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Presentation Abstract

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Abstract: The random nature of generated torque limits the stability and precision of posture and movement. Understanding the mechanisms underlying torque variability is important in studies such as motor control and neurology. The purpose of this work was to compare Triceps Surae (TS) plantar flexion torque (PFT) variability values obtained from a computer-simulated large-scale neuromuscular model (http://remoto.leb.usp.br) with experimental data. In particular, simulations were performed to investigate how PFT is influenced by: (1) the statistics of input processes driving the spinal motoneuron (MN) pools, and (2) the motor-unit twitch (MUT) model. In the experiments, subjects were asked to perform isometric contractions by matching target forces ranging from 10%-80 % of the MVC. PFT and TS EMGs were acquired and post-processed. The neuromuscular model comprises MN pools associated with the TS muscles, driven by common drive spike trains (CST) with specific interspike interval (ISI) statistics. EMG envelope signals and torques were the simulation outputs whose standard deviations (σ) were related to the mean (μ) torque level exerted by the TS. Additional output measurements were the MN ISIs. For a higher contraction level a smaller CST ISI μ was used. MUT were generated either by a linear or a nonlinear model. First the simulations were performed using Poisson processes for the CST. Torque σ as a function of torque μ followed approximately a square root relation. Log-log relationship between σ and μ had a slope 0.42 using the linear and 0.40 using the nonlinear MUT model, below the range found experimentally: 0.51 to 1.11 (μ =0.80). The corresponding MNs ISI σ's turned out to be higher than the values reported in the literature, especially at low mean firing rates, which may explain why the

fittings were rather poor. A significant improvement was obtained using gamma-distributed ISIs for the CST, with orders that decreased when the CST intensity increased. The new simulations resulted in a log-log of PFT σ x PFT μ slopes within the experimental range, with the results from the nonlinear MUT model being closer to the mean of the experimental data. The relations between EMG envelope μ and PFT μ and EMG envelope σ and PFT μ for the three TS muscles resulted within the experimental ranges as well. The differences in the simulation results using different CST ISI distributions showed that torque and EMG variability is highly dependent on the CST ISI statistics and suggested that a signal-dependent noise law already originates at the drive commanding the MN pools.

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COMPUTATIONAL MODEL

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