The Effect of Energy-Matched Exercise Intensity on Brain-Derived Neurotrophic Factor and Motor Learning

By

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Brain plasticity is important to motor learning, and is a critical component of motor rehabilitation. Exercise prior to motor training may facilitate plasticity by increasing brain-derived neurotrophic factor (BDNF). However, many studies that have investigated exercise-enhanced plasticity have assessed motor skill performance on tasks involving single finger button presses or small movements of a joystick, results that may not relate to more complex, real-world movements. Additionally, while high-intensity exercise has been shown to benefit motor learning, the effects of low-intensity exercise have yet to be fully investigated. A bout of low-intensity exercise, when completed at an energy expenditure that is equivalent to that of a high-intensity exercise bout, may also benefit learning and might be particularly relevant to individuals with neurological disorders who may only be capable of achieving low-levels of physical activity. Therefore, our first aim was to develop a motor learning task that involved 3-dimensional (3D) reach movements. Our second aim was to investigate the effects of exercise intensity on motor learning of the same task. In Study 1, we developed a motor learning task in a virtual environment that involved 3D reach movements to sequentially presented targets. With this task, we produced results similar to those traditionally observed in the motor learning literature; individuals improved with practice ($p < 0.001$) and performance was maintained at retention ($p = 0.386$). Since our task involved 3D reach movements, results from studies utilizing this task may be more relatable to real-world movements. In Study 2, we used the 3D reach task to investigate

the effects of exercise intensity on motor learning. We compared performance on the 3D reach task and the BDNF response to exercise between a rest group, a high-intensity exercise group, and a low-intensity exercise group. Both exercise groups expended 200 kilocalories of energy. Overall improvement on the motor task, indicated by a reduced response time, did not differ by group. However, exercise at both a high and low-intensity altered the kinematic profile used to improve performance over time. The rest group improved in the spatial domain of performance more than the exercise groups, while both high and low-intensity exercise groups improved more in the temporal domain of performance. Therefore, exercise at a specific energy expenditure, whether at a low or high-intensity, may facilitate the temporal components of motor performance. A significant rise in BDNF was not observed after exercise in either exercise group. Furthermore, the high variability observed in the exercise-related BDNF response was not related to BDNF genotype. However, BDNF genotype did have an effect on performance of the 3D reach task. Individuals with the BDNF polymorphism had faster response times throughout task practice. Future work is needed to fully understand the effects of the polymorphism on motor performance and learning. Our investigation revealed that energy expenditure, not exercise intensity, is the critical component for inducing an exercise-related effect in the kinematics of reach behavior. In addition, exercise may influence motor behavior through neural mechanisms other than BDNF.