EMOTION AND COGNITION IN MUSIC:
WHICH COMES FIRST?

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ABSTRACT

Are emotional reactions to music independent of cognitive processes? The goal of this study was to test whether the emotional reaction or the perception of the tonality comes first when listening to a piece of music. In the present study, 55 subjects (musicians and non-musicians) were tested with pairs of clips using an emotion categorization task.

12 peaceful and 12 sad melodies, from Peretz , Gosselin, Khalfa, Bouchard and Gagnon (forthcoming) were used to create 48 pairs of melodies, 24 being in the same key, and 24 being one step apart.

We hypothesized that subjects would process the key of each melody before categorizing it, and thus, that the analysis of our data would show a key effect on the response times. We expected a shorter response time on the second clip of pairs played in the same key, as compared to response times for the second clip of pairs played in different keys.

Our results for response times showed a significant key effect. This study therefore suggests that cognitive processes and emotional reactions to music are not independent processes, and that processing the key of a piece of music may be necessary to feeling the emotion it expresses.

1. BACKGROUND

Are emotional reactions to music independent of or dependent on cognitive processes?

The question of whether the emotional reaction to music can take place before cognitive processes, or whether it follows from them is a controversial issue. This discussion takes place in the larger framework of the same debate concerning emotions in general. Can emotional reactions be considered as reflexes, as biologically determined or as learned responses, as most neurophysiologists would say (Damasio, 1994; Ledoux, 1996) or are they the result of cognitive processes, as appraisal theorists would argue (Lazarus, 1991)?

Reacting to the emotion expressed in music probably means perceiving schemas of tension and release. However, these schemas can only be perceived after the key of the music has been identified, if only implicitly. It is within the frame of a specific key that each note of a melody has a different weight: the highest being the tonic tone, then decreasingly the fifth and the third, and then the others tones. I quote Meyer (1956)

In the major mode in Western music the tonic tone is the tone of ultimate rest toward which all other tones tend to move. On the next higher level the third and the fifth of the scale, though active melodic tones relative to the tonic, join the tonic as structural tones; and all the other tones, whether diatonic or chromatic, tend toward one of these.

The tonic tone of a melody, and to a lesser extent the fifth and the third are therefore used as reference points for the perception of other tones. If perceiving tension and release in a piece of music implies the perception of its key, then reacting emotionally to the piece must be the result of cognitive processes.

Our hypothesis is not widely accepted. This same question has been studied by Peretz and colleagues. In a study on I.R. (Peretz, Gagnon, & Bouchard, 1998), she concluded that her patient exhibits a dissociation between spared affective and impaired cognitive processing, therefore concluding that "emotional appreciation of music is best conceived as the product of a specialized cortical arrangement". But another study with I.R. published more recently (Peretz, Blood, Penhune & Zatorre 2001) draws the conclusion that "dissonance might be computed (...) by specialized mechanisms prior to its emotional interpretation".

2. AIMS

The goal of this study was to test whether the emotional reaction or the (implicit or explicit) perception of the tonality comes first when listening to a piece of music.

A simple distinction in emotional response to music is between positive and negative response, that is to say between music that arouses positive emotions, and music that arouses negative ones. Our hypothesis is that to feel this most basic difference, one would need to perceive the key of the musical piece.

Therefore we wanted to show whether subjects—a group of musicians, and a group of subjects without any formal musical training—would take the time to process the key of a musical clip before categorizing it emotionally.

The subjects listened to pairs of clips, and were requested to indicate whether each first excerpt sounded peaceful or sad, and then whether each second clip expressed the same emotion as the previous one or not. We took their categorization responses as an indication of their emotional response. It should be noted that their answers were thus un- mediated by language.

3. METHOD

3.1. Participants

55 subjects participated in the experiment: 33 students who never received any formal musical training, and never practiced a musical instrument (referred to as "non-musicians"), and 22 musicians, from the Music Teachers Training Center in Dijon (Cefedem), the national music conservatory of Dijon, the national music school of Romainville, and two professional pianists. All participated in the experiment on a volunteer basis.

3.2. Materials

The musical excerpts used in this study came from Peretz et al. (forthcoming). They were composed, in the genre of film music to express happiness, sadness, fear or peacefulness. 24 excerpts were selected, 12 peaceful clips, and 12 sad clips.

To prevent peaceful and sad clips from being distinguished on the basis of small differences in range (the peaceful melodies being on average higher in pitch than the sad ones) or small tempo differences (the peaceful clips being slightly faster than the sad ones), the clips were slightly modified to align them to similar ranges and tempi.

For the purpose of the experiment the key of these clips was also manipulated so that the tonic of the two clips in the pair were either identical or one step apart. The 24 clips were thus used to create 48 pairs of clips : twenty-four pairs of "same emotion," half of them being sad, and half peaceful; and twenty-four pairs of "different emotion," half of them beginning with a sad melody, and half beginning with a peaceful melody. Each series of twelve pairs was made of six pairs in the same key, and six pairs in different keys.

3.3. Apparatus and Procedure

The clips were played on a Midi keyboard by a professional pianist in order to convey the clearest possible expression (sad or peaceful).

The midi files were modified using Performer, on Macintosh. The sound stimuli were then captured by SoundEdit Pro software with CD quality and the experiment was run on PsyScope software. The response times were recorded by a Macintosh timer.

For each pair of clips, the subjects listened to the first melody entirely and had to indicate if it expressed peacefulness or sadness. The main task was performed on the second clip of the pair. The participants had to decide as quickly as possible whether that melody expressed the same emotion as the previous one. They were informed by a feedback signal if they gave an incorrect response. It should be noted that participants were not asked to identify the emotion verbally in the second task, when their response times were measured.

Crossing the emotional value of the two melodies of the pair (similar versus different emotions), the emotion expressed by the first melody of each pair (peaceful versus sad), and the key relationship of the two melodies of the pair (same versus different) produced 48 pairs of melodies. Each participant thus heard 48 pairs of clips presented in a random.

4. RESULTS

The first analysis, run on the emotional judgments made on the first clip of each pair, replicated Peretz et al's finding (Peretz, Gosselin et al. forth coming) by showing that participants correctly identify the emotional valence of the clips, with a significant advantage for musical experts (92.58% for musicians versus 86.36% for non-musicians).

We analyzed response times for correct answers. This means that we analyzed the response times for the clips that had been correctly categorized, only when the first clip of the pair had also been correctly categorized.

Averaged response times are presented in Table 1. A 2 (key) X 2 (emotional value) X 2 (session) X 2 (musical expertise) ANOVA was performed on response times. There was a main effect of key, with longer response times for pairs of melodies played in different keys ($F (1.53) = 9.85$; $p < .003$). There was also a main effect of session ($F (1.53) = 12.03$; $p < .001$), with shorter response times during the second session, and a main effect of emotional value ($F (1.53) = 6.23$; $p < .02$), with shorter response times for pairs of different emotions. There were no other significant effects. Musicians answered slightly faster than non-musicians (2824 ms/3002 ms), but this difference was not significant.

Accuracy data showed a main effect of expertise ($F(1.53) = 19.06$; $p < .0001$); musicians answered correctly more often (93.08%) than non-musicians (83.30%).

Given that clips of the same emotion remained in the same mode (either major or minor), the analysis of the correct response for the pairs of same emotion was especially important. Indeed, in this situation, the manipulation of the key of the clips was not confounded with a change in mode. An ANOVA run with the pairs of same emotion confirmed a significant key effect ($F (1.53) = 4.36$; $p < .05$). Interestingly, this key effect was observed for both sad and peaceful clips, as well as for both group of listeners.

Emotion	Musicians		Non-musicians	
	same	different	same	different
Same key	2880	2446	2955	2888
Different key	3060	2909	3108	3059

Table 1: Correct response times in milliseconds as a function of key, emotional value, and musical expertise.

5. CONCLUSIONS

Our results suggest that subjects processed the key of the clips before they could categorize them emotionally. This study therefore implies that emotional reactions to music are the result of cognitive processes.

As a side note, this study was not intended to contribute to the debate between cognitivists, who think we *perceive* emotion expressed in music, and emotivists, who think we *feel* the emotion expressed in music. We used subjects' categorization responses as a measure of the emotion they felt while listening to the music because we feel/think that this debate between perceiving and feeling emotions expressed by music opposes what are simply two different levels of emotional response.

To use an analogy, let's compare two emotional reactions. First, imagine walking in the street, and passing someone crying. You would probably say that you perceive that that person is sad. Then, imagine watching a close friend cry. You would probably say then that you feel that that person is sad. Is your reaction fundamentally different in these two situations, or is your emotional reaction simply of two different intensities?

6. REFERENCES

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