Reading with and without Background Music: An Exploration with EEG, Eye Movement and Heart Rate

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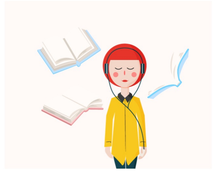
Statement of the Problem



Background Music (BM) is a common practice

- To adjust mood, behavior and engagement during learning

Inconsistent findings: effects of BM on learning (de la Mora Velasco & Hirumi, 2020)

- Positive effects (37%), Neutral (33%) or Negative effects (30%)
- Emotional benefits: Positive vs. Cognitive load: Negative

Research Gap

- predominantly behavioral measures, lack of physiological measures
- whereas EEG, eye movements, heart rates can indicate mental workload and emotional states

Objectives

- This study aims to elucidate the inconsistent findings w.r.t BM on learning
- at both behavioural & physiological levels (e.g., EEG, eye movement, heart rate)

Experiment: Reading Task

Reading Materials

- 8 passages in English
- GRE-level samples from a diversity of fields
- Comparable across passages
  - Flesch-Kincaid Grade; word count
- Questions: text-based, inferential

Two Audio Conditions (within-subject)

- Half of the trials performed with **self-provided preferred music**
- The other half **in silence**

Multimodal Data Collected

14 undergraduate students (7M, 7F) in the U.S.

Data from interactions with computer

- Reading performance
- Self-reported Emotion, Meta-cognition

Data from wearable devices

- EEG signals
- Eye movement data
- Peripheral physiological signals

(a) Cognionics (b) Pupil Core (c) Empatica E4

Data Analysis

Data Processing Pipeline:

Signal Collate & Cleaning → Signal Segmentation → Multimodal Features Extraction → Compare Features across Conditions

Measures (preliminary analysis):

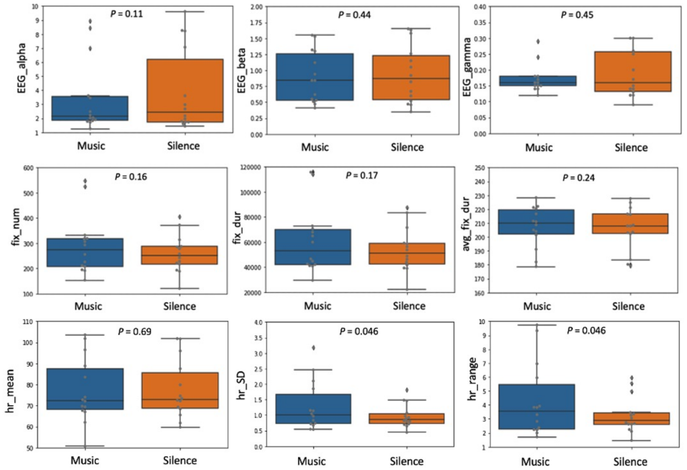
- Alpha(8-13Hz), Beta(13-30Hz), Gamma (30-80Hz) using EEGLAB
- Fixation Number, Fixation Duration, Mean Fixation Duration using Pupil Player
- Heart Rate Descriptive Statistics: Mean, SD, Range

To analyze difference btw. audio conditions

- Boxplots: visualize results in EEG signals, eye fixations, HR for each condition
- Paired-sample T-tests: calculate significant (sig.) levels of differences (diff.)

Preliminary Results

1) sig. diff. in HR SD & range; 2) No sig. diff. in other measures.



Summary

- Demonstrate the feasibility of probing BM on learning through MMLA
- Produce novel methods of broadening LA from behavioral to physiological

Future Work

- Recruit more participants
- Analyze fine-grained characteristics of gathered music from participants
- Interpret multimodal results from emotional and cognitive perspectives