Is movement organization in cat paw shake response optimal?

BORIS PRILUTSKY, ALEXANDER KLISHKO, Georgia Inst of Tech — Animal musculoskeletal systems are highly redundant: they have more kinematic degrees of freedom and muscles than strictly necessary to execute a given motor task. Such redundancy gives the animal many choices in selecting kinematic and muscle activity patterns to achieve movement goal. Given a stereotypic execution of cat paw shake response (very fast periodic oscillations of the paw) among deferent cats despite the motor redundancy, we hypothesized that the movement strategy in this reflex is optimal. The goal of this study was to test several physiologically plausible cost functions, optimizations of which could explain the functional significance of chosen movement strategy in paw shake. A 2D, 5 degrees-of-freedom forward dynamics cat hindlimb model was developed. The model has 5 body segments, 4 frictionless hinge joints, 11 muscles with realistic muscle and activation dynamics. Muscle activations were computed using a simulated annealing optimization algorithm and several cost functions. The best match between simulated and experimentally recorded muscle activity patterns was obtained when peak paw acceleration was maximized.

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