 DOI: 10.3217/978-3-99161-050-2-107

Closed-Loop Augmentation of Cognitive States

Z. Steine-Hanson[1*], M. Mahmood[1], A. Covalin[2], N. Khodaparast[2], J. Kohl[1], I. Plotkin[1], J. Artuso[1], C. Russomanno[1]

[1]*OpenBCI, Inc* [2]*Spark Biomedical, Inc* * 67 West St, Brooklyn, NY 11222 Email: zoe@openbci.com

Introduction:
Enhancing cognitive ability is crucial for improving decision-making and job performance in the future. In this study, our objective is to extend periods of optimal cognitive performance by applying neurostimulation to buffer participants against the effects of increased levels of stress, distraction, and cybersickness. We use OpenBCI's Galea biosensing headset to measure cognitive state and Spark Biomedical's Sparrow Link neurostimulation device to deliver external stimulation in a closed-loop system (figure 1).

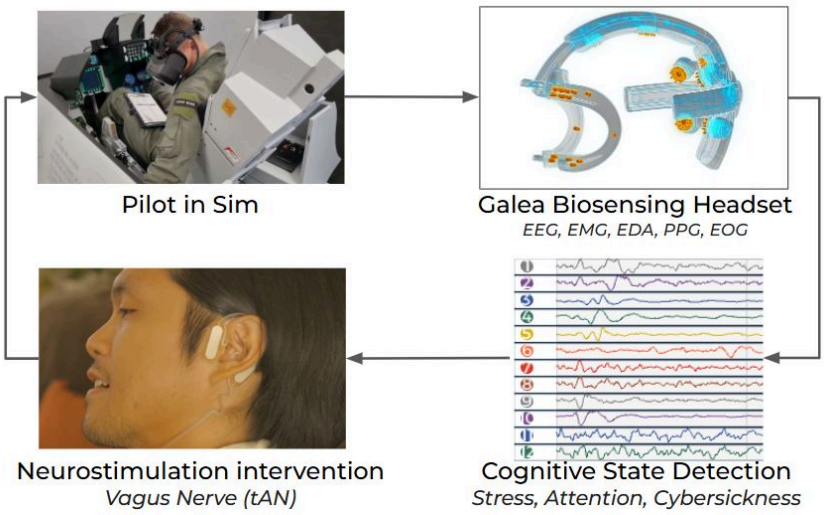

Figure 1: *Overview of the CAMSAN project. Pilots often use virtual reality to train for in-the-field scenarios. We can improve pilot performance during training by developing a closed-loop system to modulate performance. OpenBCI's Galea biosensing headset is used to record multi-modal biosignals during VR experiences. We interpret the signals to predict a users stress, attention and cybersickness. When these cognitive states cross a threshold, we apply neurostimulation on the vagal nerve using Spark Biomedical's Sparrow Link tAN system.*

Material, Methods and Results:
This study contains three phases of data collection. In Phase 1, participants completed four tasks in VR: Flanker [1], GradCPT [2], MATB [3] and a custom cybersickness task, while wearing the Galea headset without any neurostimulation. Galea simultaneously collects EEG, EMG, EDA PPG and EOG during these tasks [4]. In Phase 2, participants completed the same tasks, but with manual tAN applied based on cognitive state. In Phase 3, participants completed the same tasks with the automated closed-loop neurostimulation system. At the time of writing, we have collected Phase 1 data from 15 participants.

Conclusion: This study shows the potential for non-implanted technologies that improve cognitive performance using a passive closed-loop BCI system, and multi-modal biosensors.

Acknowledgments and Disclosures: All authors of this submission are employees of either OpenBCI or Spark Biomedical. As such, they may derive financial gain from the submitted work, whether in cash or in-kind, through mechanisms such as product sales, intellectual property, or other business-related benefits. This research is sponsored by the U.S. Air Force.

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