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

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Abstract

Objective: We investigated the effect of moderate (2900m–MA) and high (5050m–HA) altitudes on measures of attention (ATT) 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 ATT and EF were measured in 19 male workers (Mean age 40.1±8.5(SD), range 28-60). Testing was conducted in a randomized order at MA and HA over two separate working-shifts. Testing session involved four tests assessing ATT (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 covariance.

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 ($F(1,15)=4.64$, $p=0.048$); latency to correct response on the OTS ($F(1,17)=18.50$, $p=0.001$); latency to response on the AST in switching blocks ($F(1,16)=6.97$, $p=0.018$); and a trend for RVP probability of a correct response ($F(1, 15)=3.68$, $p=0.073$). This pattern was not seen on the RTI task. However, participants had significantly faster movement, but not reaction times at HA on the RTI.

Conclusions: 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 function[1] and attention[2,3].
- 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 memory[4]

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)

Variable	Mean (SD)
Age (yrs)	40.1 (8.5)
Years of Education	17.6 (3.1)
Hemoglobin Visit 1	17.3 (1.3)
Hemoglobin Visit 2	16.9 (1.4)

Methods

Cambridge Neuropsychological Test Automated Battery (CANTAB)

The Cognitive function test battery consisted of four tasks and was performed using the CANTAB Connect Research Suite (Cambridge Cognition) for iPad. Instructions and feedback were administered via the program in Latin American Spanish.

One Touch Stockings of Cambridge (OTS):

The OTS is a measure of executive function, specifically spatial planning ability. Outcomes include time to correct response (latency) and accuracy.

Reaction Time (RTI):

The RTI is an attention test of motor and processing speed. It measures movement time, reaction time, accuracy and impulsivity.

Attention Switching Task (AST):

The AST is an attention task measuring top down control, or inhibition of irrelevant information. It measures reaction time, accuracy, and target sensitivity.

Rapid Visual Processing (RVP):

The RVP is a sustained attention test. It measures reaction time, accuracy, and target sensitivity.

Statistical Approach

- Statistical significance was determined with repeated measures analysis of covariance (ANCOVA).
- All analyses controlled for age.

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.

Results

Figure 1. OTS Latency to Correct Response

Order of Altitude Exposure
- 2900m → 5050m
- 5050m → 2900m

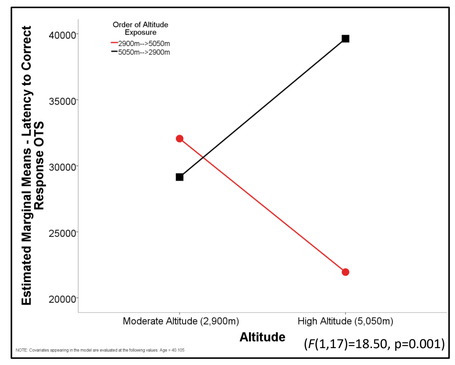


Figure 2. AST latency to response in switching blocks

Order of Altitude Exposure
- 2900m → 5050m
- 5050m → 2900m

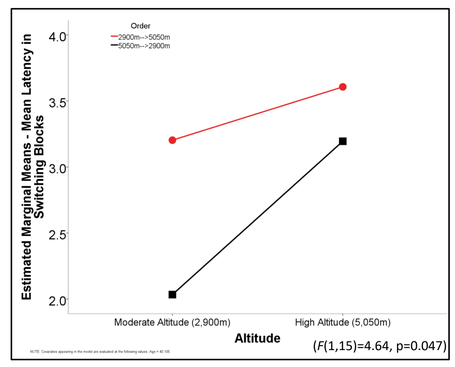
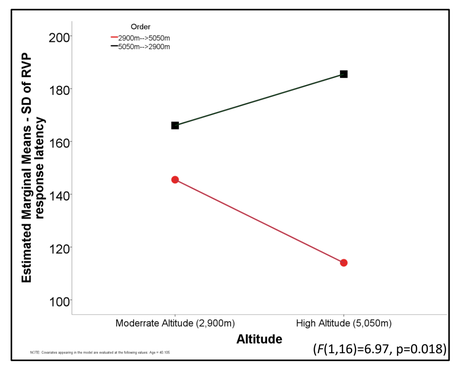


Figure 3. RVP deviation of response latency

Order of Altitude Exposure
- 2900m → 5050m
- 5050m → 2900m



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.

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