November 12, 2010

Modularity for motor control

Andrea d'Avella, Ph.D.

Department of Neuromotor Physiology
IRCCS Fondazione Santa Lucia

ABSTRACT OF THE TALK

A fundamental challenge in neuroscience is understanding how the central nervous system (CNS) controls the large number of degrees-of-freedom of the musculoskeletal apparatus to perform a wide repertoire of motor tasks and behaviors. A long standing hypothesis is that the CNS relies on a modular architecture to simplify motor control and motor learning.

I have been testing this hypothesis by characterizing the regularities in the spatiotemporal organization of the muscle activation patterns recorded in different species, behaviors, and conditions. In humans, a large fraction of the variation in the muscle patterns recorded during reaching in different directions, with different speeds, and to targets whose location suddenly changes are captured by linear combinations of a small number of time-varying muscle synergies, coordinated recruitment of groups of muscles with specific spatiotemporal activation profiles.

These results suggest that muscle synergies are basic modules providing a low-dimensional representation of the motor commands necessary to perform all conditions of a task and, thus, implicitly incorporating knowledge of the complex dynamic behavior of the musculoskeletal system.