Neural Activity in Primary Motor Cortex: a System Level Physiological Model

Ehud Trainin[1], Ron Meir[1], Amir Karniel[2]

[1] Department of Electrical Engineering, Technion, Haifa, Israel

[2] Department of Biomedical Engineering, Ben-Gurion University, Beer-Sheva, Israel

Correspondence should be addressed to rmeir@ee.technion.ac.il

Abstract

What determines the specific pattern of activation of primary motor cortex (M1) neurons in the context of a given motor task? In order to address this question, we develop a system level physiological model and compare its predictions with experimental data related to the caudal part of M1, during voluntary trained tasks. Our model describes the transformation from the neural activity in M1, through the motor control signal, into joint torques and down to endpoint force and movement. The redundancy of the system is resolved by adding a biologically plausible optimization criterion. We compare the predictions of our model to the experimental results and reproduce the observed activity in M1 during a variety of tasks. Using our model we were able to explain, for the first time, many basic experimental observations in a mechanistically explicit way.