TRACKING ALTITUDE-RELATED CHANGES IN PROCESSING CAPACITY WITH BRAIN SIGNAL VARIABILITY

Alison W. Heard[1], Jessie M. Hart[1], Ford Burles[1], Sara E. Hartmann[2], Michael Furian[3], Mona Lichtblau[3], Lara Muralt[3], Patrick R. Bader[3], Silvia Ulrich[3], Konrad E. Bloch[3], Jean M. Rawling[4], Penny M. Pexman[1,5], Marc J. Poulin[2,5,6], Andrea B. Protzner[1,5]

[1]Department of Psychology, University of Calgary, Canada, [2]Department of Physiology and Pharmacology, University of Calgary, Canada, [3]Department of Respiratory Medicine, University Hospital of Zurich, Switzerland, [4]Department of Family Medicine, Cumming School of Medicine, University of Calgary, Canada, [5]Hotchkiss Brain Institute, Canada, [6]Cumming School of Medicine, University of Calgary, Canada

Introduction

- Cognitive decline at high altitude is well documented, however brain changes associated with this decline are understudied.
- We examined altitude-related changes in brain (resting state EEG), and behaviour (response time (RT) and accuracy) during a lexical decision task (LDT) at both high (5050m) and low altitude (520m).
- To characterize EEG changes, we focused on brain signal variability (BSV; i.e. transient temporal fluctuations in brain signal) [1]
- Changes in BSV have been shown to track changes in cognitive capacity associated maturation, disease, and individual differences in performance [2,3,4].

Hypotheses:

1. Altitude changes will alter BSV.
2. Lower BSV during resting state will be associated with worse task performance.

Methods

Participants

- 14 adults participated in the study; 6 in cycle 1 (4 females, mean age = 26), and 8 in cycle 2 (4 females, mean age = 22).

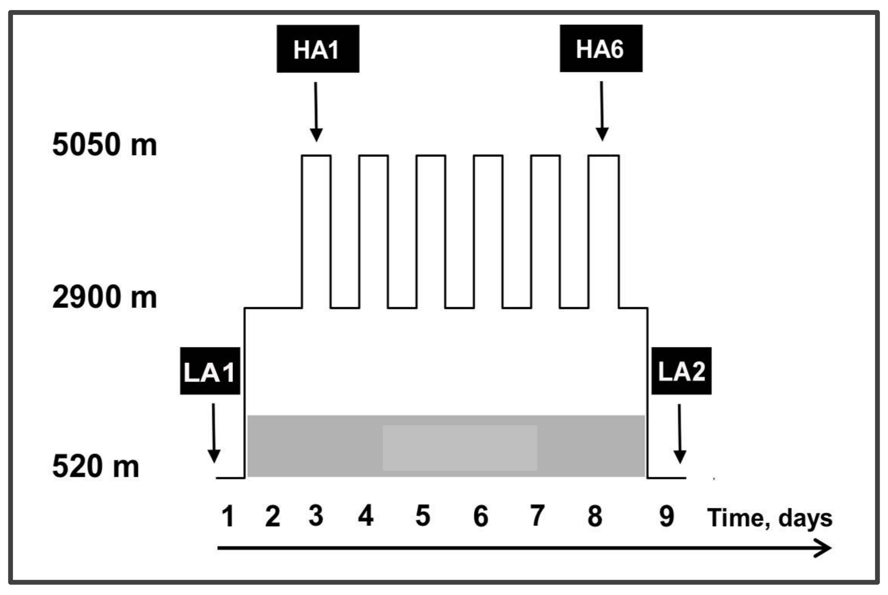
Altitude Change Procedure:

Cycle 1, three testing days: HA1, HA6, and LA2

- HA1: very high altitude (5050m); HA6: following five days acclimatization at very high altitude (5050m); LA2: upon return to low altitude (520m)

Cycle 2, four testing days: LA1, HA1, HA6, and LA2

- Individuals not tested during Cycle 1 exposure participated in Cycle 2 following five days at low altitude.
- Additional testing day prior to ascent, LA1.



Methods (continued)

Brain Data

- EEG was recorded for 10 minutes of eyes-open resting-state (staring at a fixation cross).
- BSV was quantified as multiscale entropy (MSE), a measure that assesses signal variability at multiple time scales, for each electrode, for each subject.

Behavioural data

- Following the resting-state recording, participants performed the LDT(i.e. "is this a word?")
- RT and accuracy were recorded.

Analysis

MSE values were statistically assessed using Partial Least Squares (PLS), a multivariate analysis technique that extracts Latent Variables (LV's) to characterize altitude related changes in MSE, and MSE-performance relationships [5]. We assessed:

- Patterns of MSE changes over recording days
- MSE changes in relation to performance

Results: BSV

We compared the overlapping data from Cycles 1 and 2, and did not find significant differences between them. Therefore, we report results collapsed over both cycles.

Cycle 1 & Cycle 2 (n = 14)

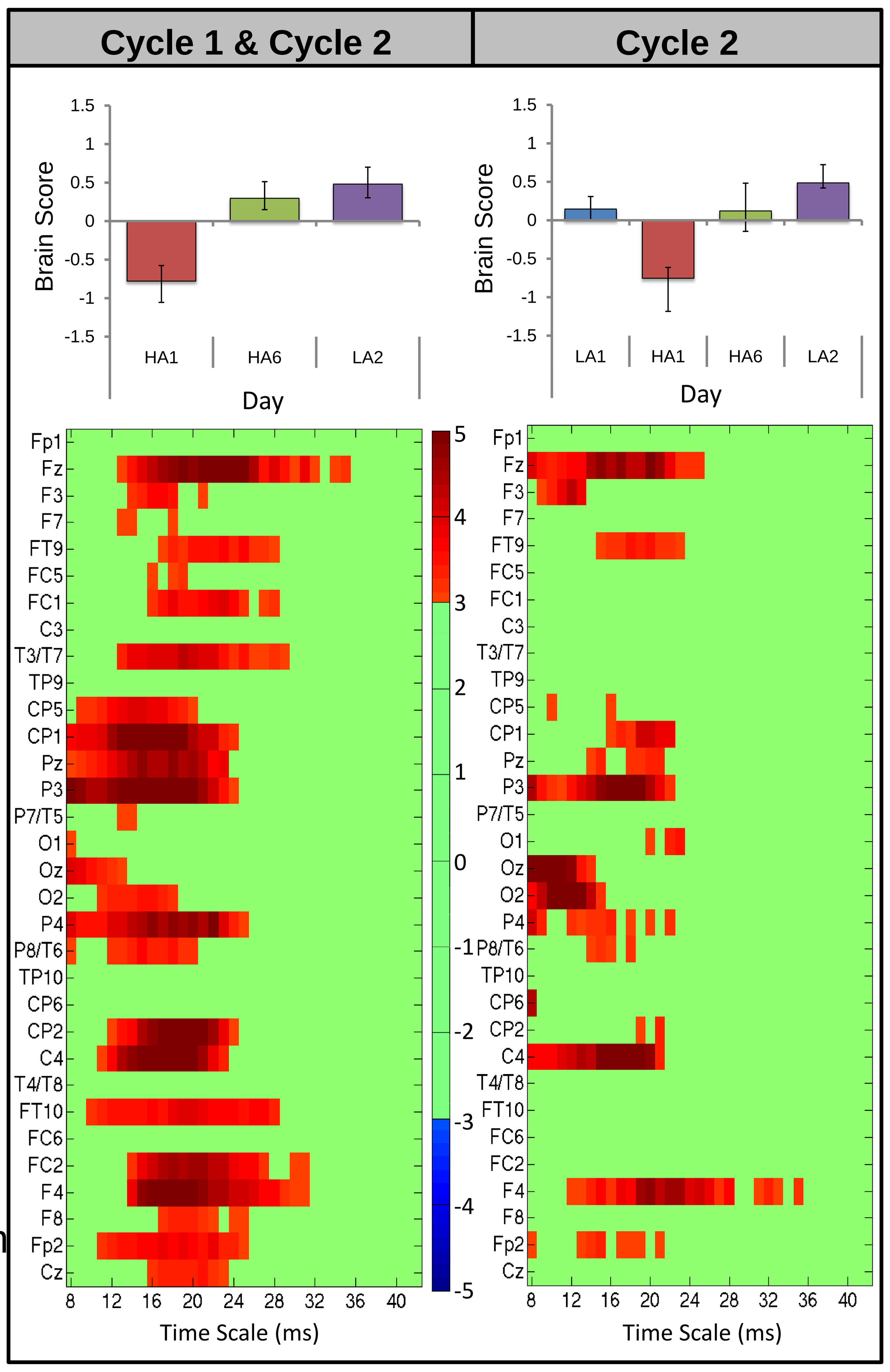
Days HA1, HA6, and LA2

- One significant LV ($p < 0.001$) differentiating HA1 from both HA6 and LA2
- BSV reliably increased on HA6 and LA2 as compared to HA1.

Cycle 2 (n = 8)

We had an additional testing day, LA1. We therefore examined how BSV changed with initial altitude exposure in this group

- One significant LV ($p < 0.001$), differentiating LA1 and LA2 from HA1
- BSV reliably decreased from LA1 to HA1, and increased again by HA6 and LA2



Relating BSV to Behaviour

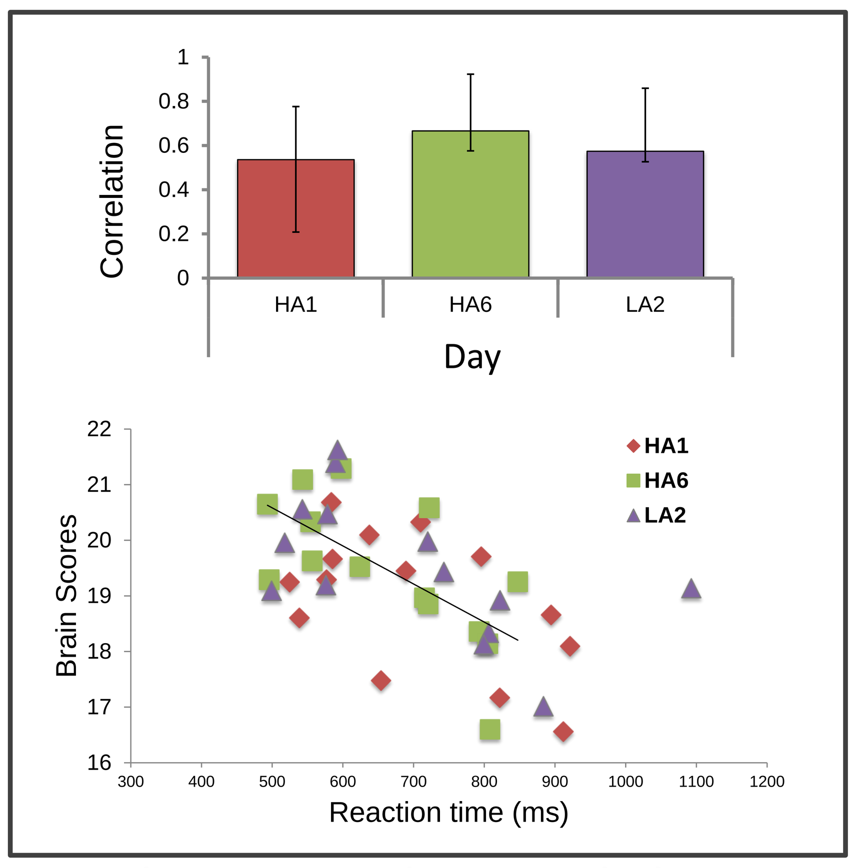
Accuracy approached ceiling (95%), thus only RT data were analyzed:

Cycle 1 & Cycle 2 (n = 14)

Days HA1, HA6, and LA2

One significant LV($p < 0.001$)

- Consistent, negative correlation between resting state BSV and RT for the LDT task across all testing days (RT decreased as BSV increased), as displayed below



Consistent negative correlations between BSV and RT were also present for all days in the Cycle 2 analysis

Discussion

- BSV was lower during initial exposure to high altitude on HA1 as compared to HA6 and LA2, suggesting that information processing capacity is initially lower at high altitude, but increases to baseline levels with prolonged exposure.
- Increases in resting state BSV were correlated with faster RT during the LDT task
- Results suggest that altitude-related changes in resting-state BSV have consequences for information processing capacity, and may have implications for workers at high altitude

References

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