Hayden Gerhart, Ph.D., December 2016 School of Health Sciences

ACUTE EFFECTS OF NORMOBARIC HYPOXIA AND COLD WATER HAND IMMERSION ON THERMOREGULATORY RESPONSE AND COGNITIVE FUNCTION (117 pp.)

Director of Dissertation, Ellen L. Glickman, Ph.D.

INTRODUCTION: Cold-induced vasodilation (CIVD) is a mechanism that protects the peripheries from cold-related injury. There is a need to elucidate mechanisms that attenuate reduced cognitive and motor performance in hypoxic environments. **PURPOSE:** The purpose of the present study was to investigate the effects of cold-water hand immersion (CWI) on changes in thermoregulation, measures of CIVD, executive function, mood, and memory in normobaric hypoxia before and following submaximal exercise. **METHODS:** 10 apparently healthy men (23±3 years) volunteered for this study. The two experimental trials (13% O_2, 21% O_2) were counterbalanced and blinded from the participants. Following a 60-min. acclimation the experimental trials consisted of two 15-min. exposures to 5ºC water of the non-dominant hand. The exposures were separated by a 30-min. bout of submaximal exercise producing the equivalent of 400 watts (W) of metabolic heat. Executive function (Stroop), total mood disturbance (TMD), memory (RMCPT), mean body temperature (MBT), oxygen saturation (SaO2), and thermal sensation (TS) of the arm were collected during the final 5 min. of each stage. CIVD was measured pre- and post-exercise during each of the cold water exposures on the nailbed of the middle finger on the non-dominant hand. **RESULTS:** No significant interaction or main effects of time or condition were reported for any score of executive

function ($F \leq 3.12$, $p \geq 0.069$) or mood ($F \leq 0.773$, $p \geq 0.477$). A significant time by condition interaction exists for throughput score ($F = 3.19$, $p = 0.039$), a measure of RMCPT. The score during CWI in the 13% O_2 condition was significant lower compared to the 21% O_2 condition ($p = 0.05$), as well as when compared to acclimation of the 13% O_2 condition ($p = 0.02$). However, the worsening TMD trend led to positive associations between skin temperature during CWI and TMD scores at baseline ($r = 0.753$, $p = 0.012$), acclimation ($r = 0.653$, $p = 0.041$), and CWI ($r = 0.657$, $p = 0.039$) in the 13% O_2 condition. A main effect of time is observed for MBT ($F = 42.477$, $p < 0.001$) in that both exercise and CIVDpost values of MBT are significantly greater than values observed at baseline, acclimation, and CIVDpre ($p < 0.001$ in all instances). A significant time (baseline, acclimation, CIVDpre, exercise, and CIVDpost) by condition (13% O_2, 21% O_2) interaction was observed for SaO_2 ($F = 38.4$, $p < 0.001$). Significant differences between conditions exist at all time points with the exception of baseline ($p < 0.001$ in all instances). Onset time was significantly later in 13% O_2 ($p = 0.043$) compared to the 21% O_2 condition at time point CIVDpre. A main effect of time was observed for amplitude temperature ($F = 20.034$, $p < 0.001$). Both peak time and amplitude temperature were significantly different ($p \leq 0.03$) across conditions during CIVDpost. **CONCLUSION:** CWI has no effect on executive functioning in both normoxia and normobaric hypoxia. The decreased skin temperature observed during CWI correlates to reduced mood throughout all time points in a hypoxic state. It appears that during rest in normobaric hypoxia, a cold stress test has minimal effect on MBT and the CIVD response. During exercise, reduced CIVD amplitude is associated with reduced SaO_2. It is clear that a

submaximal bout of cycling exercise is not the proper stimulus to acutely induce a CIVD response to the magnitude at which positive physiological adaptations occur. Further research is necessary to elucidate mechanisms to improve mood in normobaric hypoxia.