information online for processing) and ``executive'' function (deciding how to manipulate working memory and perform processing). Although many computational models of working memory have been developed, the mechanistic basis of executive function remains elusive. In effect, the notion of an executive amounts to a homunculus whose magical and unexplained powers make the frontal cortex smart. This talk presents an attempt to deconstruct this homunculus through powerful learning mechanisms that allow a computational model of the prefrontal cortex to control itself and other brain areas in a strategic, task-appropriate manner. These learning mechanisms are based on structures in the basal ganglia (NAc, VTA, striosomes of the striatum, SNc) that can modulate learning in other basal ganglia structures (matrisomes of the striatum, GP, thalamus), which in turn provide a dynamic gating mechanism for controlling prefrontal working memory updating. Computationally, the learning mechanism is designed to simultaneously solve the temporal and structural credit assignment problems. The model's performance compares favorably with standard backpropagation-based temporal learning mechanisms on the challenging 1-2-AX working memory task, which has also been studied under fMRI in humans.