Sensorimotor Adaptations with Rewards

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When a perturbation is applied in a sensorimotor transformation task, subjects can adapt and maintain performance by either relying on sensory feedback, or, in the absence of such feedback, on information provided by rewards. For example, in a classical rotation task where movement endpoints must be rotated to reach a fixed target, human subjects can successfully adapt their reaching movements solely on the basis of binary rewards, although this proves much more difficult than with visual feedback. Here, we investigate such a reward-driven sensorimotor adaptation process in a computational model. We study how the learning dynamics depend on the target size, the movement variability, the rotation angle and the number of targets. We show that when the movement is perturbed for multiple targets, the adaptation process for the different targets can interfere destructively or constructively depending on the similarities between the sensory stimuli (the targets) and the overlap in their neuronal representations. Destructive interferences can result in a drastic slowdown of the adaptation. As a result of interference, the time to adapt varies non-linearly with the number of targets. Our analysis shows that these interferences are weaker if the reward varies smoothly with the subject's performance instead of being binary. We demonstrate how shaping the reward or shaping the task can accelerate the adaptation dramatically by reducing the destructive interferences. We argue that experimentally investigating the dynamics of reward-driven sensorimotor adaptation for more than one sensory stimulus can shed light on the underlying learning rules.