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Many researchers study either musculoskeletal biomechanics or neural control. While such focused approaches are clearly important, there is also a need for research which investigates how the musculoskeletal and nervous systems *interact* to produce coordinated movement. Musculoskeletal biomechanics have a significant effect on motor behavior, and to understand either neural control or the role of biomechanical properties will require a deeper understanding of the interplay between brain and biomechanics. I suggest three areas of research to elucidate this important relationship.

How do musculoskeletal biomechanics enable control of complex movements?

During the last three decades, our understanding of limb control has increased significantly, but studies have usually focused on a subset of a limb. For example, reaching movements (involving only the shoulder and elbow) have received much attention, while our understanding of wrist and hand movements is still very limited. However, integration of all joints (shoulder, elbow, wrist, and hand joints) is necessary to understand real upper limb movements such as reach-to-grasp. Whole arm movements are more complex than the sum of their parts, and understanding them requires knowledge of both mechanics and neuroscience. Modeling whole-limb dynamics is an essential tool, but it requires reliable estimates of biomechanical impedance properties (inertia, damping, stiffness) at the whole-limb level. While inertial properties are available in the literature, damping and stiffness parameters have, in general, rarely been measured, and only in a few degrees of freedom (and usually one at a time). Yet stiffness and damping can play significant roles in motor control (for example, stiffness effects dominate over inertial effects in wrist rotations). Systematic characterization of whole-limb biomechanical impedance parameters is necessary for understanding whole-limb movement. Understanding whole-limb movements would allow us to investigate how biomechanical properties specifically enable *functional* movement.

How do biomechanical properties specifically enable interaction with the environment?

Most past motor control research has (understandably) focused on highly controlled and repeatable movements in the laboratory, isolated from interaction with the environment. Yet the purpose of virtually all upper limb movement is functional interaction with one's environment; therefore, understanding the interaction between brain and biomechanics requires studying subjects' functional interaction with their environment. For example, in controlling their movements, how do humans make use of the physiological properties of their bodies and the physical properties of the environment to accomplish the functional goal of the movement? Understanding how biomechanics enable *functional* movement will focus our attention on what is most relevant and necessary for daily living—an important step toward improving assistance and rehabilitation.

Why does the interaction between brain and biomechanics fail in patients with movement disorders? What is the optimal way to assist and rehabilitate them?

Neurological and biomechanical movement disorders (such as stroke and muscle injury) are often viewed as purely neurological or biomechanical, respectively. However, if coordinated movement is the result of appropriate interaction between musculoskeletal biomechanics and neural control, it stands to reason that movement disorders occur through inappropriate interaction of biomechanics and neural control. If we understood exactly how a movement disorder produces a mismatch between neural control and biomechanics, we could develop more specific therapy and more effective assistance. If motor behavior and biomechanical properties were measured on individual patients (which is now possible with rehabilitation robots), we could even design patient-specific therapy and assistance to directly target their individual mismatch between their biomechanics and neural control.