Exercise at Different Intensities Enhances Implicit Learning

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Summary
This project investigated the interaction between exercise intensity to determine the dose effect response on motor learning. By investigating the relationship between exercise parameters and motor learning, our research seeks to establish exercise prescription guidelines that promote neuroplasticity and optimize motor skill acquisition. Implicit motor learning is the unconscious acquisition of movement skills, resulting in automatic and robust long-term performance. Preliminary results indicate exercise promotes implicit motor learning.

Introduction
Long-term exercise is known to improve various cognitive functions such as attention, executive function, and long-term memory [1]. In fact, even a single bout of exercise can improve motor learning and memory [2]. Such benefits on motor learning are thought to stem from exercise-induced neuroplasticity [2, 3]. Notably, these effects may depend on factors such as exercise characteristics (i.e., intensity) and the type of motor learning involved (i.e., implicit and explicit processes). This project seeks to systematically investigate how exercise intensity may differentially influence distinct categories of motor learning processes using a sensorimotor adaptation task.

Methods
Eighteen healthy, right-handed adults (age 24±6 yrs; height 1.7±0.1 m; body mass 67.4±10.2 kg; sex 6 male, 12 female) volunteered and consented to participate. In two separate testing sessions, participants: 1) completed a 40-minute functional threshold power test (FTP) on a stationary bicycle; 2) completed a sensorimotor adaptation task (SMT) before and after a 19-minute randomized protocol of (i) high intensity exercise (Ex90%); ii) low intensity exercise (Ex45%); iii) no exercise (CON)). FTP outputs were used to determine relative exercise intensities for Ex45% and Ex90% conditions in session two.

The SMT was performed on a Wacom Pen Tablet, with feedback of reaching movements displayed on a computer monitor. Participants executed horizontal reaching movements with the right hand, moving a 7 mm cursor from a central starting position to a 1 cm target located at one of four positions on a virtual ring (10 cm radius). Task instructions were to move quickly and "slice" through the target within 250ms of movement onset, returning to the start position without visual feedback. Three trial conditions were used: null trials (veridical feedback), rotation trials (12° rotation of the cursor), and no-feedback trials (no visual feedback during the entire trial). After familiarization, a total of 46 blocks were completed, comprising: Baseline1 (5 blocks, 40 trials with feedback), Baseline2 (5 blocks, 40 trials with no feedback), "Clamp" training [4](30 blocks, 240 trials of rotation trials at 12°), "Washout" (1 block, 8 trials), and "Aftereffect" (5 blocks, 40 trials with feedback).

Custom Matlab scripts (Matlab R2024B) were used to compile data for further analysis. The overall degree of adaptation observed for each block was extracted for analysis. Heart rate (HR) from every minute of the SMT and exercise tasks were analyzed. One-Way Repeated Measures Analysis of Variance (ANOVA) and Bonferroni post-hoc analyses were conducted using Jamovi (V2.4); $p \leq 0.05$.

Results and Discussion
Preliminary results* demonstrate a main effect of exercise intensity during the clamp training phase of the SMT ($p < 0.001$). Bonferroni post-hoc analyses indicated Ex90% effects were significantly different to CON (mean difference = -5.53, SE = 1.35, (Bonferroni adjusted) $p = 0.014$) but did not significantly differ from Ex45%. HR was significantly increased during Ex45% and Ex90% compared to the CON condition (n=10). Anecdotally, initial results highlight that exercise promotes learning, as evidenced by aftereffects phase measures shown. *Additional data is currently being collected and analyzed (n=18 are presented).

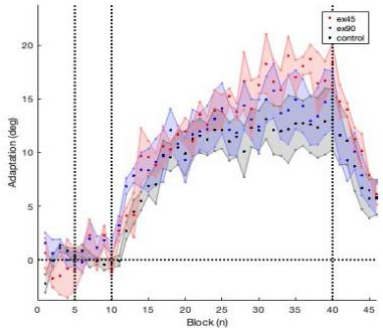

Figure 1: Individual reaching adaptation (degrees) results presented for sensorimotor task testing conditions. Shaded area represents SE.

Conclusions
Findings indicate that exercise intensities differentially influence implicit motor learning. Further analysis is required to determine the clear presence of a dose response and to what extent exercise intensity impacts implicit learning.

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