Cognitive Control Dynamics: Neural and Computational Mechanisms of Goal-Directed Cognition

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Achieving our daily goals requires constant adjustments in which information we process and which actions we take. Cognitive control processes allow us to accomplish our goals by focusing on goal-relevant information, and flexibly reconfiguring information processing as we move between goals. In this talk I will outline the neural and computational mechanisms through which cognitive control determines how we engage with our current goal and how we flexibly move to the next one. First, I will present a series of experiments demonstrating that goal engagement levels are dynamically modulated by the expected value of control. This work combines normative models of control with reinforcement learning, to show that levels of goal engagement are driven by the costs and benefits of engaging effortful control processes. Second, I will present a dynamical systems model that specifies how transitions between control states (e.g., high vs. low levels of task focus) generate costs. This model posits that there is inertia in the control system: control states are gradually adjusted from their current levels to the target levels specified by a new goal. Across a series of experiments, we validate predictions of this model and demonstrate that the costs of adjusting control emerge from inertia in the control system. Taken together, this work emphasizes the critical role of control dynamics in understanding human goal-directed cognition. Rather than a fixed set of abilities, it offers a dynamical perspective in which control depends on the current environment and previous learning. In this way it offers a new avenue for understanding impairments in goal-directed behavior and cognition present across many mental disorders.