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Flexible motor sequence generation by thalamic control of cortical dynamics through low-rank connectivity perturbations

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One of the fundamental functions of the brain is to flexibly plan and control movement production at different timescales to efficiently shape structured behaviors. I will present a model that clarifies how these complex computations could be performed in the mammalian brain, with an emphasis on the learning of an extendable library of autonomous motor motifs and the flexible stringing of these motifs in motor sequences. To build this model, we took advantage of the fact that the anatomy of the circuits involved is well known. Our results show how these architectural constraints lead to a principled understanding of how strategically positioned plastic connections located within motif-specific thalamocortical loops can interact with cortical dynamics that are shared across motifs to create an efficient form of modularity. This occurs because the cortical dynamics can be controlled by the activation of as few as one thalamic unit, which induces a low-rank perturbation of the cortical connectivity, and significantly expands the range of outputs that the network can produce. Finally, our results show that transitions between any motifs can be facilitated by a specific thalamic population that participates in preparing cortex for the execution of the next motif. Taken together, our model sheds light on the neural network mechanisms that can generate flexible sequencing of varied motor motifs.

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