Modeling Psycho-Physiological Measurements of Emotional Responses to Multiple Music Genres

Eduardo Coutinho

Department of Music, University of Sheffield, UK

BACKGROUND AND AIMS

A considerable corpus of literature has consistently reported that listeners agree rather strongly about what type of emotion is expressed in a particular piece and even in particular moments or sections. These studies suggest that sound features as well as relationships between musical events encode characteristics of affective expression to which listeners respond. We sustain that the structure of affect elicited by music is largely dependent on low-level music properties to which humans are particularly sensitive. In support of this claim, we have previously provided evidence that spatio-temporal patterns in "secondary" music structural parameters resonate with the perception of emotional expression in music (Coutinho & Cangelosi, 2009). In this work, those investigations were extended in two aspects. Firstly, whilst previously the focus relied primarily on western classical music, here a repertoire of multiple music genres was used in order to verify the extent to which the relationships linking sound features and emotion reflect general principles across music genres, or, instead, are genre-specific. The second aspect involves the evaluation of physiological cues as predictors of emotional responses to music.

METHOD

The work reported here combines empirical data and computational modeling. The empirical data was obtained from a previous study by Grewe, Nagel, Kopiez and Altenmüller (2007). Participants' listened to a set of musical pieces from seven different genres – instrumental classical, dance, film, rock, pop, vocal classical and death metal - while reporting continuously their emotional experience in terms of two psychological dimensions of affect: arousal and valence. At the same time, participants' skin conductance response (SCR) was measured. The computational model consists of a previously developed framework based on spatio-temporal connectionist networks, which predict continuous changes in experienced emotions by assessing psychoacoustic patterns (organized through music) distributed across space (i.e., relationships among individual sound features and their interactions) and time (i.e., the memory of the past states of these features and their relation to emotional responses) (Coutinho & Cangelosi, 2009). A subset of the data (four pieces: dance, rock, pop, death metal; 1031 s of music) was used to train the model, i.e., to explore the associations between low-level music features and listener's emotional responses. The remaining three pieces (instrumental classical, vocal classical and film music; 933 s of music) were used to assess the model's prediction accuracy, i.e., to evaluate the similarity between its predictions to unknown stimuli and human listeners' responses. Two separate simulation experiments were run: one that uses only the six low-level music features (independent variables) to predict human subjective feelings of emotion (dependent variables), and another which evaluates the additional contribution of physiological arousal as a predictor of listeners' reported emotions.

RESULTS

Results show reliable predictability of the emotional responses for the different genres. We found that a significant part of the listeners' reported emotions (explaining more than 70% of the total variance in arousal and in valence for all pieces) is conveyed from a set of six psychoacoustic features - loudness, tempo, pitch level, melodic pitch, sharpness and texture. The accuracy of those predictions was improved with the inclusion of SCR, although its contribution was rather small compared with the supremacy of sound features (reflected in an increment of 5% in the variance explained). These results are coherent with our previous studies (Coutinho & Cangelosi, 2009, 2010). The fact that the figures reported here correspond to the model predictions to unknown music (approximately half of the pieces) indicates that sound features are good predictors of emotional experiences to music. Furthermore, in the context of this experiment this fact is even more determinant: configurations of low-level perceptual features with emotional meaning learned from pop, dance or rock music, were successfully applied to the prediction of emotional responses to classical and film music. These results strongly suggest common underlying principles ruling the expression of emotion across music genres.

CONCLUSIONS

A connectionist model was used to make accurate predictions of listeners' emotional responses to music based on low-level music features and, alike our previous studies, we were able to bring the prediction of emotional responses to music to an appropriately high level, including predictions of emotional valence which are recurrently harder to ascertain. We have also confirmed that subjective feelings responses are also a function of visceral activity, a finding also supported by previous work. In addition, we demonstrated that the configurations of psychoacoustic features with emotional meaning learned from one genre are applicable to the prediction of emotional responses to a different one, showing that similar acoustic templates are shared across genres to convey emotional meaning. In this context, this work contributes with new insights to the study of musical emotions by specifying a detailed description of the emotion-related acoustic characteristics that appear to be responsible for the perception of emotions across music genres. Moreover, it provides support for the broad-applicability of the developed model in the analysis of emotional responses to music, particularly in those contexts in which a deep understanding of music affective power is fundamental for continued application (e.g., cognitive skills enhancement, physical and cognitive recovery).

REFERENCES

Coutinho, E., & Cangelosi, A. (2009). The use of spatio-temporal connectionist models in psychological studies of musical emotions. *Music Perception*, 27 (1), 1-15.

Coutinho, E., & Cangelosi, A. (2010). Musical emotions: predicting second-by-second subjective feelings of emotion from psycho-physiological measurements. *Manuscript submitted for publication*.

Grewe, O., Nagel, F., Kopiez, R., & Altenmüller, E. (2007). Listening to music as a re-creative process: physiological, psychological, and psychoacoustical correlates of chills and strong emotions. *Music Perception*, 24 (3), 297-314.

TOPIC AREAS

Music and emotions; Cognitive modeling of music; Acoustics and psychoacoustics.