Did you know that Music can...

- ... Help stroke survivors recover their ability to speak and move?
- ... Enable heart attack survivors to exercise longer?
- ... Improve blood vessel function?
- ... Decrease the amount of drugs needed to sedate patients?

Algo-arias

Music and A.I.

Advik Rai

Grade 11, River Hill High School

Mentor

Dr. Alexander Pantelyat, M.D., FAAN

Director, JHU Center for Music and Medicine

Associate Professor of Neurology,

Johns Hopkins University School of Medicine

Agenda

Background on Music Therapy

Emerging Technologies

Research Question, Design

Results and Conclusions

Music Through the Ages

- 60,000-year-old Paleolithic instruments: potential survival value
- Plato: characterized music as a guide toward goodness
- Pythagoras: prescribed music for health

Growth of Music Therapy

- Florence Nightingale (1820–1910)
  - Sustained tones helped patients recover faster
  - Discontinuous tones had negative effects

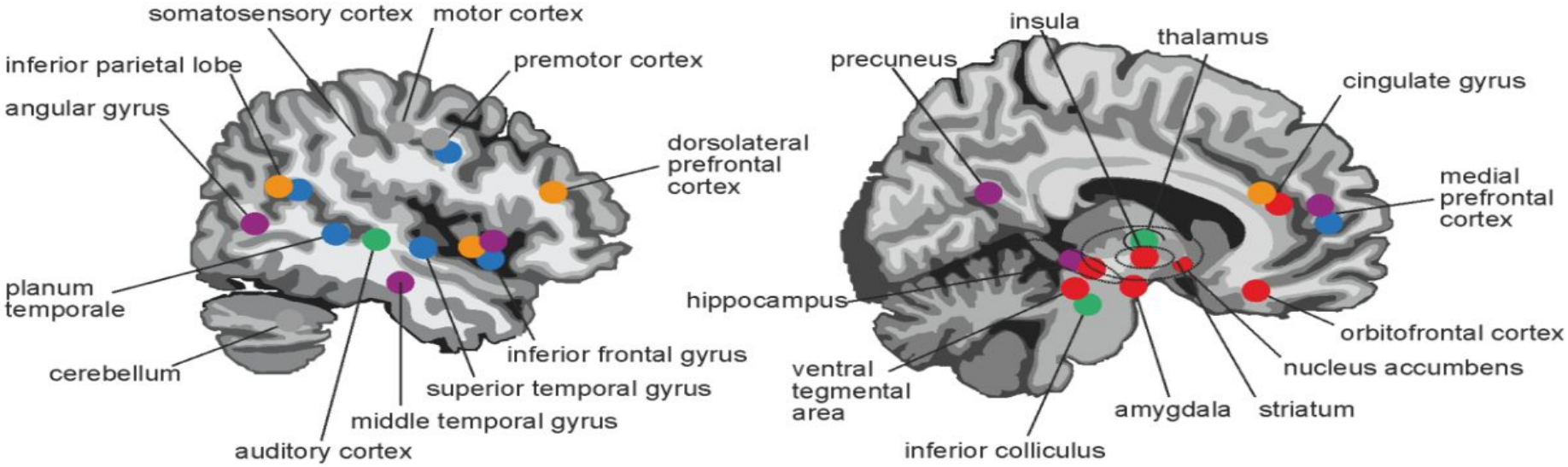
- U.S. War Department music program used to recondition service members (1944–)
  - For PTSD, recuperating from injuries, etc.
  - In-hospital performances
  - First music therapy degree created

Music Therapy Facts

- Dropped ~4.4 mg ME of opioids used by surgical patients in 10 studies (Fu et al., 2020)
- Tailored music intervention reduced $2,155 in expenses per ICU patient (Chlan et al., 2018)

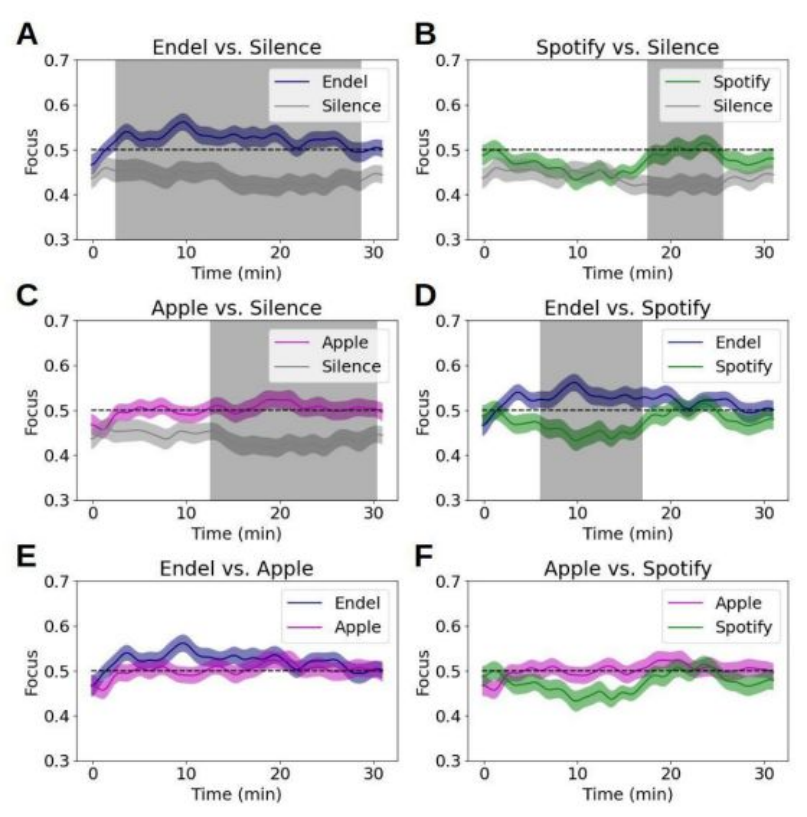
(Woods et al., 2021)

Key Brain Areas for Music Processing



- Basic auditory pathway: perceiving the basic acoustic features of music
- Music-syntactic network: perceiving higher-order musical features
- Attention and working memory network: focusing and keeping track of music in time
- Episodic memory network: recognizing music and recalling associated memories
- Motor network: playing, singing and moving to the beat of music
- Reward and emotion network: music-evoked emotions and experiencing pleasure and reward

Background



- Music is growing in popularity as a non-invasive medical intervention
- Music generated through Affective Algorithmic Composition (AAC) affects your brain directly
- Real-time input highly personalizes this music for much stronger effects

(Haruvi et al., 2022)

My Research Design

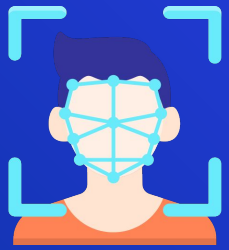
- Imagine a system that "reads" your music taste through facial expression/mood as you listen to different types of music
- It would analyze your facial microexpressions to understand which components of the music resonate most with you
- It would then create personalized music that perfectly complements your unique taste in real-time
- Contrasts with traditional methods which may lack this level of real-time personalization and precision

Research Question

How can AI technology make highly effective and personalized music using computer vision in conjunction with the knowledge of specific musical components such as rhythm, chord progressions, melodies, timbre, etc. to improve emotional regulation in patients with mental health and neurological conditions?

Architecture of My App

User



Music clips

(Headphones)

Facial Expressions

(Camera)

Web App Interface

Timestamps of greatest effect

(Morphcast)

Database of musical components

Musical components at recorded timestamps

Algorithms

Affective Algorithmic Composition

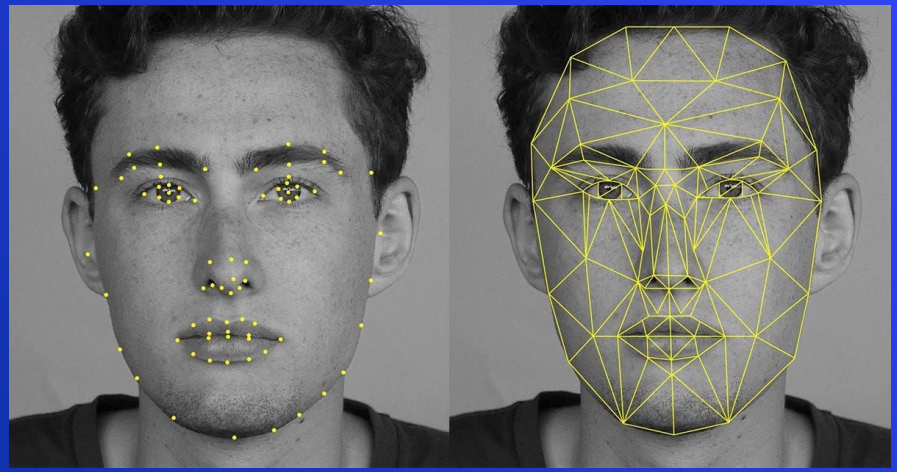
New music

Functioning of the Proposed Application

1. Various samples of music differing in genre, key, timbre, etc. played.
2. Facial microexpressions of the user analyzed in real-time.
3. Timestamps where the user experiences the strongest changes noted.
4. Musical components around those times recorded.
5. New music generated tailored to the user's emotional responses during next session.

Facial expression recognition

Analyzing facial changes to map the mental states caused by music

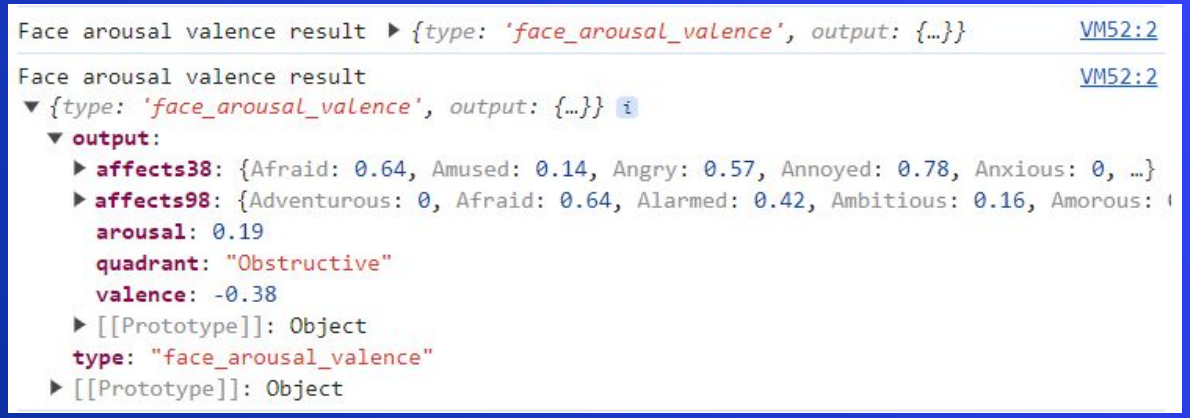


- Universal language
- Provides immediate feedback
- Free from bias and conscious manipulation

(Weth et al., 2015)

Raw Data

Camera pixel data for each frame



Facial **arousal** & **valence** data for each frame

Raw Data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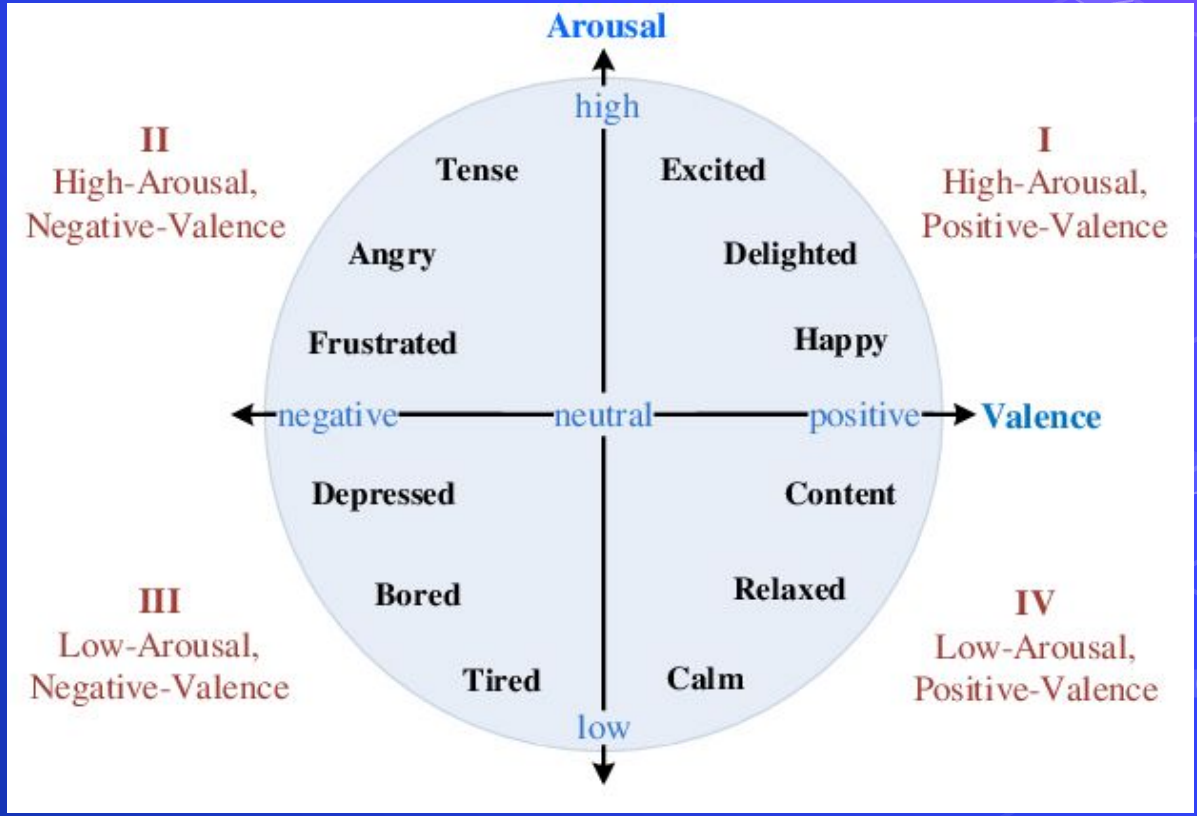
Valence Arousal Circumplex Model



Data Charts

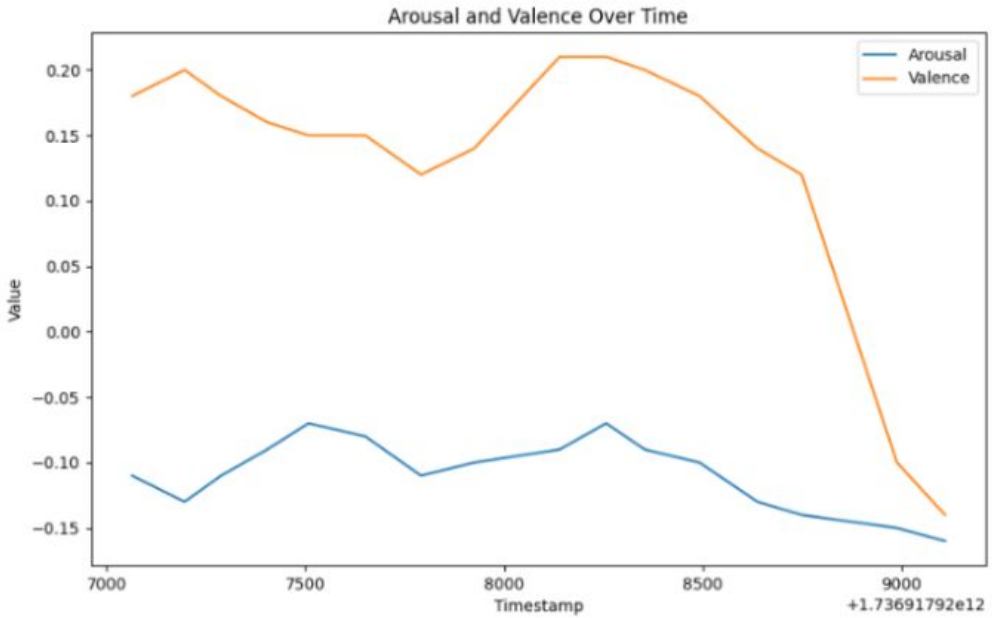
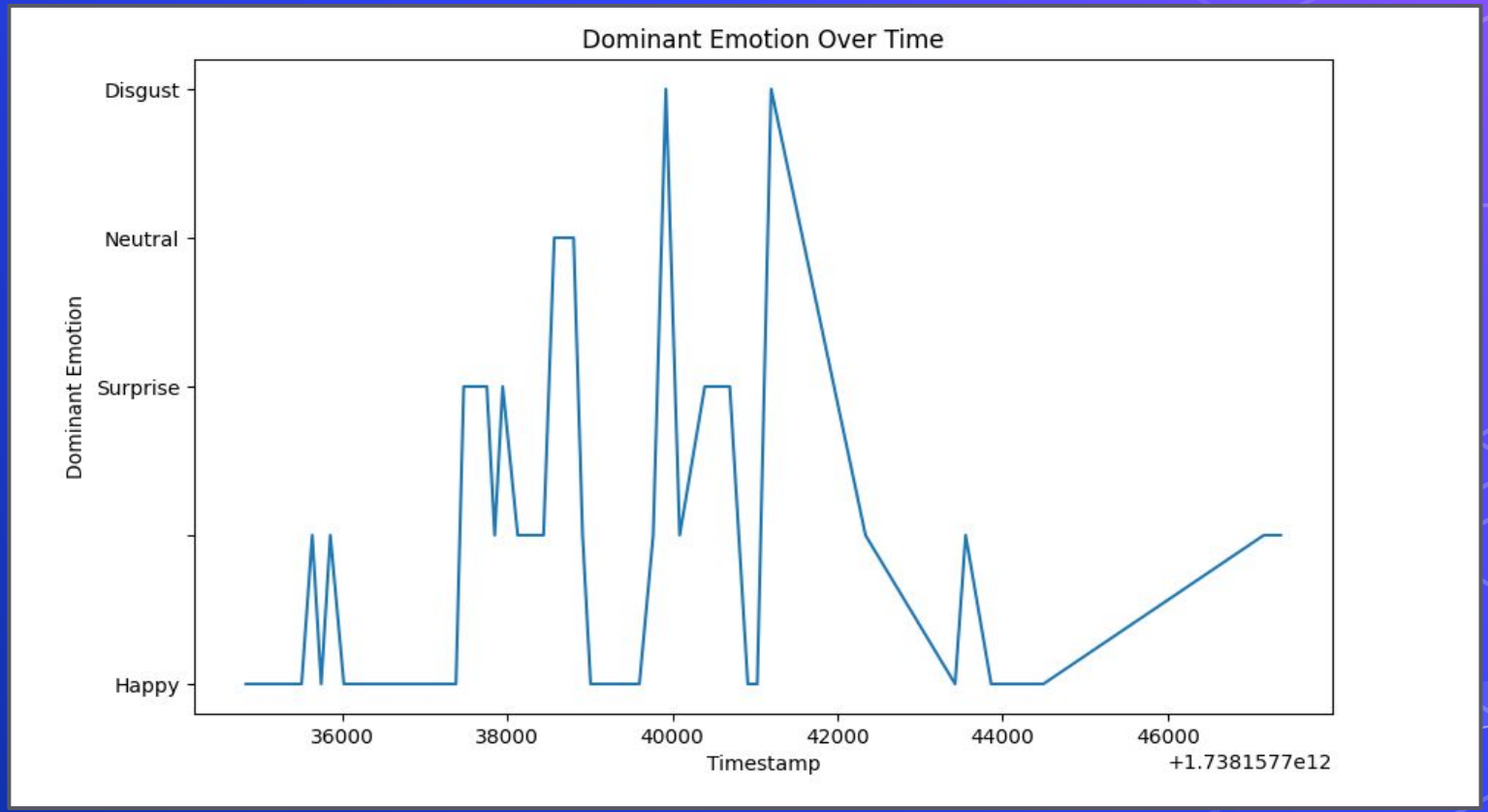


Figure 1.4. User Arousal and Valence plotted over about 2000 ms using Python's matplotlib.

Data Charts


Dominant Emotion Over Time
Disgust
Neutral
Surprise
Happy
Dominant Emotion
36000
38000
40000
42000
44000
46000
Timestamp
+1.7381577e12

Applications and Future Work

- Cost-effective solutions to **alleviating anxiety, stress**
- Reducing duration of **hospital stays**
- Aiding in **substance abuse recovery**
- Reducing the need for opioid dosages for **pain management**
- Contributing to the burgeoning field of **Precision Music Medicine**
- Finding a sufficient blend of music that tests **all musical components**
- Feasibility of **real-time** music generation vs. batch/offline processing
- Aiding those with **neurological** conditions
- Have a **streamlined user experience**
- A **Mobile app** interface

Conclusions and Outcomes

- Music has a **powerful effect on our emotions** which can be harnessed therapeutically
- **Music-based interventions** (MBIs) can surpass cultural boundaries and work for people of all backgrounds
- Personalized MBIs have the potential to **improve mental health**, **manage pain**, aid in substance abuse recovery, etc.
- Technological advancements like **Affective Algorithmic Composition (AAC)** and **Facial expression recognition** offer new possibilities for personalizing MBIs.

“One good thing about music:
when it hits you, you feel no pain.”

—Bob Marley

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