

Psychophysiological and Performance Effects of Commercial Brain-Computer Interface Technology

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Introduction

- Biofeedback gaming devices have become more prevalent and serve as an inexpensive variant of medical-grade EEG.
- In turn, these commercial off-the-shelf (COTS) brain-computer interface (BCI) devices may be useful for more accessible and economical biofeedback training.
- Physiological self-regulation training with biofeedback gaming devices could be utilized as a leisurely activity performed at home to aid people in a variety of applications (Pope & Prinzel, 2005), including those with attention deficits (e.g., ADHD) and whose jobs require sustained attention (e.g., aerospace operators, baggage screeners, medical technicians).
- Study goal: Examine the effects of self-regulation training with COTS BCI (Training with Mattel Mind Flex™ and Uncle Milton Star Wars Force Trainer™) on users' cortical activity, cognitive performance, and self-reported workload.



Hypotheses

- Training with Mattel Mind Flex™ and Uncle Milton Star Wars Force Trainer™ will result in:
 - Improvement in ability to self-regulate EEG activity
 - Increase high frequency and decrease low frequency EEG activity
 - Increase in cognitive performance on attention tasks
 - Decrease in self-reported workload

Method

Participants

- Recruit approximately 30 participants, ≥ 18 years of age
- Exclusionary criteria: Experience with BCI or biofeedback technology, history of neurological disorder, TBI, cardiovascular disorder, or smoking behavior

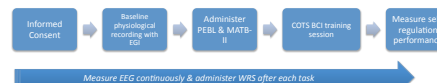
Measures

Dependent Variables	Measures
Self-regulation	3-minutes freeplay with COTS BCI device and evaluate ability to adjust brainwave activity to target pattern
Brainwave activity	32-channel EGI Geodesic Dense Array EEG System 300 to collect continuous EEG data
Sustained attention	PEBL 5-min. computerized version of Connor's Continuous Performance Task (Mueller, 2009)
Working memory span capacity	PEBL Digit Span Task (Mueller, 2009)
Visual attention and task switching	PEBL Trail-Making Task (Mueller, 2009)
Visual attention and working memory	PEBL Letter-Digit Substitution (Mueller, 2009)
Operator Multi-Task Performance	Multi-Attribute Task Battery-II (MATB-II; Comstock & Arnegard, 1992)
Workload	Workload Rating Scale (adapted from NASA TLX; Hart & Staveland, 1988) administered throughout experiment

Procedure

- Participate in up to 4 sessions

Session 1:



Subsequent Sessions:



- Approved by NASA LaRC's IRB

Analysis and Discussion

- Exploratory analyses for the repeated-measures design will be conducted to compare pre- and post-outcome measures across sessions.
- Individual differences that may impact physiological activity and performance will be tested as covariates (i.e., gaming and computer usage, ADHD self-report symptoms, boredom proneness, laterality).
- If training with COTS BCI improves self-regulation, cognitive performance, and/or perceived workload, then follow-up studies should be conducted across various applications to determine the generalizability of the finding.
- Conversely, if self-regulation training fails to present significant improvements, then the utility of these particular devices may be in question.
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