# Can Listeners Identify Emotions in Foreign Music?
# A Cross-Cultural Experiment on the Perception of Emotion in Music

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**ABSTRACT**

Studies of the link between music and emotion have primarily focused on listeners' sensitivity to emotion in the music of their own culture. In this experiment, our group aim to find out how Western listeners perceive the emotions in non-Western music, in particular of traditional 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 music (operas and instrumental music) 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, and binomial distribution to simulate the likelihood of the results. The results suggest that listeners are sensitive to musically expressed emotion in an unfamiliar musical system, but some psychophysical features might contribute to multiple emotions, and thereby confuse the participants even when the features are correctly identified.

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## 1. Introduction

### *Motivation*

It is generally agreed that humans tend to make associations between emotion and music, but studies of the link between music and emotion have primarily focused on listeners' sensitivity to emotion in the music of their own culture. As people who have received both traditional Western and East Asian music education, our group were intrigued by the contrast between Western and East Asian classical music, and we think it is reasonable to assume that the

perception of emotion in music is adaptable between cultures. We wanted to explore the listeners' ability to identify expressed emotion in foreign music as emotional communication is an important and interesting aspect of the human musical experience.

***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 the 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 operationalize perceived emotions as emotions that were perceived through the expression in music, contrasting the listeners' emotional response to music. 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 tonal system— most participants were not at all familiar with

traditional Chinese music before the experiment. One confounding variable that we came across was the participants' level of knowledge in music theory. This affects the experiment because the psychophysical variables were often described in music theory terminology. We tried to control the confounding variable by generalizing and expanding the musical terms (e.g., using 'pitch range' instead of 'tessitura') to help with the participants' comprehension. The nuisance variable is the participants' mood, which might interfere with our dependent variable. The nuisance variable was controlled by telling the participants before the experiment that they should respond to the emotion that they believe is being expressed by the music instead of the emotion the music induced.

***Stimuli***

Traditional Chinese music, both instrumental and vocal, often 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 the ground truth. 4 musical excerpts in each of the 4 targeted emotion categories were prepared (16 excerpts total). For each emotion, 2 excerpts were instrumental and 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 deployed a within-in subject design 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 at a time, and then answer what emotion they thought the music intended by clicking one of the 4 choices: 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.

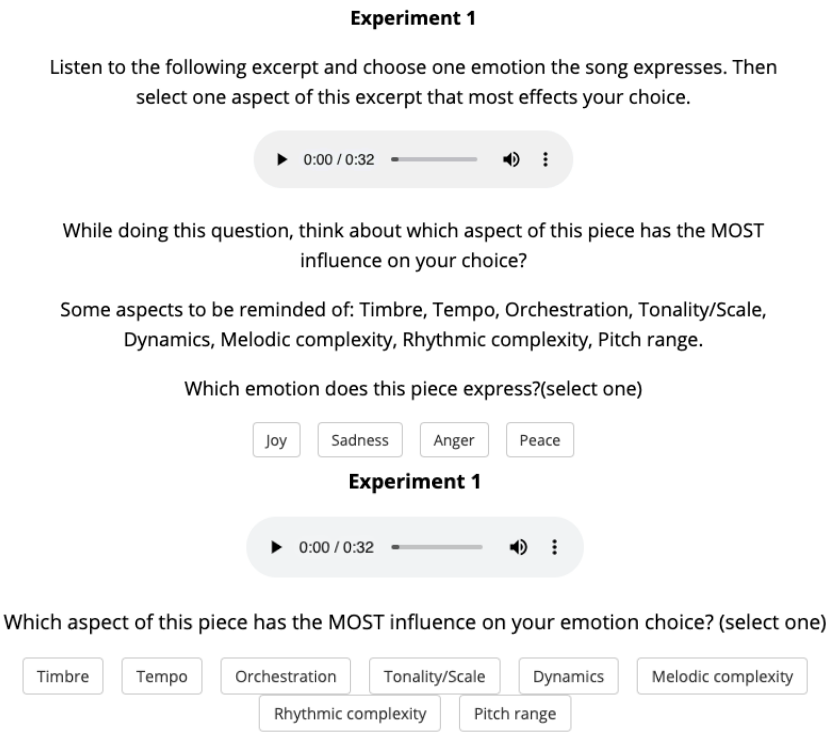
***Experiment Interface (Fig. 1)***

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

**3. Data Collection**

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

Fig. 2 captures the counts of the participant's responses.




| Stimuli # | Perceived Emotion | Joy | Sadness | Anger | Peace |
|---|---|---|---|---|---|
| 1 | Happy | 22 | 1 | 0 | 2 |
| 2 | Calm | 1 | 11 | 2 | 11 |
| 3 | Angry | 6 | 0 | 19 | 0 |
| 4 | Sad | 3 | 16 | 1 | 5 |
| 5 | Angry | 19 | 0 | 5 | 1 |
| 6 | Calm | 0 | 16 | 0 | 9 |
| 7 | Happy | 7 | 0 | 0 | 18 |
| 8 | Sad | 4 | 8 | 2 | 11 |
| 9 | Sad | 17 | 6 | 2 | 0 |
| 10 | Angry | 8 | 5 | 2 | 10 |
| 11 | Calm | 8 | 11 | 6 | 0 |
| 12 | Happy | 9 | 2 | 14 | 0 |
| 13 | Angry | 3 | 9 | 12 | 1 |
| 14 | Sad | 18 | 3 | 4 | 0 |
| 15 | Calm | 11 | 10 | 1 | 3 |
| 16 | Happy | 6 | 0 | 19 | 0 |

Fig. 1. An example of our online experiment interface.

Fig. 2. Detailed count of the participants' response.

**4. Analysis**

***Summary of Emotion Identification***

By grouping the stimuli by their ground truths, we established the contingency table:

| 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 |

The average counts for all stimuli table shows that people gravitate towards joy and steer away from peace when interpreting the emotions.

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

***Statistical Test of Emotion Identification***

$H_0$ 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

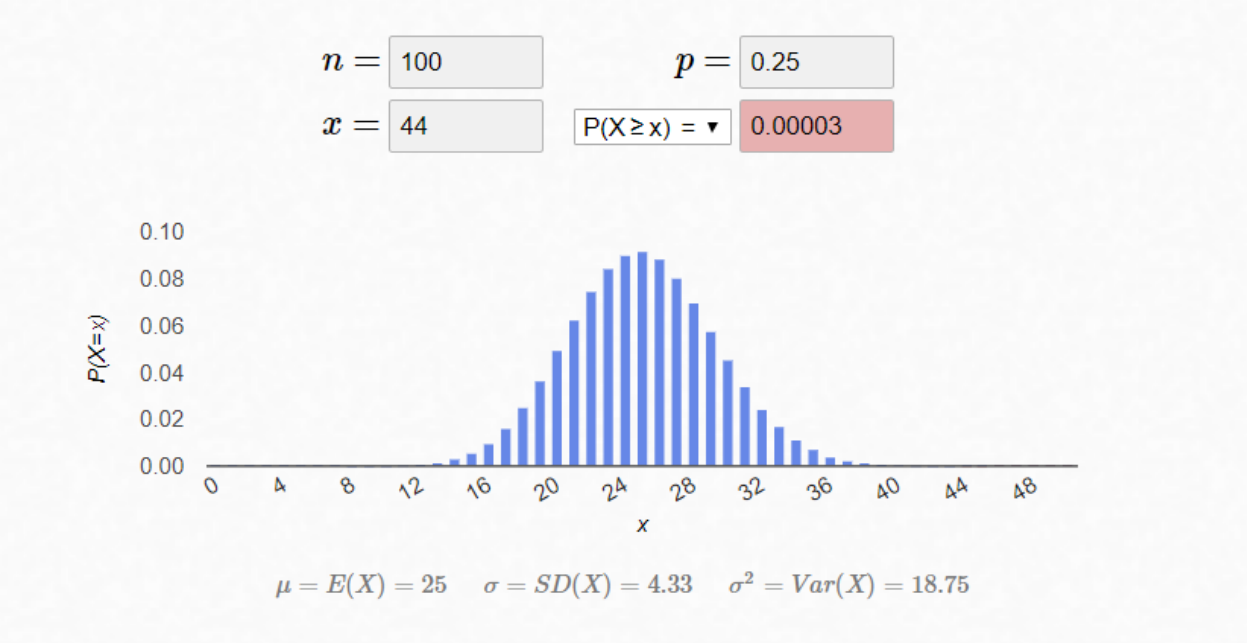
| Stimuli | Perceived (truth) | Joy | Sadness | Anger | Peace | Total |
|---|---|---|---|---|---|---|
| 1, 7, 12, 16 | Joy | 35.5 | 24.5 | 22.25 | 17.75 | 100 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **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  p value = $1.7 \times 10^{-16}$

The null hypothesis is rejected, 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 (joy) 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




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 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. One explanation would be that the psychophysical cues appears to be more directly related to the two-dimensional valence-arousal model. For example, a decrease in dynamics might suggest low arousal and an increase in melodic complexity might suggest high valence.

***Psychophysical Cue Identification***

The table below presents the sum across all stimuli against the psychophysical cues. Out of the nine musical elements, tonality, orchestration and timbre ranked as the most effective indicators for all 4 emotions. Happiness and anger are determined primarily by tonality and scale. Orchestration also has a huge effect on happiness. 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 the determination of sadness and calmness. The features are quite equally distributed for sad and calm pieces.

| **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** |
| **Total** | **55** | **44** | **61** | **86** | **44** | **51** | **39** | **20** | **0** |

Although the majority of the participants have little or no knowledge of traditional Chinese music, there are 3 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 in terms of the definition of foreign music.

**5. Conclusion**

We conclude that listeners are sensitive to musically expressed emotion in an unfamiliar musical system. Our participants did cluster around certain types of emotions regardless of the ground truth. They were 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).

**6. References**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