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AUGMENTING EXERCISE PROTOCOLS WITH INTERACTIVE VIRTUAL REALITY ENVIRONMENTS

Abstract

As international spaceflight missions explore distances further and further from Earth, maintaining optimal astronaut performance becomes increasingly challenging. Physical exercise proves to be our best countermeasure against the multi-system decrements of reduced gravity, but a rise in mission duration brings a concomitant rise in risk to human health and a compounding decline in adherence to those countermeasures. Virtual Reality (VR) technology is already utilized in multiple health solutions: post-operative orthopedic rehabilitation, pain reduction, psychological treatments, and aiding surgeons when performing complex robotic surgery. Though the technology is beginning to reach mass implementation, evidence supporting positive outcomes relating to exercise adherence, affect, motivation, and other performance measures while utilizing VR remains to be collected.

The current pilot study examines outcomes of virtual reality on a flight-validated exercise prescription (SPRINT – Integrated Resistance and Aerobic Training) on 20 subjects using existing NASA technology. The MultiMode Exercise Device (MMED) is a single device that combines rowing ergometry with resistance exercise for the lower body, while outputting digital measures of subject performance. The device was successfully implemented in a NASA bed rest study from 2014 wherein subjects participated

in the SPRINT protocol, a well-defined, bi-phasic exercise program consisting of both continuous aerobic exercise and high-intensity interval training. While the current study has broad applicability, our 20 subjects have been selected to be representative of the astronaut population: healthy, fit, age 18-50, and with equal gender balance. 10 subjects are randomly assigned to a VR exercise group, and 10 remaining subjects complete the same protocol without VR in a neutral environment.

Rowing in the VR scenarios is designed to simulate a river rowing scene, featuring no heads-up displays, high-resolution terrain and objects (boats, rowers, etc), and intuitive, unambiguous feedback from user actions. Virtual presence, exercise affect, restorativeness, anxiety, and exertion have been measured continually during the protocol. Baseline cognitive and behavioral metrics such as cognitive function (via WINSCAT battery), personality, emotional state, stress, and motivation are compared before and after the protocol along with biometrics of physical performance such as strength, body composition, and cardiovascular fitness. It was is hypothesized that program adherence and performance outcomes will be improved in the VR group, predicted by better outcomes in anxiety, motivation, emotional state, stress, and engagement as well as increased performance and reduced perceived exertion. Data is still currently being collected currently and will be presented for the first time here at IAC2020.