Effect of Hypoxia on Cerebrovascular and Cognitive Function During Exercise

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Optimal cognitive function requires a balance between cerebral blood flow to active brain regions (oxygen supply) and oxygen extraction by cerebral tissue (neuronal metabolic demand). Exercise and cognitive engagement creates competing demands for oxygen which can be exaggerated during hypoxia. **PURPOSE**: Investigate the effect of acute hypoxia on cerebral and cognitive function during exercise. **METHODS**: Thirty healthy participants (21±4yrs, BMI 24.0±2.6 kg·m^{-2}; 15 men) were randomized to both a ~2.5 hour normoxic (20.0% O_2) and hypoxic (12.5% O_2) condition on two separate days. During the final 25 min of each condition, participants underwent 10 min of exercise-alone and 15 min of exercise+cognitive testing (cycling at 55% HRmax). Accuracy and reaction time (RT) were averaged across memory, N-Back and Flanker tasks. Prefrontal cortex tissue saturation index (TSI) and middle cerebral artery (MCA) blood flow velocity were measured using near-infrared spectroscopy and transcranial Doppler respectively at rest, during exercise alone, and during exercise+cognitive tasks. **RESULTS:** MCA velocity was overall greater in hypoxia vs normoxia, and increased similarly from rest to exercise in normoxia (66±3 to 79±3 cm/s, $p<0.05$) and hypoxia (71±3 to 82±3 cm/s, $p<0.05$). Addition of cognitive tasks during exercise had no effect on MCA velocity in normoxia (74±3 cm/s) or hypoxia (80±3 cm/s). ΔTSI increased from rest to exercise in normoxia (-0.02±0.05 to 1.15±0.35%, $p<0.05$) with no further changes with the addition of cognitive tasks (0.86±0.50%). ΔTSI decreased from rest to exercise in hypoxia (-0.05±0.05 to -1.77±0.26%, $p<0.05$) with attenuated reductions occurring with addition of cognitive tasks (-1.28±0.30%, $p<0.05$). Accuracy on cognitive tasks was similar in normoxia (84.2±7.0%) compared to hypoxia (83.9±1.0%) while RT was slower in hypoxia vs normoxia (537±14 vs 513±13 ms; $p<0.05$). **CONCLUSION**: Prefrontal oxygenation was reduced during exercise and cognitive engagement in hypoxia despite greater MCA blood flow in hypoxia and similar changes in MCA blood flow during exercise and cognitive engagement vs normoxia. Cognitive slowing during hypoxic exercise may be related to reductions in prefrontal oxygenation rather than macrovascular cerebral blood flow.

Supported by a Foundation Research Grant from ACSM