by other parts of the song circuit.

doi:

II-61. Cortical preparatory activity avoids causing movement by remaining in a muscle-neutral space

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Motor and premotor cortex are involved in the execution of reaching movements, but are also active during the preparation of those movements. Since the arm remains motionless during preparation, we ask: why does preparatory activity not cause movement? One possible mechanism is that activity does not escape the motor cortices because output is suppressed by local inhibition. This mechanism is known to operate in the brainstem for saccade control. We have previously searched for such a 'gating' mechanism in the activity of inhibitory interneurons in motor and premotor cortex of monkeys. We found that inhibition does not appear to gate movement in either premotor (Kaufman et al., 2010, J Neurophys) or primary motor (Kaufman et al., 2010, SFN) cortex. We thus propose and test an alternative model. Since there are many more neurons than muscles, there must be many possible neural states for any given pattern of muscle forces. We therefore predict that there will be an 'iso-force space' in neural space, where any neural state within this space will produce the same muscle output. This iso-force space could be exploited to permit motor preparation without causing movement. Here, we attempt to identify such an iso-force space using neural data from two monkeys. We tested whether some dimensions in neural space might be 'muscle-potent,' identifiable because activity in these dimensions correlates with muscle activity, while other dimensions might be 'iso-force.' We found that preparatory activity preferentially occupies the iso-force (non-muscle-like) space, while movement-epoch activity explores a greater volume of both spaces. This result held both when testing trial-averaged mean data and when examining single-trial activity. Such a mechanism might have implications beyond the motor system, conceivably allowing areas to switch their functional connectivity on and off.

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II-62. A spiking neuron model of movement and pre-movement activity in M1

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We present a spiking neuron model of the primary motor cortex (M1) in the context of a reaching task for a 2-link arm model on the horizontal plane. The M1 population is embedded in a larger scale, hierarchical optimal control model of the motor system called NOCH (DeWolf & Eliasmith, 2010). NOCH characterizes the overall functioning of the motor system, and has been shown to reproduce natural arm movements, as well as movements resulting from perturbations due to motor system damage from Huntington's, Parkinson's, and cerebellar lesions. Here, we demonstrate that the observed dynamics of spiking neurons in awake behaving animals can be accounted for by the NOCH characterization of the motor system. To do so, the M1 neural population is provided with target information and proprioceptive feedback in end-vector space, and outputs a lower-level system command, driving the arm to the target. The implemented neural population represents a single layer of the M1 hierarchy, transforming high-level, end-vector agnostic control forces into lower-level arm specific joint torques. The population is preferentially responsive to areas in space that have been well explored, providing more exact control