# The Effect of Familiarity on EEG

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# Introduction and Motivation

- How does a person's familiarity with a piece of music affect the brain?
- The familiarity of a song might be correlated with one's emotional response and attention while listening
  - Does a familiar song elicit a greater response in the frontal lobes due to increased attention?
- People often play music while studying or working, and examining the brain's response to familiarity could aid in choosing the right type of music to be more focused

Kaushika

# Related Work

- Music and Emotions in the Brain: Familiarity Matters
  - Pereira, C. E., Teixeira, J. A., Figueiredo, P., Xavier, J., Castro, S. L., & Brattico, E. (2011). Music and Emotions in the Brain: Familiarity Matters. *PLOS ONE*, *6*(11), e27241. https://doi.org/10.1371/journal.pone.0027241
- Neural Correlates of Familiarity in Music Listening: A Systematic Review and a Neuroimaging Meta-Analysis
  - Freitas, C., Manzato, E., Burini, A., Taylor, M. J., Lerch, J. P., & Anagnostou, E. (2018). Neural Correlates of Familiarity in Music Listening: A Systematic Review and a Neuroimaging Meta-Analysis. *Frontiers in Neuroscience*, *12*. https://doi.org/10.3389/fnins.2018.00686

# Related Work

- Mere exposure effect: the more familiar or more exposed to something we are, the more we tend to like it
- The N400 wave, an ERP component, is known to be associated with conceptual or semantic processing
- Familiar music, when compared to unfamiliar music, resulted in a larger N400 wave in frontal regions, which could be a result of increased attention due to increased emotional processing

# Methods: General Overview

**Research Question:** How does the familiarity of a song affect one's EEG?

**Basic Plan:**

- ★ Create music stimulus with combination of 10 familiar and unfamiliar music snippets geared towards each participant
- ★ Record EEG using OpenBCI Cyton while playing stimulus out loud
- ★ Compare the EEG results from both participants across familiar and unfamiliar songs

Kaushika

# Methods: Design

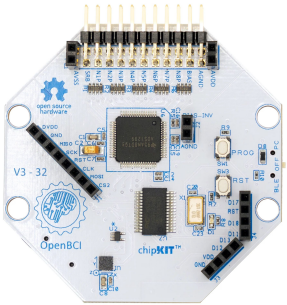
**Participants:** 2 UCSD students

**Stimulus:**

- Created using iMovie, 15-second snippets were taken from each song (5 familiar, 5 unfamiliar), with order randomized by coin flip
- 5 seconds of silence inserted in between each snippet
- Familiar song chosen by participants, unfamiliar song chosen by tester
    - all songs within the pop genre

Kaushika

# Methods: Design




**Procedure:**

- Participant fitted with EEG cap and electrodes were connected to the OpenBCI Cyton
  - Channels used for data collection: ‘Fp1’, ‘F3’, ‘Fz’, ‘F4’, ‘T3’, ‘C3’, ‘Cz’, and ‘T4’
  - Ground electrode placed at ‘AFz’ and reference placed at ‘CPz’
- Music stimulus was played while the participant sat still in a chair in front of the laptop being used for data acquisition
- The period of music playing was manually marked on the OpenBCI GUI through the Cyton, by pressing the button for channel D17

# Analysis: Convert Raw Data

The format of the data we recorded using OpenBCI was a .txt file. To process and analyze the data, we used Python to **transform the data**.

- ★ converted the text file to a data vector with shape **(10, 175, 8)**:
  - **10 trials (5 w/ familiar music; 5 w/ unfamiliar music)**
  - **175 data in each trial (15 sec)**
  - **8 channels** 'Fp1', 'F3', 'Fz', 'F4', 'T3', 'C3', 'Cz', and 'T4'

Zairan

# Analysis: Pre-Processing

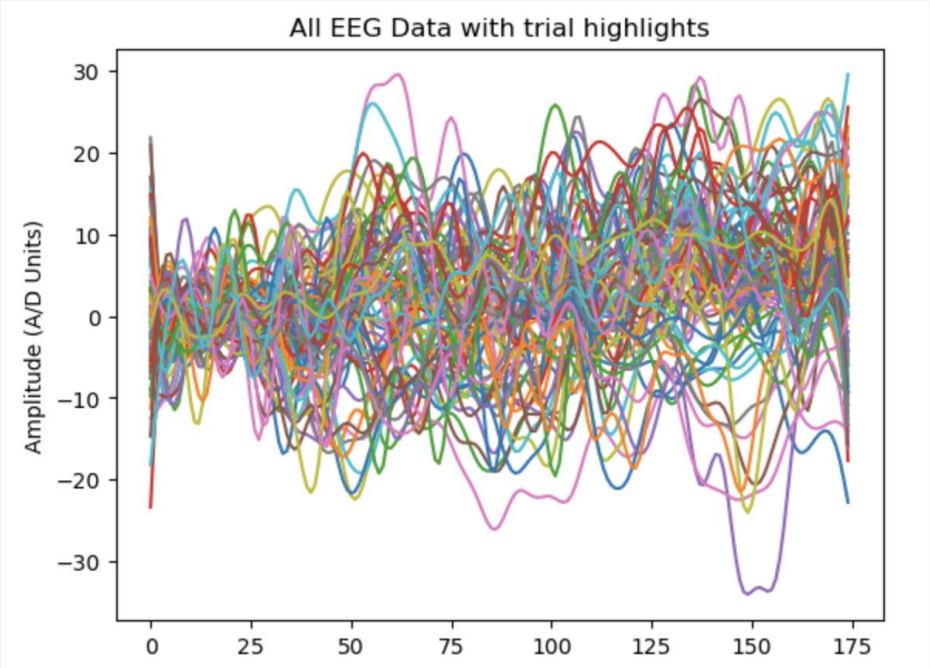
- **Band pass filter**
  (we used a non-causal, zero-phase filter signal.filtfilt)
  - sampling rate of 250Hz
  - low cutoff frequency: 0.1 Hz
  - high cutoff frequency: 30 Hz

- **Epoch:** 0ms before onset, and 700ms after onset
- **Baseline correct**

Zairan

# Analysis: Pre-Processing

there are not too many large noise artifacts:



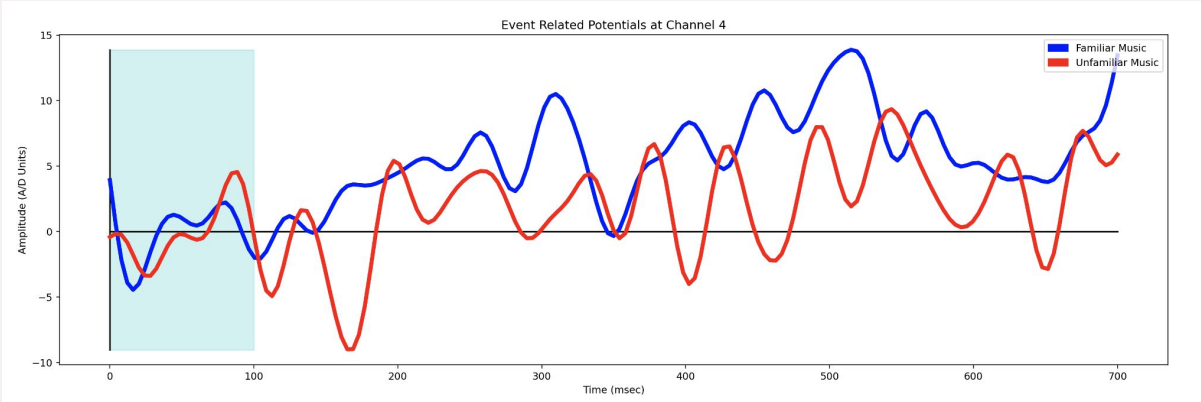

Zairan

# Analysis: Plot ERP

ERP: short segments of EEG data that are time-locked to music-playing events of experimental interest, and averaged over 5 trials of a session.

**Take the average of all trials to create an averaged ERP and plot each channel for familiar and unfamiliar music.**

Example of T3 channel of Participant #2

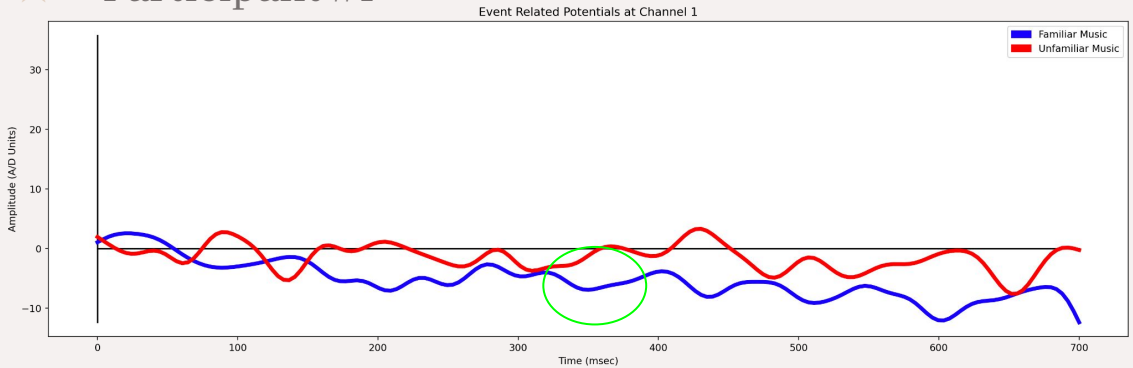



Zairan

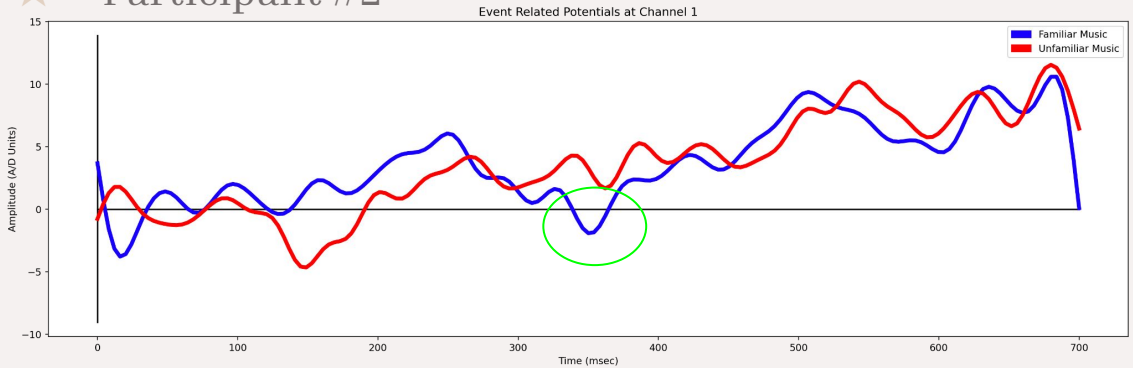
# Results - N400 waves

## Channel F3

★ Participant #1




★ Participant #2

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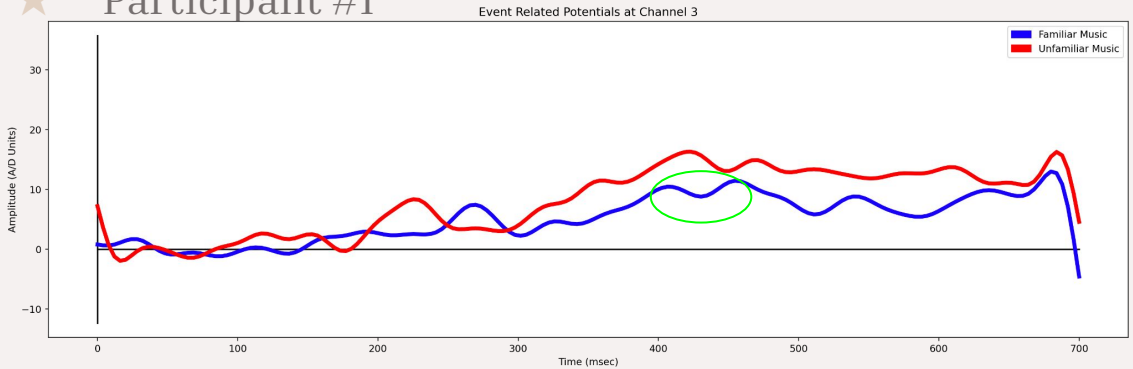
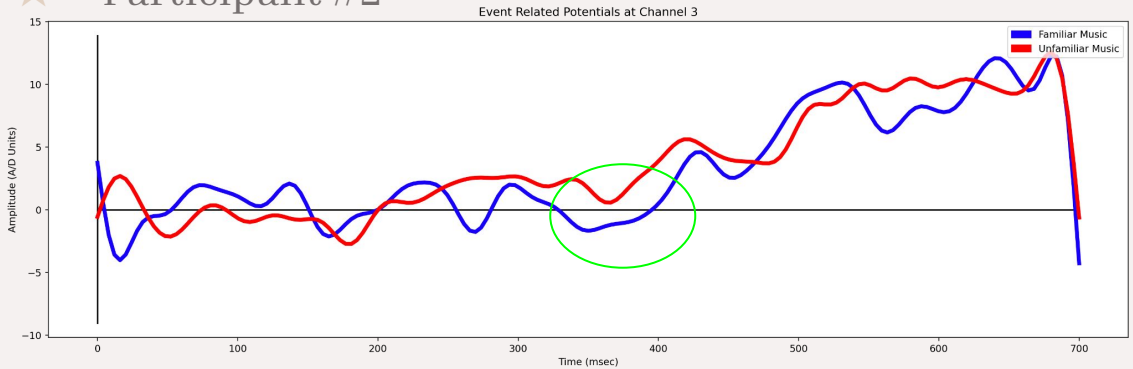
# Results - N400 waves

## Channel F4

★ Participant #1




★ Participant #2

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# Results - Discovery

- The frontal channels exhibited a greater N400 ERP component for snippets of familiar music when compared to snippets of unfamiliar music
  - This therefore could suggest that familiar music results in increased semantic processing due to processing of emotions and/or semantic associations linked to the song
  - This is what we expected to see as familiar songs would have a greater likelihood of an emotional connection
- What went wrong: we had very little data to work with, and therefore, the ERP might not be highly accurate

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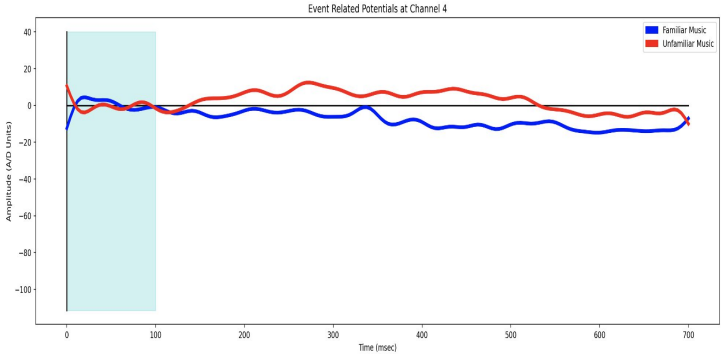
# Results - Difficulties




- We had to redo Participant #1's data collection
  - One of the problems that we ran into on the first day of recording was coordinating the music stimulus without pre-recording it
  - There was also something wrong with the EEG recording itself, as the data seemed to not be collected properly on the first day
- It was difficult for us to perform artifact filtering since we had trouble figuring out which data points in channel Fp1 are considered as artifacts.

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# Discussion - What did we learn?

- ★ We learned how to properly design an EGG experiment, set up a procedure for testing, and collect EGG data using OpenBCI
- ★ Evaluate ERP data and waveforms by analyzing the relationship between time vs. amplitude
- ★ Use Jupyter Notebook and Python to pre-process our data through filtering and epoching
- ★ Greater N400 waves in frontal regions for familiar music compared to unfamiliar music

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# Discussion - Improvements

- Given more time, we would collect data from a diverse number of participants and/or with more trials so ERPs have better accuracy
  - Having a more diverse sample of participants help to increase the generalizability of findings between different demographics, like age, gender, and culture
- Control for differences in music stimuli better, such as factors like BPM, so there are no confounding variables
- Minimize environmental noise and distractions in the recording room to reduce signal artifacts
- Use more of a statistical approach in analysis to test for significance

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# Thank you for your time!