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Neural Basis of Memory and Cognition

Research interests in the Miller laboratory center around the neural mechanisms of attention, learning, and memory needed for voluntary, goal-directed behavior. Much effort is directed at the prefrontal cortex, a cortical region at the anterior end of the brain that is greatly enlarged in primates, especially humans. The prefrontal cortex has long been known to play a central role in cognition. Its damage or dysfunction disrupts the ability to ignore distractions, hold important information "in mind", plan behavior, and control impulses. The lab explores prefrontal function by employing a variety of techniques including multiple-electrode neurophysiology, psychophysics, pharmacological manipulations, and computational techniques.

Recent work in the lab has shown that neurons in the prefrontal cortex have complex properties that are ideal for a role in cognitive control. Their activity is highly dependent on, and shaped by, task demands. They are selectively activated by relevant sensory inputs, involved in recalling stored memories, and they integrate the diverse information needed for a common behavioral goal. Perhaps most importantly, they transmit acquired knowledge. Their activity reflects learned associations between diverse stimuli, actions, and their consequences. They can even convey abstract behavioral information such as "rules." This representation of the formal demands of tasks within the prefrontal cortex may provide the necessary foundation for the complex forms of behavior observed in primates, in whom this structure is most elaborate.

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Histed MH, Pasupathy A, Miller EK. Learning substrates in the primate prefrontal cortex and striatum: sustained activity related to successful actions. Neuron. 2009 Jul 30;63(2):244-53.

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Additional Publications

Research Figures

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