



Modeling neural adaptation to tendon transfer

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Motor adaptation has been mostly studied in the context of learning to counteract changes in the environment or external forces applied to the body. Yet, adaptation to changes in the neuromusculoskeletal system remains poorly understood.

Previous work examined this question through tendon transfer surgeries. A human study [1] investigated within-session adaptation to a virtual tendon transfer under two conditions: compatible surgeries that preserved existing muscle synergies, and incompatible surgeries that disrupted them, thus requiring new patterns of muscle coordination. Incompatible surgeries led to dramatically slower adaptation. A study in monkeys [2] showed that multiple processes may underpin the multi-week process of regaining hand function after incompatible tendon transfer. Thus, different learning processes with distinct timescales may underpin adaptation to changes in the neuromusculoskeletal system. Yet, their details remain unclear.

We used a musculoskeletal model (MyoSuite) and reinforcement learning to investigate adaptation to different types of tendon transfer surgeries. We focused on how agents learned to counteract tendon transfers in a hand model performing pose control and object manipulation tasks. We simulated both compatible and incompatible tendon transfers affecting one to four fingers, and analyzed adaptation dynamics and control policy changes following each surgery.

Our first results confirm that incompatible transfers require longer adaptation periods with larger initial performance drops compared to compatible transfers, with adaptation difficulty scaling to the number of affected fingers. Even without additional constraints, compatible transfers preserved the original muscle synergies, but incompatible transfers led to new synergies. We aim to gain insights into neural adaptation following persistent neuromusculoskeletal changes.

tendon transfer, reinforcement learning, musculoskeletal model, adaptation, motor control

