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SURFACE ELECTROMYOGRAPHY PROVIDES NEUROMUSCULAR INSIGHTS FOR SKILL ACQUISITION IN MICROGRAVITY

Abstract

Purpose: Movement in microgravity poses unique challenges especially for highly skilled movements that require object interactions. It has been shown that human sensorimotor performance deteriorates by as much as 50

Methods: Subjects performed an object manipulation task where they lifted a block over a barrier in virtual reality (VR) and in the real world. The virtual block had no weight, while the real-world blocks were either light (0.022 kg) or heavy (0.111 kg). Subjects performed 20 repetitions of the task for each block weight, while their muscle activity was measured using surface electromyography and their kinematics was measured using Oculus hand tracking cameras (VR) or a Leap Motion Controller (real reality).

Results: The temporal profiles of EMG signals from hand muscles differed across the tasks. Multiple muscles with agonistic and antagonistic actions around a given joint showed altered profiles, implying different levels of co-contraction associated with objects of different weight.

Conclusions: These results indicate that external forces caused by the object weight are compensated for by the nervous system through the co-contraction of muscles in order to increase the whole limb stiffness. This suggests that the inappropriate co-contraction in microgravity that is mismatched to the reduced reaction forces on the limb from the object is likely contributing to the reduction in skillful performance.

Discussion: The EMG metric of co-contraction could be used to assess the levels of skill and performance in microgravity. Future research will help identify targets for intervention to ameliorate the deterioration of skillful performance in microgravity. The intervention with haptic feedback simulating expected object reaction forces driven by real-time EMG signals is the most promising approach for mitigating the effect of microgravity on skillful performance.