Using Machine Learning to classify Timbre based on EEG Data

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Objective

Explore how different timbral characteristics are encoded in EEG data

Current goal: Determine if a machine can discriminate between EEG data recorded when a participant is listening to different musical instruments

Purpose: For use in development of auditory prosthesis such as BCI-based hearing aids

Current music listening experience for hearing aid users less than ideal

Methods

10 participants

Age (SD)	Gender
27.4 (11.05)	7 Female 3 Male

Experiment

0.5-second A3 (F0: 220 Hz) tones of 4 different instrument timbres: Piano, Trombone, String and Clarinet, and Pure tone

Each instrument presented a total of 200 times

Data recording and pre-processing

EEG recorded from 70 electrodes

5 identical tones were presented in sets, and participants reported the instrument they heard after each set

High pass filter of 0.1Hz

Artifact removal using ICA

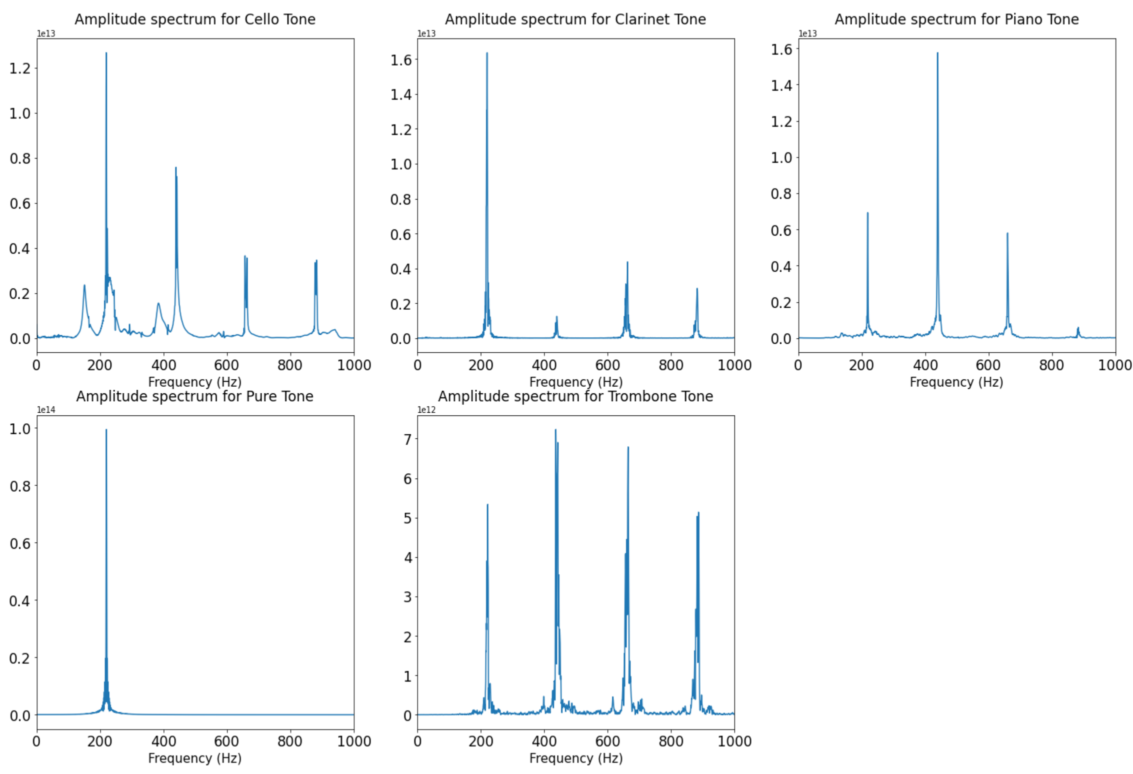
Epochs segmented from -1s to 2s

Classification

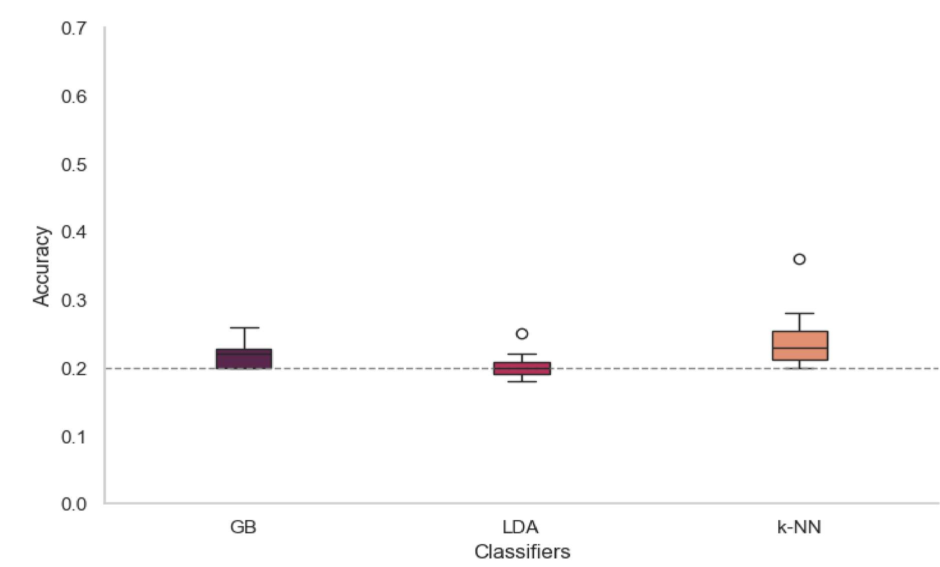
Tested three classifiers: LDA, GB, k-NN

Funding

Results: Harmonics

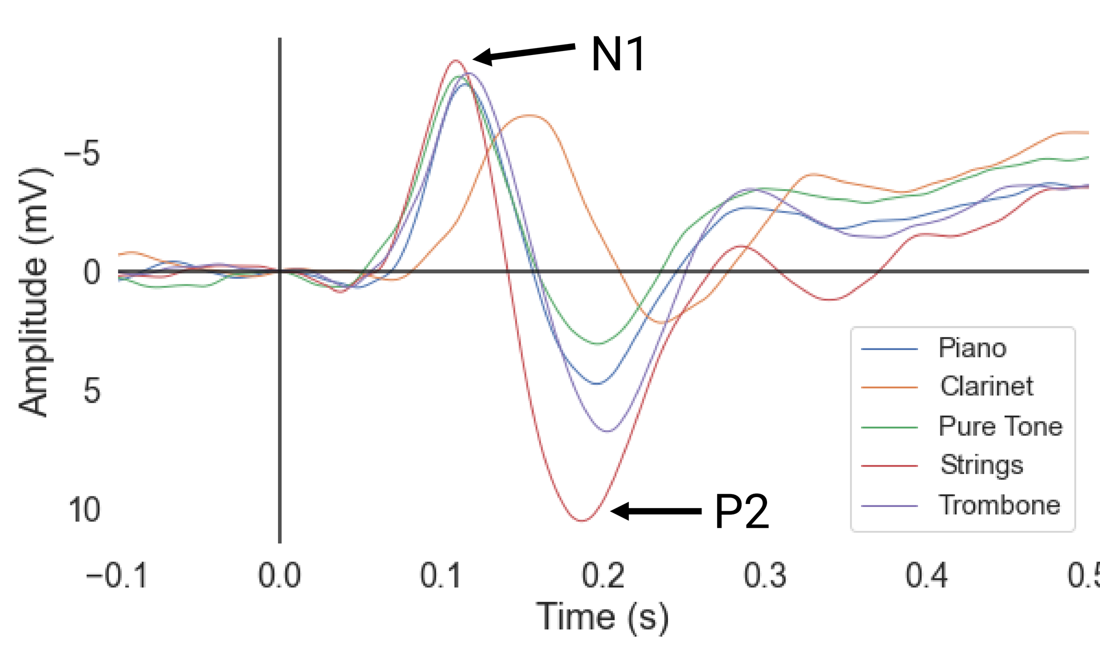


Within-Subject Accuracy using Harmonic Frequency-based Features

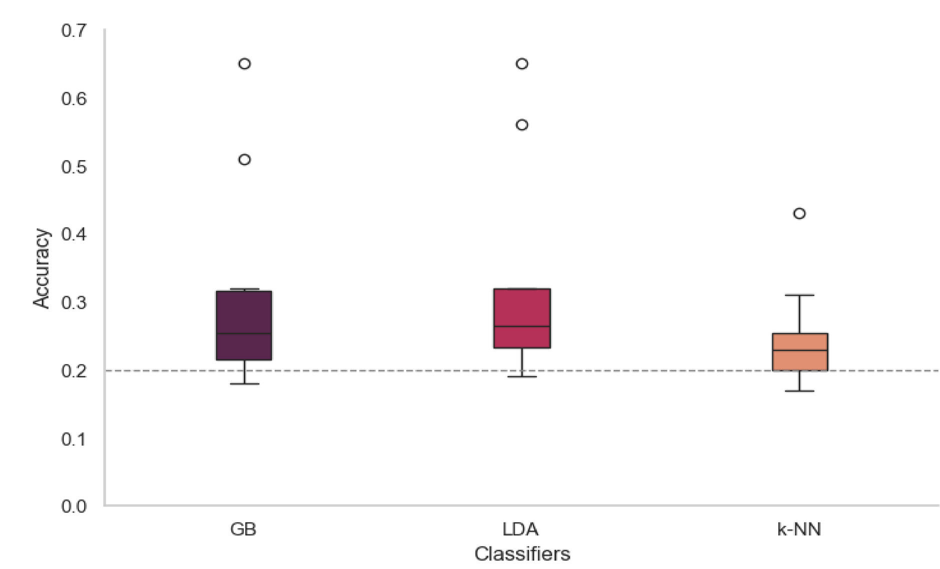


Results: ERP-N1/P2

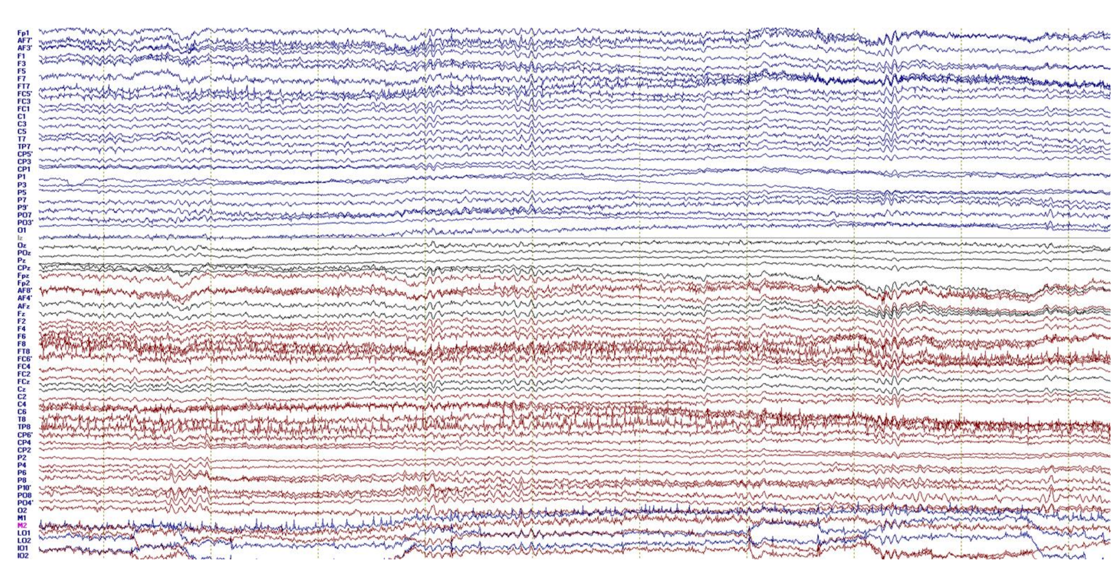
Grand Average ERPs across Participants



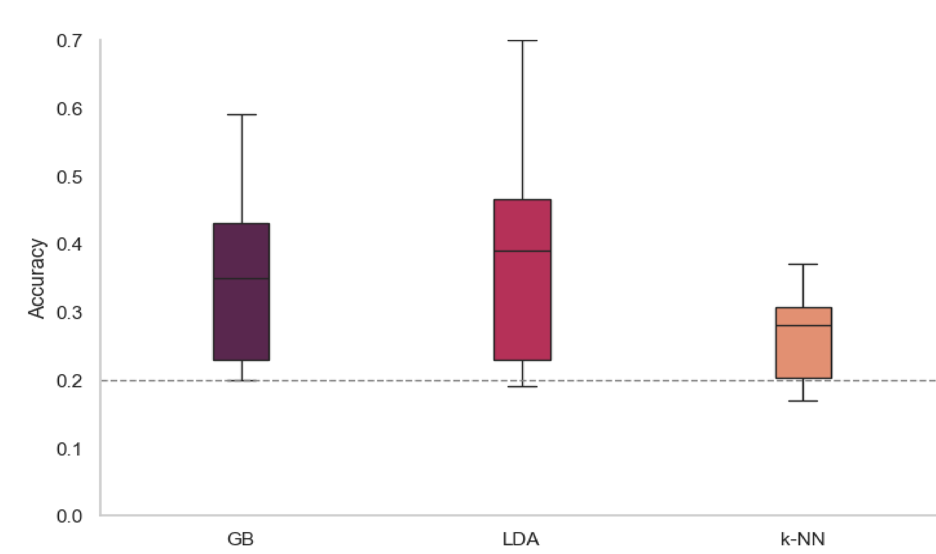
Within-Subject Accuracy using ERP-based Features



Results: Raw EEG

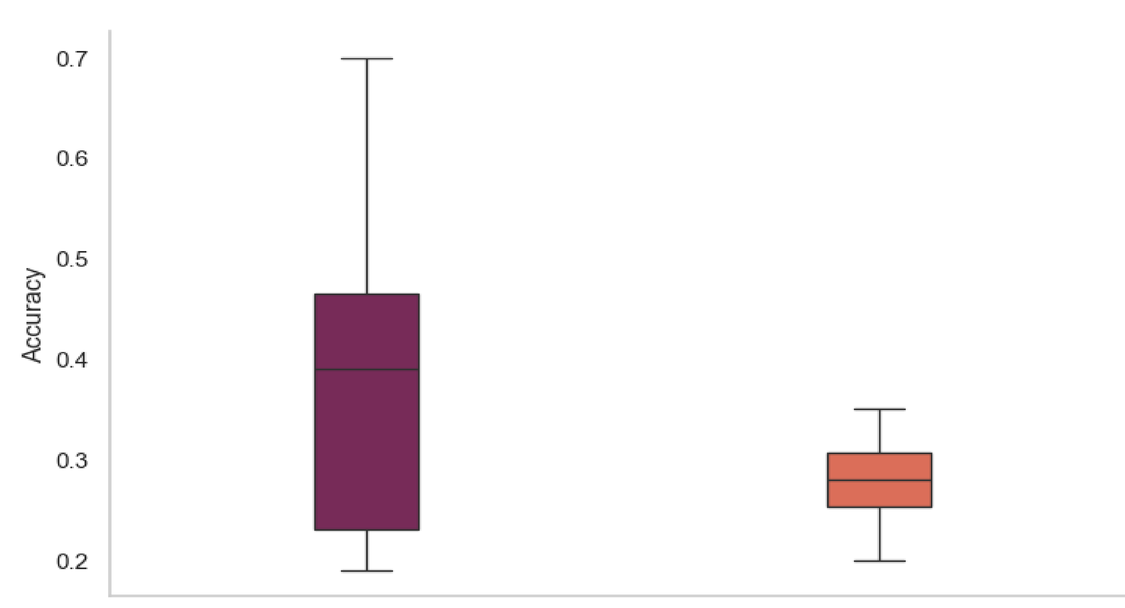


Within-Subject Accuracy using Raw EEG

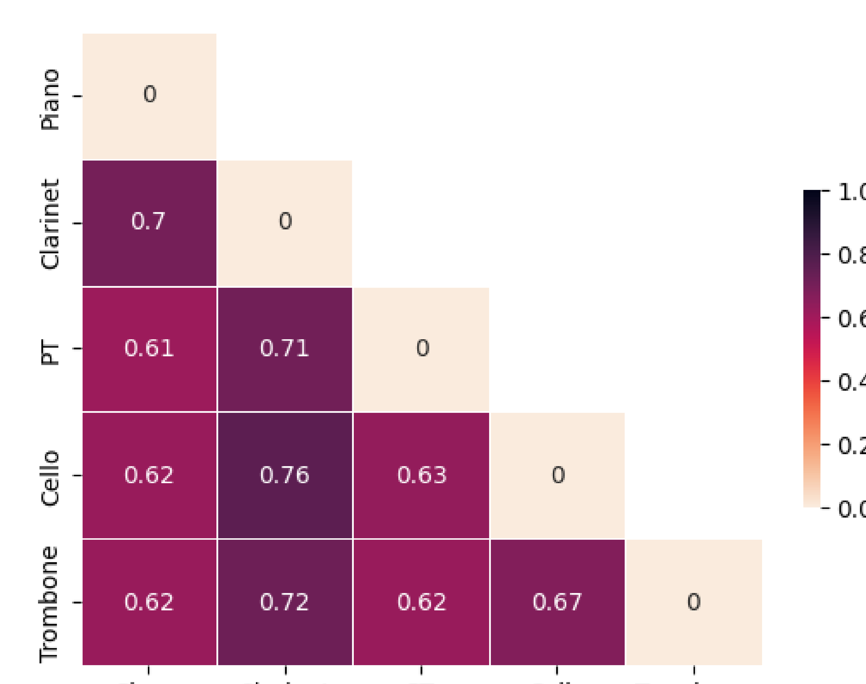


Results: Within-vs Between Participant

Within vs Between-Participant Accuracy using Raw EEG



Results: Pairwise Classification



Methods

Within-Subject models trained on following features individually:

Spectral information around **harmonic frequencies** of audio tone:

Performed FFT on EEG signal
Extracted power around frequencies *27.5Hz, 55Hz, 110Hz, 220Hz, 440Hz, 880Hz*

ERP – N1/P2:
Used mean and peak amplitude and latency of N1 and P2

Raw EEG
Raw EEG input without any feature extraction

PCA used for **feature reduction**

Between-Participant classification performed with **Raw EEG**

Discussion

- Classifier performed **above chance**
- Features related to **harmonic frequencies** did not seem to contribute to classifier performance as much compared to **raw EEG** and **ERP-Based features**
- Performance of **within-participant model > between-participant model**
- More complex models could possibly lead to higher accuracy rates
- Pairwise classification indicates **Clarinet** and **Cello** are the most easily discriminated