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Presentation Title:

A New Framework for Action and Perception

Anatol G. Feldman, PhD, D Sci.,

University of Montreal

Department of Neuroscience

Abstract :

Conventional, biomechanical, and computational internal model theories (CIMTs) have hindered progress in the understanding of how action and perception are controlled in normal and pathological states. In particular, it is known that input/output functions of motoneurons (MNs) are irreversible, and based on computations it is impossible to determine which input signals should be delivered to MNs to compel them to generate the desired EMG activity and force. In other words, in the framework of CIMTs, no internal models exist for force production in isometric tasks or in other motionless tasks such as pushing with hands against a wall, holding a solid object, generating forces counteracting the ground reaction forces, etc. This limitation of CIMTs is combined with unjustified attempts (see Zhang et al. 2022) to disregard the alternative, equilibrium-point hypothesis (EPH) and its advanced formulation, the referent control theory (RCT) for action and perception (Feldman 2015). Both EPH and RCT suggest that rather than directly specifying the desired motor outcome, the nervous system controls action and perception indirectly, by setting the values of parameters of physical and physiological laws independently of values of kinematic and kinetic variables including EMG patterns describing the motor outcome. Several such parameters transmitted by descending systems identified using TMS and GVS techniques will be described. A solution to the classical posture-movement problem of how movement can be produced without evoking resistance of posture-stabilizing mechanisms (reflexes) will be offered. Practical examples of how parametric control of different motor actions -- arm movements, body leaning forward, a single step and continuous locomotion, and the transition from walking to running and jumping forward will be considered. Dynamic models of eye movements, including saccades in the referent control framework, in comparison with the conventional biomechanical models of eye movements, will be described.

Short CV:

Dr. Feldman is a Professor in the Department of Neuroscience at the University of Montreal and a research scientist at the Center for Interdisciplinary Research in Rehabilitation (CRIR) having Sensory Motor control Labs at the Jews Rehabilitation Hospital in Laval and Institute for Rehabilitation in Montreal. He has a Ph.D. in math and physics and a Doctor of Science in Neurophysiology. He has studied neural mechanisms in the control of motor actions in animals and humans for more than half a century with a major focus on experimental identification of physical and physiological principles underlying action and perception using a combination of perturbation methods, transcranial magnetic stimulation, galvanic vestibular stimulation in a variety of behavioral tasks, including human locomotion based on the equilibrium-point hypothesis now advanced to the theory of referent control in behavioral neuroscience.