Can Listeners Identify Perceived Emotion in Music from a Foreign Culture?

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ABSTRACT

In this experiment, we aim to find out how listeners perceive traditional folk music, in particular of Chinese origin. We hypothesize that people can perceive the expressed emotion to some extent regardless of enculturation. We found 16 musical excerpts of traditional Chinese operas and asked the participants to choose the emotion perceived from four choices: sad, happy, angry, and calm. Immediately after that, the participant will choose 1 out of 9 psychophysical features of the excerpts that mostly influenced their selection on emotion. We used chi-square statistics for categorical data to analyze the data. Furthermore, we used binomial distribution to simulate the likelihood of the results. As it turned out, there is a strong correlation between the perceived emotion and the ground truth for each stimulus. However, some psychophysical features might contribute to two different emotions, thereby confusing the participants. We found out that our hypothesis is valid to a certain extent. There are psychophysical cues, but they contain mixed meanings on the intended emotion even when the cues are correctly identified.

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1. Introduction

Motivation

We were intrigued with the contrast between Western classical music and Eastern traditional music. We wanted to explore listeners' ability to identify perceived emotion in a foreign culture's music, for one important and interesting aspect of musical experience is emotional communication.

Literature

Previous researches suggest that listeners can at least identify the emotion being communicated in the music of a different culture after little exposure, even though the listener may not be 'moved' internally by that music. An earlier study by Meyer, Palmer, and Mazo (1998) found that Western listeners identified the emotional intention of Russian laments as more sorrowful and more internally coherent if recordings included a specific timbral cue. Balkwill and Thompson (1999) played excerpts of Hindustani *ragas* to Western listeners and asked them to rate the music on the degrees of joy, sadness, anger, and peace. The listeners' ratings correlated strongly with the intended emotions for three of the emotions. In another study, Balkwill, Thompson, and Matsunaga (2004) found that Japanese listeners accurately recognized the emotions that Japanese, Western, and Hindustani music were intended to convey. In both studies, Balkwill and his colleagues observed that listeners' judgments of emotions in music corresponded with listeners' evaluations of musical dimensions such as tempo, loudness, and complexity of the melody. Fritz and his colleagues (2009) studied a native African population with no prior exposure to Western music at all, and found that they were able to identify three basic emotions expressed by pieces of instrumental Western music. An important possibility to consider is that although musical properties vary greatly across cultures, there appears to be a universal set of emotional prototypes. This argument has been made strongly in a book entitled *The World in Six Songs* by Daniel Levitin (2008). By Levitin's account, music is an intrinsic part of human identity. Therefore, the messages communicated in music reflect core elements of humanity, and these elements come up as universal themes.

Hypothesis

Listeners of one culture (Western) can perceive the intended emotion in music from an unfamiliar tonal system (traditional Chinese instrumental and vocal music). Furthermore, there is a strong association between judgments of emotions and psychophysical aspects of music.

2. Methodology

Experimental Design

We used the emotions of the 16 traditional Chinese music excerpts and 9 psychophysical features as independent variables. Our dependent variables are emotions rated by the listeners for each piece and psychophysical variables rated by the listeners. The control variable was participants' familiarity with traditional Chinese music and its tonal system. Most participants were not familiar with traditional chinese music before the experiment. Participants were also given the same musical excerpts. One confounding variable that came across was the participants' level of knowledge in music theory, for the psychophysical variables were specific musical terms. We tried to control by using the most general musical terms and renaming some

musical terms to help the participants understand the language (like pitch range instead of range). One nuisance variable would be participants' mood, since our dependent variable relatively corresponds with their emotions. It was controlled by making sure participants understood that they should respond to the emotion that they believe is being expressed by the music, not the emotion they feel.

The operational definitions that were used in this experiment are the 4 specific emotions (joy, sadness, anger, and peace) and the definition of perceived emotion. Each musical excerpt was intended to convey one of the four emotions (happy, sad, angry, and calm) that corresponded to the four emotions rated by listeners (joy, sadness, anger, and peace) respectively. For the pieces that had multi movements with different emotions, we made sure to only capture a segment of the piece that corresponded with intended emotions to set the ground of truth. We also specified the emotions the participants could choose from 2 (joy and sadness) to 4 emotions to capture precise data.The participants were informed to choose the emotion that they feel is being expressed by the music, not necessarily the emotion they feel themselves by the music.

Stimuli

Most traditional Chinese music, both instrumental and vocal, tells a story, depicts a state of mind, or reflects on a value. We looked into the story, background information, title, and lyrics to identify conveyed emotions. 4 musical excerpts in each of the 4 targeted emotion categories were prepared (16 excerpts total). For each emotion, 2 excerpts were instrumental and the other 2 were vocal. Each except was about 30 seconds in length.

The participants were presented with all 16 musical excerpts to listen and respond. We designed our experiment as a within-in subject design, because we wanted to make sure the participants were exposed to all specific targeted emotions to minimize biased results and to maximize our data with just 25 participants.

Measuring the dependent variable

The participants were tested individually. After filling out a demographic questionnaire, they were instructed to listen to one musical excerpt, a stimuli, at a time, then answer what emotion they thought the music intended by clicking one of the preselected 4 boxes with joy, sadness, anger, and peace. The participants chose what musical aspect most heavily influenced their prior choice from the 9 pre-selected psychophysical features (timbre, orchestration, melodic complexity, rhythmic complexity, tonality, tempo, dynamic, pitch range) immediately after.

Experimental Interface

Our experiment can be found:
http://ccml.gtcmt.gatech.edu/experiments/Group4/experiment.html

3. Data Collection

2 participants out of 25 answered they were very familiar with traditional chinese traditional music and opera, 1 participant answered moderately familiar, 7 participants answered very little familiar, and 15 participants answered not familiar at all.

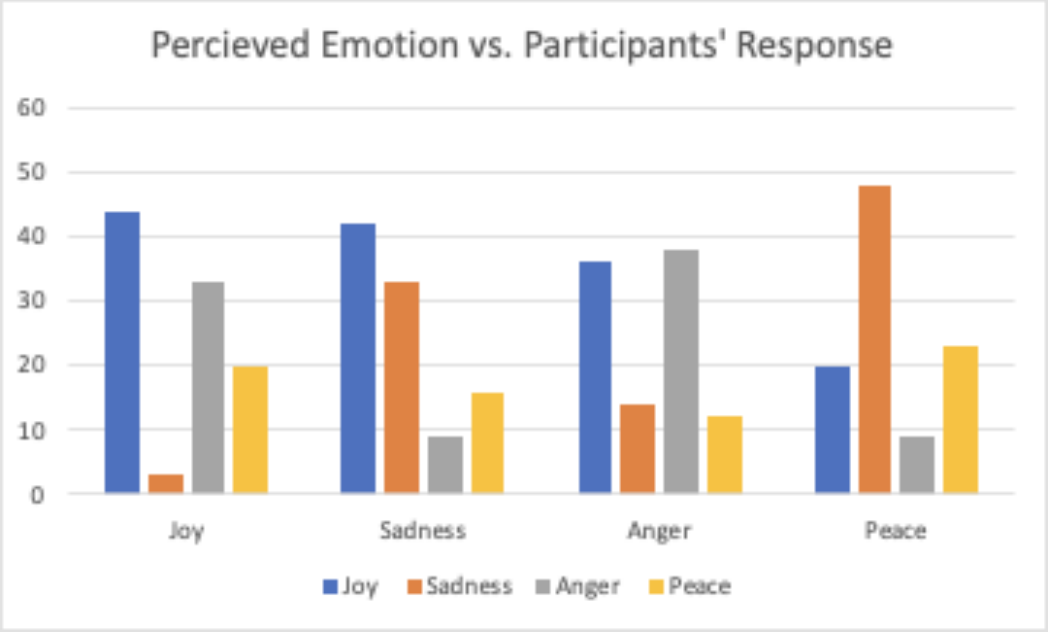
Below is the table that captures the counts of participant's responses.
https://docs.google.com/spreadsheets/d/1kM5nh0smgfV0HaKQ2-_qF4Hp7Tm_rMhC7rDQ9Zu0jSA/edit?usp=sharing

4. Analysis

Summary Description

Grouping the Stimuli into 4 groups by their "ground truths," we established the contingency table below

Stimuli	Perceived (truth)	Joy	Sadness	Anger	Peace	Total
1, 7, 12, 16	Joy	44	3	33	20	100
4, 8, 9 , 14	Sadness	42	33	9	16	100
3, 5, 10, 13	Anger	36	14	38	12	100
2, 6, 11, 15	Peace	20	48	9	23	100
Total		142	98	89	71	400



Descriptive Statistics

	Joy	Sadness	Anger	Peace	Total
Average Counts for all stimuli	**35.5**	**24.5**	**22.25**	**17.75**	**100**

This table above shows that people gravitate towards joy and steer away from peace when interpreting the emotions. The data is similar to expected counts in the statistics test later.

Statistical Test

H_0 The selections of perceived emotion by the participants are not associated with the ground truth

H_1 The selections of perceived emotion by the participants are associated with the ground truth

Expected counts

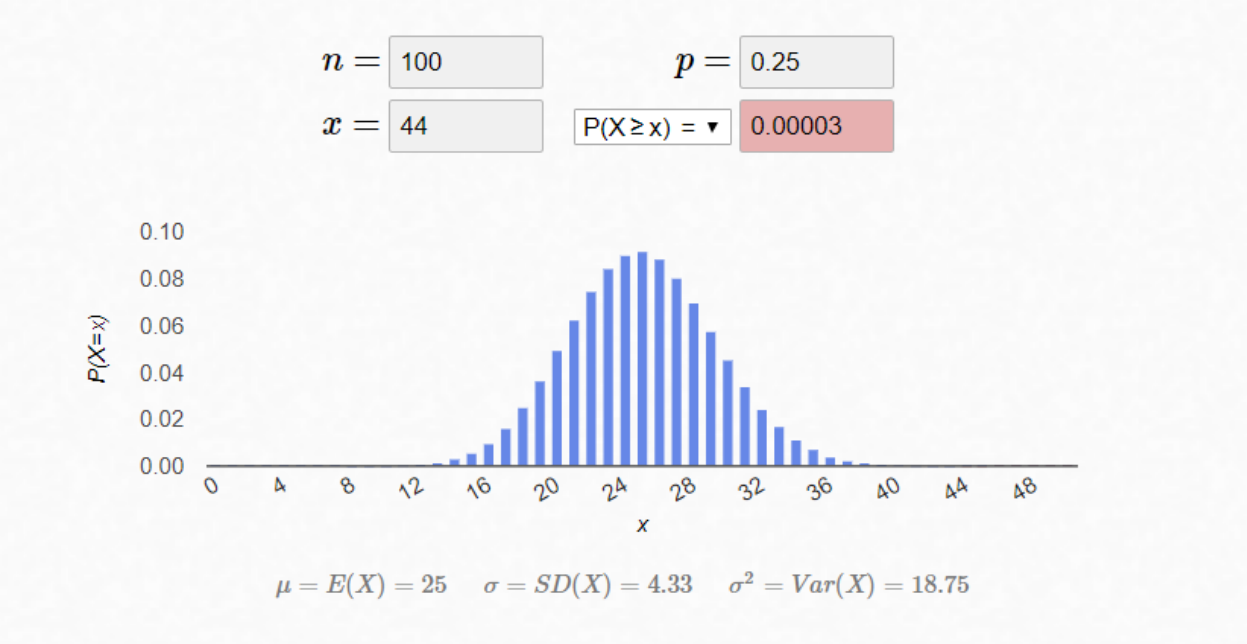
Stimuli	Perceived (truth)	Joy	Sadness	Anger	Peace	Total

1, 7, 12, 16	**Joy**	**35.5**	**24.5**	**22.25**	**17.75**	**100**
4, 8, 9, 14	**Sadness**	**35.5**	**24.5**	**22.25**	**17.75**	**100**
3, 5, 10, 13	**Anger**	**35.5**	**24.5**	**22.25**	**17.75**	**100**
2, 6, 11, 15	**Peace**	**35.5**	**24.5**	**22.25**	**17.75**	**100**
Total		**35.5**	**24.5**	**22.25**	**17.75**	**400**

Chi-square = 94.854
Degrees of Freedom = 9
p value = 1.7×10^{-16}

The null hypothesis is rejected, since $p < 0.05$, and we can conclude that there is an association between the selected emotions and the actual emotions. The test concluded that randomness is hardly a factor in the results of the experiment. However, it does not tell how well the participants can correctly identify the emotion expressed in each piece. Therefore, we decided to use a binomial cumulative probability distribution function to calculate the probability of such occurrences.
Trial number: 100 probability: 0.25 actual turnout: 44 (happy) 33(sad) 38(anger) 23(peace)

H0: it is equally likely (25%) for the participants to choose one among the four emotions
H1: it is not equally likely for the participants to choose one among the four emotions



After four runs of binomial pdf, here are the results:

For the stimuli that are happy as the ground truth, 0.003% of the time would result in 44 counts or more out of 100 trials. For the stimuli that are considered sad as the ground truth, 4.46% of the time would result in 33 counts or more out of 100 trials. For the stimuli that are considered as angry, 0.275 % of the time would result in 38 counts or more out of 100 trials. For the stimuli that are considered as calm, 71.3% of the time would result in 23 counts or more out of 100 trials.

The data above shows that the selection is far from random probability distribution. Except for stimuli that are considered as calm, the other stimuli were somewhat correctly predicted by the participants. However, there are confounding variables that hinder the independence of the variables. We see that joy and anger have a strong positive correlation with one another. We also observed that sadness and calmness have a strong positive correlation with one another. Perhaps, our operational definition wasn't clearly elicited to the participants before the experiment. Another explanation would be confounding variables of the psychophysical cues. For example, a decrease in dynamics might suggest sadness and calmness. An increase in melodic complexity might correspond with increases in anger and happiness.

The table below presents the sum across all stimuli against the psychophysical cues, which suggest the emotion of the participants' choice. Out of the nine musical elements, tonality, orchestration and timbre ranked the most effective indicator, respectively, for emotional indicator for all 4 perceived emotions. For happiness, scale ranked as the most effective indicator. For sadness, melodic complexity ranked as the most effective indicator as well as tonality.

	Timbre	Tempo	Orchestration	Tonality	Scale	Dynamics	Melodic Complexity	Rhythmic Complexity	Pitch range
Count (total)	**55**	**44**	**61**	**86**	**44**	**51**	**39**	**20**	**0**

We did similar analysis on psychophysical features. We grouped the stimuli into four groups by their intended emotion. From the table below, we can easily see that happiness and anger are determined primarily by tonality and scale. Orchestration has a huge effect on happiness of the piece. Timbre has a great factor on the severity of anger. In contrast, sadness and calm go hand in hand under some psychophysical circumstances. Dynamics plays a huge role in determination of sadness and calmness. Otherwise, the features are quite equally distributed for sad and calm pieces. This also explains the reason the counts for happiness and anger have a positive correlation, and sadness and calmness have a positive correlation.

Stimuli	Timbre	Tempo	Orchestration	Tonality	Scale	Dynamics	Melodic Complexity	Rhythmic Complexity	Pitch Range
1, 7 12, 16 (happy)	**11**	**5**	**20**	**22**	**22**	**12**	**4**	**4**	**0**
4, 8, 9, 14 (sad)	**16**	**16**	**14**	**19**	**7**	**14**	**10**	**4**	**0**
3, 5, 10, 13 (anger)	**29**	**14**	**11**	**19**	**24**	**9**	**12**	**10**	**1**
2, 6, 11, 15 (calm)	**19**	**12**	**9**	**23**	**6**	**15**	**6**	**10**	**0**

5. Conclusion

After extensive research, experimentation, data collection and analysis, we arrived at the conclusion that participants do cluster around certain types of emotions regardless of the ground truth. They are keen in observing psychophysical details, but fell short to make correct inference on the emotion based on psychophysical traits. Tonality, Orchestration, and timbre are the three most prominent aspects when classifying perceived emotion. Happiness and anger are stimulated

by similar psychophysical features (tonality and scale); sadness and calmness are stimulated by similar psychophysical features (dynamics). Although the majority of the participants have little or no knowledge of traditional Chinese music, there are quite a few outliers who claim to be good listeners of Chinese music. Those data points might stray away from the group, and therefore hinder the accuracy of the experiment since this experiment is on "foreign" music.

6. References

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