COGNITIVE EFFECTS OF ACUTE EXPOSURE TO HIGH ALTITUDE IN ALTITUDE-EXPERIENCED WORKERS

Lauren L. Dragos PhD1,2,3, Charlotte Pon1, Sara E. Hartmann PhD1,2, Michael Furian MSc3, Adrianna M. Dyck4, M. Lichtblau MD5, Lara Muralt MD5, Patrick R. Bader MD1, Fernando Moraga PhD5, Daniel Soza5, Ivan Lopez5, Jean M. Rawling MD PhD5, Silvia Ulrich MD5, Konrad E. Bloch MD5, Barry Giesbrecht PhD5,6, Marc J. Poulin PhD DPhil1,2,4

Department of Physiology & Pharmacology1, Hotchkiss Brain Institute2, Cummings School of Medicine3, & Department of Family Medicine4 University of Calgary, Calgary, Alberta, Canada; Pulmonary Division, Sleep Disorders Centre and Pulmonary Hypertension Clinic, University Hospital Zurich, Zurich, Switzerland5; Department of Psychological and Brain Sciences6 & Institute for Collaborative Biotechnologies5, University of California Santa Barbara, Santa Barbara, United States of America; Alma Observatory, Chile7; Universidad Católica del Norte, Coquimbo, Chile8

Abstract

Objective: We investigated the effect of moderate (2900m–MA) and high (5050m–HA) altitudes on measures of attention (ATF) and executive function (EF) in altitude-veteran workers from the ALMA observatory, Chile. We hypothesized that cognitive performance at HA would be lower than cognitive performance at MA.

Methods: Cognitive measures of ATF and EF were measured in 21 male workers (Mean age 40.1±8.5), range 26-66. Testing was conducted in a randomized order at MA and HA over two separate working shifts. Testing session involved four tasks assessing ATF (Attention Switching Task (AST), Reaction Time (RTI), Rapid Visual Processing (RVP)), EF (One Touch Stockings of Cambridge (OTS)) using CANTAB (Cambridge Cognition Ltd). Instruction and testing was administered on iPads using Latin American Spanish. Data were analyzed using repeated measures of covariates.

Results: Contrary to our hypothesis we did not observe main effects of altitude on RVP, OTS, or AST. There were significant interactions between altitude and order of administration (MA to HA; HA to MA). More specifically, there was a practice effect only when the first administration occurred at MA, but not HA on RVP SD of response latency (F(1,16)=3.68, p=0.073). This pattern was not seen on the RTI task. However, participants had significantly faster movement, but not reaction times at HA on the RTI.

Conclusion: This study provides evidence that learning effects on tasks may be diminished at HA. These data suggest that repetition or training should occur at MA, whenever possible.

Introduction

• Acute hypoxia is known to severely reduce the performance on tasks of cognitive function in a range of domains, including domains of executive function1 and attention.3
• High altitude workers experience a unique exposure to sustained hypoxia. However, the impact of this exposure on cognitive measures of attention and executive function is unclear.
  • One previous study suggests residents of high altitude experience decreases in verbal memory4.

Objective: To investigate the effect of moderate versus high altitude on cognitive measures of attention and executive function in a population of experienced altitude workers.

Hypothesis: Cognitive performance will be lower at high altitude when compared to moderate altitude.

Participants

Participants
• 21 altitude-experienced (Mean age = 40.1±3.7 years, all males) participated.
• Participants were randomized to have their cognitive testing in two orders:
  • High (5,050m) → Moderate (2,900m) Altitude
  • Moderate (2,900m) → High (5,050m) Altitude
  • Two participants did not complete the second visit.

Table 1. Participant Characteristics (n = 21)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>40.1 (8.5)</td>
</tr>
<tr>
<td>Years of Education</td>
<td>17.6 (3.1)</td>
</tr>
<tr>
<td>Hemoglobin Visit 1</td>
<td>17.3 (1.3)</td>
</tr>
<tr>
<td>Hemoglobin Visit 2</td>
<td>16.9 (1.4)</td>
</tr>
</tbody>
</table>

Results

• Contrary to our hypothesis we did not observe main effects of altitude on RVP, OTS, or AST.
• There were significant interactions between altitude and order of administration
  • MA to HA –OR– HA to MA
• There was a practice effect only when the first administration occurred at MA, but not HA on OTS, AST and RVP.
• This pattern was not seen on the RTI task. However, participants had significantly faster movement, but not reaction times at HA on the RTI.

Discussion

• We did not find evidence that performance was significantly decreased at HA.
• However, the effects of order of test administration on performance on the RVP, OTS and AVP provides evidence that learning effects on tasks may be diminished at HA.
• These data suggest that repetition or training should occur at MA, whenever possible.

References:


Funding and Support: NSERC Discovery Grant (MJP, 2014-05554), The Brenda Strafford Foundation Chair in Alzheimer Research (MJP), the Alma Observatory, Swiss Lung Foundation, Lunge Zurich, Swiss National Science Foundation, and Alberta Innovates Postgraduate Fellowship (LLD).