Synchronization of motor neuron activity

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Summary:
It has been experimentally observed that the discharge timings of pairs of motor neurons during voluntary contractions in humans show a certain degree of correlation (synchronization). The strength of this correlation depends on the muscle, force level, and training, among other factors. It has long been hypothesized that correlated discharges of motor neurons reflect a functionally relevant mechanism for force control. For example, it has been speculated that low values of synchronization would allow more accurate force production. We have revised these long-established concepts by analyzing the role of common synaptic input to populations of motor neurons for the generation of muscle force. We demonstrated that a pool of motor neurons act as a linear filter tuned on the synaptic input components common to all motor neurons. This implies that the effective neural drive to muscle (the ensemble of motor neuron discharges driving the muscle activity in the frequency band of force production) replicates almost exactly the common input and is thus the main determinant of force production. This new perspective argues against a significant role for motor unit synchronization in force control and reveals that synchronization between motor neurons is a necessary observation for force control to be possible by the central nervous system.

Relevant publications:


4: Negro F, Holobar A, Farina D. Fluctuations in isometric muscle force can be


**Biosketch:**

Dario Farina received the M.Sc. degree in electronics engineering from Politecnico di Torino, Torino, Italy, in 1998, and the Ph.D. degree in automatic control and computer science and in electronics and communications engineering from the Ecole Centrale de Nantes, Nantes, France, and Politecnico di Torino, respectively, in 2002. During 2002–2004, he was Research Assistant Professor at Politecnico di Torino and in 2004–2008 Associate Professor in Biomedical Engineering at Aalborg University, Aalborg, Denmark. From 2008 to 2010 he was Full Professor in Motor Control and Biomedical Signal Processing and Head of the Research Group on Neural Engineering and Neurophysiology of Movement at Aalborg University. In 2010 he was appointed Full Professor and Founding Chair of the Department of Neurorehabilitation Engineering at the University Medical Center Göttingen, Georg-August University, Germany, within the Bernstein Center for Computational Neuroscience. He is also the Chair for NeuroInformatics of the Bernstein Focus Neurotechnology Göttingen. His research focuses on biomedical signal processing, modeling, neurorehabilitation technology, and neural control of movement. Within these areas, he has (co)-authored approximately 350 papers in peer-reviewed Journals and over 400 among conference papers/abstracts, book chapters and encyclopedia contributions. Dr. Farina has been the President of the International Society of Electrophysiology and Kinesiology (ISEK) between 2012 and 2014. He has been the recipient of the 2010 IEEE Engineering in Medicine and Biology Society Early Career Achievement Award for his contributions to biomedical signal processing and to electrophysiology and in 2012 he has been elected Fellow of the American Institute for Medical & Biological Engineering (AIMBE) for his contributions to neurotechnologies. He is currently a Distinguished Lecturer of the IEEE Society on Medical and Biological Engineering (EMBS) and Associate Editor of the IEEE Transactions on Biomedical Engineering.