Using EEG-validated Music Emotion Recognition Techniques to Classify Multi-Genre Popular Music for Therapeutic Purposes

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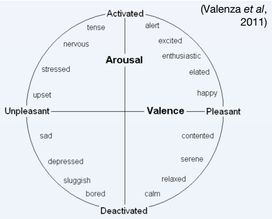
Introduction and Methodology

Music-based musical treatments have much potential for therapeutic and medical purposes, and have been repeatedly validated for use in the latter. However, there is presently a lack of ability to **generalize music-based therapy** to the general public, especially through the use of relatable **popular music**.



(Valenza *et al*, 2011)

Need to validate as method relies on subjective annotation (potentially inaccurate)

Machine Recognition of Music Emotion (Uses Simple Low-Level Music Features)

Low classification accuracy in existing research (~66%) makes it unreliable for use

Objectives

1. Obtain **subject-independent** classification accuracies for **EEG** and **Music Feature** data
2. **Experimentally validate** the viability of **subjective annotation** in determining music emotion
3. **Experimentally validate** the viability of **machine recognition** of music emotion
4. Analysing **subjective annotations** and **topographic maps** for further use
5. Design methods for **emotional induction** and classify **2500** songs by emotion
6. Implement **validated application** allowing for **genre specific** playlist creation

Experimental Methodology

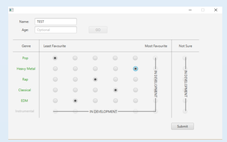
Setting up the EEG setup → User Survey and Instructions → Music Excerpt Playing (26s) → Survey on Played Song/Genre

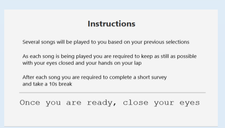
Repeat for 5 genres, 8 songs each

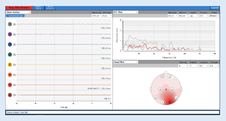
Experimentation → Segmentation → EEG Feature Extraction

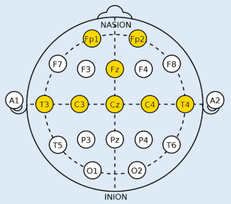
Music Feature Extraction → Cross-Validation of Classification Accuracy

Creation of Topographic Maps ← Data Visualization and Organization






Automated Experiment Program



10-20 Electrode Placement Map


Subject with EEG Electrodes

Results and Discussion

Classification and Validation of Labelling Methods

Songs are selected through expert-annotated process w/ internet chatter → Validate classification methods by comparing with the set → The expert annotated set should be accurate, and strong results will further validate this assumption

Age Range: 13 – 45
Number of Participants: 20
Profile: No Music Education

Random Forest	Instance-based
98.2%	86.8%

Electroencephalography Data

1

Random Forest	Instance-based
95.0%	84.0%

Low-Level Music Features

Alpha (α: 8–13 Hz)	Low beta (β: 14–17 Hz)	Beta (β: 18–31 Hz)
90.4%	**91.2%**	88.0%

Most Predictive Frequency Bands

10-Fold Cross Validation Accuracies for EEG Data, Music Feature Data and Selected Frequency Bands 2 3

2/3 of all instances in a song have the same predicted music emotion → That song will be predicted to possess that said emotion

EEG Classification	Music Feature Classification	Subjective Annotation
100% (40)	100% (40)	74.2%

Accuracy of individual music classification methods (as compared to expert-annotated set)

We arrive at an **integrated approach** to predict music emotion – combining music features and subjective annotations.

Low-Level Music Features + **User's Subjective Annotation**

Subjective Annotations and Topographic Map Data

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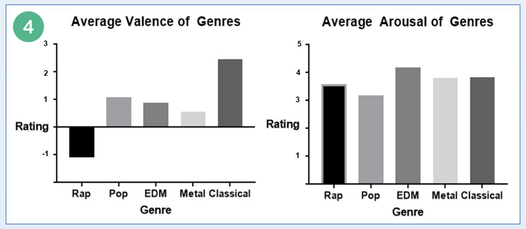
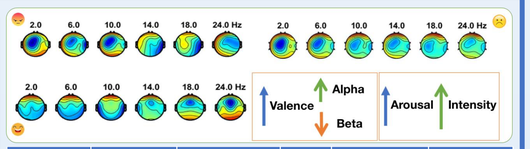




Type	Classical	Heavy Metal	Pop	Electronic	Rap
Preferred	70%	20%	60%	40%	10%
Disliked	10%	70%	20%	20%	80%

Preference for Genre → Higher Perceived Valence → More Positive Emotional Affect

Application – Music Playlist Creation App

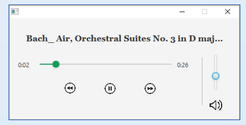
Integrated Model for Prediction of Music Emotion

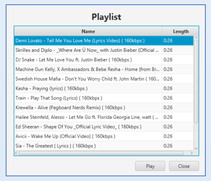
Prediction of emotion through low-level feature classifier

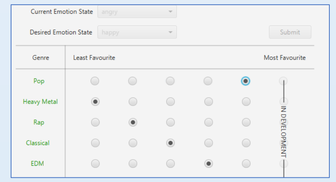
Use of expert-based annotation to annotate music (blinding used)

If both agree, song is classified as such. **2500 songs classified as such**

5







Lack of application for general public to **induce emotional change** for **therapeutic benefits**

Develop application to create musical playlists which will **induce desired mood** in users

Music must be **preferred** by listener to **emotionally engage** the listener

Music must **transition** from original to final emotion to **keep the user engaged**.

Validation for Application

6

Custom playlists were created **on popular streaming platforms** → A total of 31 users were asked to listen to the playlist **after providing** a mood rating (upon 10) → After listening to the playlist, they were asked to **rate their mood** again

	Happy Songs Only	Custom (2 Genres)	Custom (1 Genre)
Mean Change	1.13	2.58	**4.18**
Standard Deviation	1.64	1.16	1.25
P-Value	-	**0.016**	**0.0001**

Validated that our custom methodology provides **more positive mood change** for users (1 genre preferred)

Conclusion

- Obtained **very high** classification accuracies with EEG and Music Feature Data
- Validated **subjective annotation** and **low-level features** for machine recognition uses
- Analysed links between **genre preference** and **perceived valence and arousal**
- Created **topographic maps** to analyse links between **frequency bands and emotion**
- Designed **music playlist creation technique** to induce desired emotion
- Classified **2500 songs** using an **integrated approach** in a validated application
- **Commercialization of technology** alongside **extension to more genres** and classes of affects
- Development of **single-image emotion recognition technology** to remove need for manual emotional input

References (Selected)

All images are self-drawn or edited unless otherwise credited. Emojis were courtesy of Icon Finder. GraphPad was used to draw graphs and Mathematica was used to create topographic maps.

[1] Yang, Y.-H. and Chen, H. H. 2012. Machine recognition of music emotion: A review. ACM Trans. Intell. Syst. Technol. 3, 3, Article 40 (May 2012), 30 pages
[2] MacDorman, Stuart Ough Chin-Chang Ho, K. F. (2007). Automatic emotion prediction of song excerpts: Index construction, algorithm design, and empirical comparison. Journal of New Music Research, 36(4), 281-299.

Acknowledgements and Publications

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Agency for Science, Technology and Research SINGAPORE

EMBC'18 Honolulu, HI