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THE EFFECT OF EXPERTISE IN EVALUATING EMOTIONS IN MUSIC

Fabio Morreale, Raul Masu, Antonella De Angeli, Patrizio Fava

Department of Information Engineering and Computer Science, University Of Trento, Italy
Morreale@disi.unitn.it

Abstract

This study investigates the role of expertise in the listener judgment of emotion in music. Previous studies suggest that the most important factors are mode and tempo, respectively influencing valence and arousal. The effect is stronger when the two parameters converge (major mode combined with fast tempo and vice versa), whereas tempo predominates when they do not converge. An open question is whether and how these judgments vary with the expertise of the listener. Our hypothesis is that non-experts will base their evaluation mainly on tempo, disregarding mode, which is more complex to be aware of. On the other hand, experts will take advantage of both sources of information. The experiment involved 40 participants. Experts were students who attended at least five years at music school. Non-experts had no formal musical training. Valence (positive vs. negative) and arousal (high vs. low) were manipulated independently in a 2*2 within-subjects design. Seven short piano pieces were composed and manipulated using the four conditions, for a total of 28 snippets. For each snippet, participants were asked to rate the values of the experienced valence and arousal on a seven-point scale. Results confirmed that for both types of listeners arousal was determined exclusively by tempo. Valence was primarily influenced by mode. Non-experts were also influenced by tempo for valence evaluation, while experts were not. As regards valence, mode is predominant in cases of divergent conditions but only for experts. Implications of these findings for the design of computing systems to allow non-musicians to create music are discussed.

Keywords: music perception, music and emotion

1. Introduction

One of the most stimulating but complex tasks in music psychology is to define the mapping between musical parameters and emotions (Juslin, 2001). In this task, the goal is to investigate the most relevant musical factors whose changes have an impact on the emotions experienced by the listeners. These musical factors inherently belong to two different categories: compositional elements (e.g., mode, harmonic progression, key) and performing elements (e.g., velocity, *ritardando*, *vibrato*).

With regards to compositional elements, most research credits to mode and tempo the highest relevance in terms of emotion elicitation (Juslin, 2001; Gagnon 2003; Webster 2005). It is important to note that the studies that have found these impacts of mode and tempo have some deficiencies, putting in question the reliability of their results. Among the common deficiencies are: (a) a lack of control of the musical stimuli used in the experiments; (b) adoption of a dichotomous classification of emotions that oversimplifies the complexity of affective states; and (c) the understatement of the influence of expertise in the evaluation of the emotion.

With the present study we aim at overcoming these limitations by setting up an experiment that (a) better controls the stimuli by systematically manipulating the factors of interest, by avoiding any bias from the composers'

intentions, and by insuring ecologic validity; (b) adopts an emotion classification approach that better takes into account the complexity of the domain; and (c) takes into consideration the listener's expertise. Our prediction is that music's impact on emotion is influenced, to a certain extent, by the listener's musical knowledge. In particular, experts, who can clearly perceive the difference between major and minor modes, may use this information to rate the emotional meaning in music.

In order to test this hypothesis, we set up an experiment with 40 participants equally distributed in two groups of experts and non-experts. The experimental material was created by one of the authors, a professional composer, guaranteeing a real control on the tested parameters and an ecological validity of the composed music. A widely used technique for testing the significance of musical factors on the listener's perception consists in manipulating the factors of interest (Gagnon, 2003; Webster 2005). Following this trend, seven similar melodies were composed, and, for each of them, mode and tempo were separately manipulated. Tempo was set to two very different levels (80 BPM for slow excerpts and 160 BPM for fast excerpts) and mode was set to minor and major. As regards the classifications of emotions, we followed a common approach that adopts the two-dimensional "circumflex model" (Russell, 1980). Russell postulates that the principal emotions can be placed in a Cartesian plane where the two dimensions are valence (positive vs. negative) and arousal (excitation vs. relaxation).

Results partially confirm what was suggested by previous studies as well as advancing novel findings. The most innovative finding shows that experts primarily use mode for evaluating valence while non-experts mostly use tempo. Confirming the conclusions of previous studies, mode is found to be exclusively responsible for determining valence while tempo has an influence on both dimensions. The paper is organized as follow: Section 2 describes the related works; in Section 3 we describe the design and the hypothesis of the experiment whose results are showed in Section 4 and analyzed in Section 5.

2. Related Works

In the last decades, different studies have attempted to discover the principal compositional elements that contribute to giving music a specific emotional connotation. Measuring and categorizing emotions is itself a demanding task that becomes even more challenging when it comes to mapping this domain onto music. There are been over 100 different experimental studies aimed at mapping different musical structures with emotional expressions (see Juslin, 2001 for a complete review). A general consensus among these studies is that the most significant compositional factors for conveying emotions are tempo and mode.

Many studies have analyzed emotions in the valence/arousal dimensions. Common findings suggest that (a) mode is mostly responsible for determining the valence, and (b) tempo has a major impact on arousal and a minor impact on valence. Thus, with regards to mode, positive emotions are associated with the major mode and negative emotions with the minor mode. With regards to tempo, high activation and, to a lesser degree, positive emotions are associated with a fast tempo; while low activation and, to a lesser degree, negative emotions are associated with a slow tempo. A number of studies have confirmed that tempo and mode are the most important elements associated with emotions in music, with a subtle predominance of tempo (Gundalach, 1935; Gagnon, 2003; Gomez, 2007; Juslin, 1997; Rigg, 1964).

What happens when tempo and mode combination suggest opposite emotion (divergent condition)? In 2003, Gagnon et al. (2003), confirmed that mode and tempo were the musical elements mainly responsible for eliciting emotions and they showed that these results were stronger in cases of convergent conditions, i.e., major mode combined with fast tempo or minor mode combined with slow tempo. When conditions were divergent, subjects seemed to rely more on tempo than mode. A limitation of this study is the dichotomous classification (happy vs. sad) to emotion measurement that cannot precisely deal with the complexity of affective states.

Back in 1935 Hevner found that major and minor modes were respectively mapped to happiness and sadness independently of musical training. More recently, Bigand et Al. ran an experiment aimed at testing the influence of expertise in emotional response to music (Bigand, 2005). Subjects, divided between experts and non-experts, were asked to group 27 musical excerpts by similarity of elicited emotions. From this experiment it emerged that the expertise did not strongly influenced the emotional response. Similar results emerge from the study of Robazza et Al. (Robazza, 1994). Eighty subjects were asked to rate the emotional elicited by different pieces of music. Expert end non-experts had similar results. Despite the relevant findings, these studies are not focused on investigating the effect of the singular structural factors but the emotional effect of music in general.

As regards stimuli selection, in the very first experiments on music perception music was performed live by professional musicians (Downey, 1897 and Gilman, 1891). The advent of modern recording and synthesis techniques allowed experimenters to select stimuli either by using existing tracks or by composing musical sequences. Pre-existing music may afford a good ecological validity, but it offers no control on the parameters that make up its structures (Bigand, 2005; Robazza, 1994). By contrast, short sound sequences have less ecological validity but the manipulation of the separate factors provides better control of the analyzed parameters (Gabrielsson, 2010).

Most of the research we have presented here uses a self-reported approach to communicate the experienced emotions while listening to music. Several studies used a list of adjectives in order to classify emotions. However, the dimensional model is the most common approach as it easily permits combinations and gradients of emotions by means of valence and arousal (Zentner, 2010).

2.1. Experimental hypotheses

In the present study we predict that the two factors that we manipulate separately, mode and tempo, will have differing impacts on people's emotional reaction. In addition, we predict that musical expertise will be a mediating factor on the impact of mode but not of tempo.

Mode. We expect mode to affect the emotional outcome only with respect to valence. More specifically, participants who hear music in a major mode should give higher valence ratings than participants who hear music in a minor mode.

Tempo. We expect tempo to affect the emotional outcome both with regards to valence and arousal. More specifically, participants who hear music with fast tempo should give higher arousal ratings and higher valence ratings than participants who hear music with slow tempo.

Expertise. As trained listeners can better perceive the difference between modes, we expect musicians to employ this knowledge when judging emotions in music. Therefore, we expect expert musicians to give higher valence ratings to music in major mode than music in minor mode, but for novice musicians to not differentiate between modes.

Divergent factors. We are particularly interested in the interaction between *mode* and *tempo*, and what happens when the two factors are divergent. Table 1 shows the convergent (major mode and fast tempo or minor mode and slow tempo) and divergent (major mode and slow tempo or minor mode and fast tempo) conditions. Since we predict that arousal ratings are impacted only by tempo, there should be no interaction effects for this dimension. However, we expect that valence will be affected by whether the factors are convergent or divergent. More specifically, participants should rate valence highest when both factors are convergent and positive (major and fast); lowest when both factors are convergent and negative (minor and slow); and somewhere in the middle when both factors are divergent (major-slow or minor-fast).

Table 1. Converging (same symbols) and diverging (different symbols) conditions of mode and tempo.

Mode / tempo	fast	slow
major	++	+-
minor	-+	--

In case of convergent conditions (major-fast and minor-slow) the perceived valence should be at its highest (lowest). On the other hand, an interesting question arises in case of divergent conditions. *Which factor will be prevalent?* Contrarily to what suggested by related works (Gagnon, 2003), we argue that expertise may have an influence on this result. As non-musicians are less familiar with mode, then tempo should greater impact their outcome, in which case, a significant difference is expected between major-fast and major-slow and between minor-fast and minor-slow. For musicians, mode should be prevalent, thus a significant difference is expected between major-fast and minor-slow and between major-slow and minor-slow.

3. Experiment

This experiment aims at studying the impact of mode and tempo in judgments of valence and arousal according to the listener's expertise.

3.1. Participants

A total of 40 participants took part in the experiment. Twenty participants were trained musicians with at least five years of music school (or comparable institutions); the remaining 20 had no formal music education. Their age ranged from 19 to 42 with an average of 24.7. There were 15 females (10 experts, 5 non-experts) and 25 males (10 experts, 15 non-experts). Three quarters of the participants (N=30) were Italian while the rest were from different European and Asian countries.

3.2. Experimental material

In order to measure the dimensions of valence and arousal, we used two Likert seven-point scales, which were presented on a computer screen.

One of the authors composed seven ad hoc musical excerpts or snippets, keeping the emotional connotation of the music as neutral as possible, by following common compositional rules such as identical harmonic progression and meaningful solo line. The snippets consisted of an accompaniment and a solo line, each organized in four bars of pseudo-ecological music, i.e., they could not be considered a song by themselves but could potentially be the first bars of a musical piece.

Each excerpt was then manipulated in order to create a minor and major mode version. Excerpts were also manipulated with regards to tempo, generating two versions for each mode-manipulated excerpt. The fast version played at 160BPM with a high density of notes in the accompaniment, while the slow version played at 80BPM with a low density of notes. Another parameter that influences the perception of the speed of a given piece is note density. Music with an high density of notes is generally perceived as faster as compared to a piece with identical BPM but lower notes density (Gabrielsson, 1973; Gabrielsson, 2010). To overcome this equivocation, we intensified the difference between the two different sets by using eighth notes in the accompaniment line in the 160 BPM pieces and quarter notes for the 80 BPM pieces. For simplicity, instead of referring to notes density, from now on we would just refer to *tempo*.

These manipulations generated 28 snippets[1]: seven excerpts * {major, minor} * {80BPM, 160BPM}.

3.2.1. Harmony

All the excerpts have the same harmonic progression, I - IV - V - I, which is one of the most common chord progressions in tonal music (e.g. baroque, classic, romantic and pop). The excerpts have different keys, to slightly differentiate the music and to reduce boringness.

3.2.2. Melody

The most significant notes of the melody are pitches of the chord, while less important ones can be notes of the scale. We regard as significant all the notes whose duration is one eighth note or longer or that are in a relevant position in the bar (e.g. first and last place). All the melodies have the same pitch range, in order to avoid the presence of higher or lower melodies. Relevant deviations in the range of the pitch,

[1] The 28 snippets can be found at goo.gl/Qg8LX

indeed, can have an emotional influence. The intervals used vary within an octave as ranging over the octave may impact emotional experience.

3.3. Procedure

Each experimental session ran in a silent room at the Department of Information Engineering and Computer Science at the University Of Trento, Italy. Participants sat in front of a laptop wearing AKG K550 headphones. The user interface was chosen to be as minimal as possible in order to draw participants' attention to the auditory stimuli only. To assign the desired value of valence and arousal, they interacted with the system through an USB mini number pad keyboard.

Before staring the experiment, each participant was informed about the task they had to complete by means of notes written in a piece of paper (in English and Italian). Participants were initially presented with four training excerpts in order to become familiar with the interface and the task. The 28 snippets were presented in a random order. At the end of each piece, subjects were prompted with a screen asking to report what emotion, in their opinion, that particular music wants to communicate. In details, they were asked to rate from 1 (*negative* or *relaxing*) to 7 (*positive* or *exciting*) the *positivity* of the music (valence) and the *activation* (arousal). This is aligned with some of the most significant experiments in music and emotions, where participants are asked to independently rate valence and arousal on bipolar scales. Between each other listening, the computer played a sequence of random notes; these sequences have been previously validated for masking the effects of previously played music (Bharucha, 1987; Hubbard, 1988).

In order to assess the homogeneity of the snippets, the participants were asked to rate each snippet from 1 to 7 with regards to how much they liked it, with 1 representing "*not at all*" and 7 "*a lot*". The snippets, which were presented in major mode and at 120BPM, were presented in random order by the computer.

The hypotheses were tested using a within-subject experiment.

4. Results

A repeated measures ANOVA was performed on valence and arousal ratings separately. In both cases, *mode* (major and minor) and *tempo* (fast and slow) were the within subject factors, and *expertise* (not-expert and expert) was the between subject factor. A repeated measure ANOVA was also performed on the data regarding the level of attractiveness of the seven snippets (within subjects) compared to the two categories of expertise (between subjects).

4.1. Valence

The analysis showed a significant main effect for *mode* [$F(1,38)= 279$ $p<.001$] and for *tempo* [$F(1,38)=106.6$ $p<.001$]. Major mode resulted in high valence (overall mean) while minor mode resulted in low valence (overall mean). As well, a fast tempo resulted in high valence (overall mean) while a slow tempo resulted in a low valence (overall mean).

However, the interactions between *mode* and *expertise* ($F_{(1,38)}=27,6$ $p<.001$) and *tempo* and *expertise* ($F_{(1,38)}=10,9$ $p<.001$) were also significant. Figure 1 illustrates the average values of valence in the four conditions (major-fast, major-slow, minor-fast and minor-slow) according to expertise.

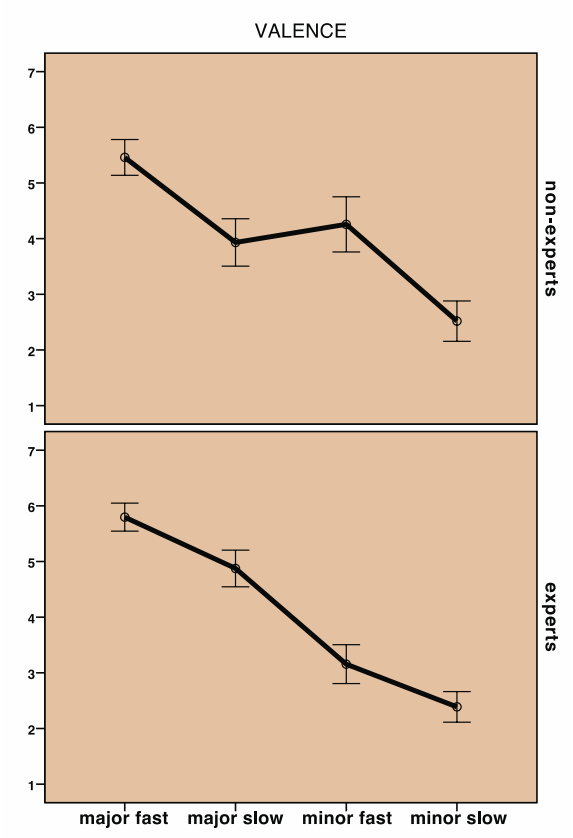

Figure 1. Average values and standard deviation of valence divided by expertise.

When listeners were experts, snippets that contained a major mode were judged as having a higher valence than snippets that contained a minor mode, no matter whether the snippets were convergent or divergent. However, when listeners were non-musicians, divergent snippets received similar neutral ratings, whether their mode was minor or major; convergent major snippets received a high valence rating while convergent minor snippets received a low valence rating.

4.2. Arousal

The analysis showed a significant main effect for *tempo* ($F_{(1,38)}$= 311.3 p<.001). A fast tempo resulted in a high arousal rating (here give the global mean) while a slow tempo resulted in a low arousal rating (here give the global mean). No significant interactions were found. Figure 2 shows the average arousal rating for the four conditions according to expertise.

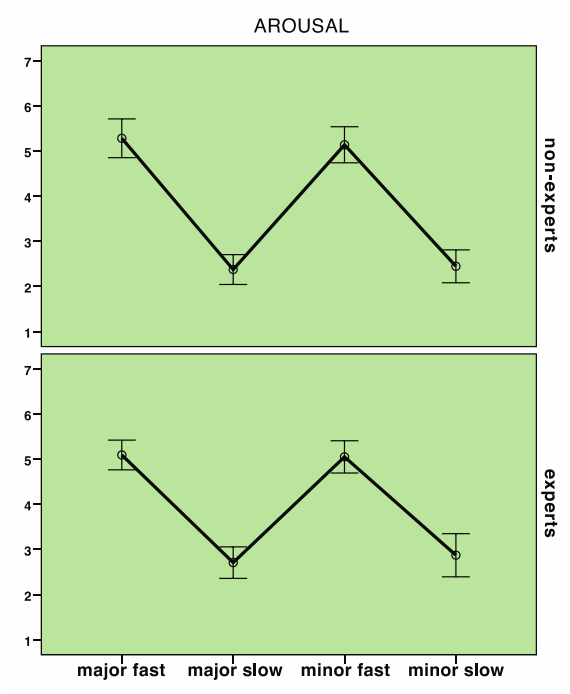

Figure 2. Average values and standard deviation of arousal divided by expertise.

4.3. Homogeneity

An ANOVA found no significant difference between snippets ($F_{(1,38)}$= 1.6 p=.178), nor any impact of expertise ($F_{(1,38)}$= .918 p<.495). The mean rating for each snippet varied from 3.4 to 4.2, with means varying from 3.1 to 4.3.

5. Discussion

Our results suggest that expertise has an impact on the emotional response to music. In particular, expertise mediates the impact of mode on ratings of valence but not of arousal. Our experts relied on mode above tempo when judging a piece of music on its valence. Our non-experts, on the other hand, appear to have been influenced by the combined impact of mode and tempo: in the case of convergent music, slow and minor music was judged with low valence while fast and major music was judged with high valence; however, when the information was divergent, non-experts rated the music halfway between the two convergent extremes. Figure 3 illustrates the divergent cases, showing that experts gave more importance to *mode* in these cases, while non-

experts assigned approximately the same value to mode and tempo.

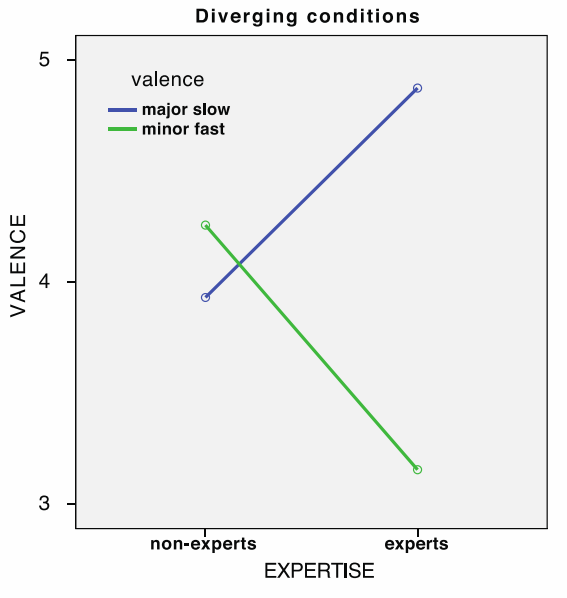

Figure 3. Expertise effect on valence in case of divergent conditions.

Arousal, by contrast, seems to be bounded only to *tempo*, disregarding *mode* and *expertise*. These results confirm past findings (Gomez, 2007; Juslin, 2001) in this area of research.

Our results show that all of the snippets were judged as similar on ratings of pleasantness. This supports the idea that the differences found were due to changes to the mode or the tempo and not to inherent qualities of the individual snippets themselves.

In summary, the acquisition of musical expertise has an influence on the emotional experience of people listening to music. As people go through formal musical training, they become particularly sensitive to mode. This result is particularly important in contexts of interactive musical systems that address a particular category of users. Performing art installations that aim at giving non-musicians access to musical compositions could make use of these finding for instructing the algorithmic generation system (Morreale, 2013).

6. Future works

The statistically identical response of non-experts to the valence scale in case of divergent conditions encourages new debates about the perception of valence for this category of users. The experiments showed that a major mode at 80 BPM has the same valence response to a minor mode piece played at 160 BPM with higher density of accompaniment notes. It is possible that different tempos could have had a different impact on our participants. Would intermediate BPM values lead to different valence judgments when combined with major and minor modes? Is there a BPM value that maximizes the difference on the perceived valence between major and major mode? How does expertise impact musical appreciation?

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