THE TEMPORAL PROCESSING OF MUSICAL EMOTION IN A FREE CATEGORISATION TASK

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ABSTRACT

This study explored the processing of musical emotions felt in response to 27 excerpts of classical music. Two free categorization experiments were conducted with musically trained and untrained listeners who were asked to group the musical excerpts according to the emotion evoked by them. In the first experiment, musical excerpts of about 30 s average duration were selected to elicit a variety of emotional experiences. Within-subject categorization stability was examined using a test-retest procedure. In the second experiment, the processing time course of musical emotion evocation was investigated with the same excerpts, firstly in a phase in which they were reduced to 1 s duration and secondly, one week later, in a second experimental session in which they were presented with their original durations (≈30 s). Emotional groupings from these two experiments were converted to a matrix of emotional similarity that was analyzed with Multidimensional Scaling (MDS). Firstly, correlation analyses between the similarity matrices from the two sessions of experiment 1 showed that emotional judgements were very stable in both groups of participants. This result demonstrates that within-subject emotional judgements are much less unstable than is generally believed. Moreover, correlations between the 1-s and 30-s duration conditions revealed a high coefficient value for musicians, suggesting that even with less elaborated musical stimuli, a speedy and accurate emotional response to music is feasible. Secondly, MDS analysis shows a three-dimensional emotional space with the dynamic of the excerpts, the emotional valence and the form of the melodic line as the first, second and third dimensions, respectively. These findings corroborate the hypothesis of dynamic and valence dimensions accounting for the psychological structure of musical emotion. In addition, these data raise the question of the nature of processing that generates this emotional response, emphasizing the cognitive hypothesis according to which emotional judgements need the processing of musical features to be extracted.

BACKGROUND

Music is known to induce strong and varied emotional responses. Most of the studies interested in this topic have focused on a small set of basic musical emotions (happiness, sadness, fear, serenity) to investigate the source of emotion in music (Panksepp, 1995 ; Sloboda, 1991; Schellenberg and al., 2000), the biological foundation of musical emotions (Blood and al., 1999 ; Peretz and al., 1998 ; Peretz and Gagnon, 1999) or the physiological level of musical emotions (Schmidt and al., 2001). Some of these studies explore the content of emotional response while others seek to specify the processes involved in the emotional responses. A crucial finding provide by Peretz and collaborator's reveals that a listener can recognize basic emotion (happiness versus sadness) from a 500-ms musical stimulus, suggesting an unexpected immediate processing of musical emotion. This question is a matter of debate. Indeed, some authors who develop a cognitive account of emotional response to music argue that emotional evaluation of musical content must be mediated by the processing of the musical features. Perhaps a very fast processing of these features would explain the immediate processing of emotion in music. In any case, the dissociation between emotional and cognitive processes in music raised by some findings from neuropsychological investigations (Peretz et coll., 1999), need a specification of the time course of emotional response.

More generally, it is hypothesized that musical emotion is induced by the dynamic (arousal response to music) and valence (positive versus negative) aspects of musical excerpts. It is also usually argued that emotional experience elicited by music is likely to vary within and between listeners, rendering the scientific investigation very problematic. It thus seems important to systematically test the variability within and between listeners.

AIMS

The present study both investigated variability of emotional responses to a various musical emotions (experiment 1) and tracked the time course of emotional reactions in musically trained and untrained listeners by manipulating the duration of the excerpts (experiment 2). In these two experiments, we used a free categorization task that is very convenient to probe the psychological representation of complex multidimensional stimuli such as musical excerpts. This paradigm allows the exploration of the intimate emotional response to music at a behavioral level without using linguistic responses, which are known not to be always sufficient to account for the subtlety of musical emotional experience.

1. EXPERIMENT 1

The content of emotional response to music was investigated with a multidimensional scaling technique that consists in representing the psychological structure contained in a similarity matrix judgements in the form of a space that may be organized along several psychological dimensions. The similarity matrix was obtained by asking the listeners to group 27 nonvocal classical excerpts presumed to elicit various intense emotions.

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1.1. Method

Participants: Nineteen participants performed two experimental sessions separated by 2 weeks. Nine of them had no musical experience and ten had musical training and instrumental practice.

Stimuli: In a preliminary phase, 27 excerpts were selected according to their ability to induce emotional response and according to the emotional content evoked, which we wished to be as varied as possible: some excerpts fit within the four basic emotions such as serenity, sadness, happiness, and anger and the others expressed more subtle emotions that were difficult to class within the four basic categories. The selection was also based on the ability of the excerpts to transcend traditional musical categories of style and instrumentation. Musical excerpts were of 20 to 40 seconds duration and corresponded either to the beginning of a musical movement or to the beginning of a musical theme or idea. They were taken from real performances and were not expected to be highly familiar to the majority of participants.

Apparatus: Each excerpt was extracted as a monophonic sound file and its loudness was adjusted by the experimenters. The 27 excerpts were randomly presented on the computer screen with the icon of a small loudspeaker.

Procedure: Listeners had to click on each of the icons in order to hear them. They were instructed to group together the excerpts that produced the same emotional experience. In this free classification task, the participants could put any number of excerpts into a group and could make as many groups as desired. There was no time limit. Participants were required to perform this experiment a second time (session 2) two weeks later.

1.2. Results

Descriptive analyses indicated that listeners distinguished about 7.7 groups on average and made 3.5 excerpts on average over both sessions. There was no influence of musical expertise on the number of groups and their size, indicating that musical expertise did not provide a finer categorization of emotional responses.

Data from the free categorization task were transformed into a 27*27 matrix of emotional similarity in which each cell represented the average number of times two excerpts were grouped. High values reflect strong emotional similarity. The high correlation between the matrices from sessions 1 and 2 obtained for musicians ($r(349) = .87$, $p < .001$) and nonmusicians ($r(349) = .78$, $p < .001$) clearly show that emotional categorization is highly reproducible inside the participants regardless of their musical expertise. This is confirmed by the correlation value ($r(349) = .83$, $p<.001$) obtained between musicians and nonmusicians on matrices averaged over the two sessions.

Given this consistency between listeners and sessions, a mean matrix of emotional similarity was computed and transformed into distance by the classical MDS model in which the excerpts are assumed to posses collectively a small number of psychological attributes. The MDS solution (Figure 1) of perceived emotional similarity provides a three-dimensional space. The first dimension distinguishes musical excerpts according to their high or low musical dynamic. The second distinguishes positive and negative valence. Finally, the third dimension seems to differentiate the excerpts with a large regular melodic shape from those with a broken melodic line. For convenience this third dimension is not represented in Figure 1. The two first dimensions seem to be the main typical aspects of musical emotion, related to arousal and valence, while the last dimension seems to reflect the influence on emotional responses of superficial features related to compositional technique. As illustrated by Figure 1, the location of excerpts indicates that emotional responses to music are not limited to the four basic categories of emotions (serenity, happiness, sadness, angry). The two-dimensional space shows a continuous ordering of the musical excerpts along each axis. This continuity suggests that the musical emotion may be gradually modulated along valence and arousal dimensions.

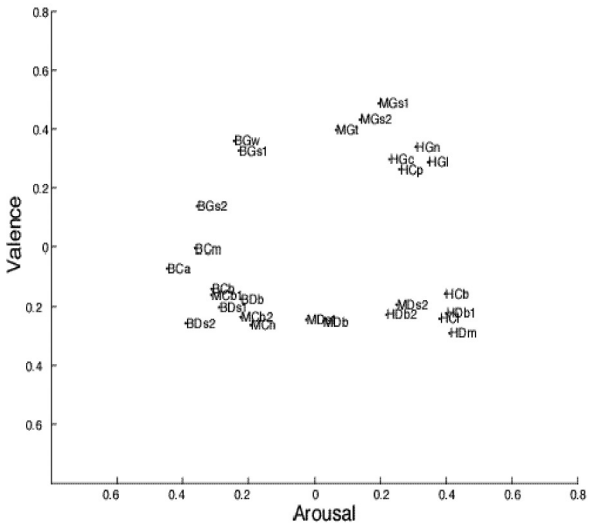

Figure 1: Three-dimensional space derived from the MDS analysis representing the two first dimensions corresponding to the arousal and valence of musical excerpts classify by listeners in the 30-s duration condition.

1.3. Discussion

Experiment 1 provided evidence that music induced straightforward emotions in listeners and that this induction was strongly consistent between listeners and sessions. This clearly shows a good stability of emotional judgements and demonstrates that musical emotion is a domain for scientific investigation. Moreover, the location of the excerpts in the three-dimensional space shows that emotional response continuously varies from one pole to the other along both the dynamic and valence dimensions, indicating that emotional experience induced by music exceeds the four main categories of emotions habitually used by researchers. Finally, the great ability of musicians and nonmusicians listeners to differentiate subtle musical emotion suggests that emotional judgement processing does not depend on explicit knowledge of Western music. In order to investigate the nature of these processes, we conducted a second experiment in which the duration of the excerpts was reduced to 1 s.

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2. EXPERIMENT 2

New listeners performed two experimental sessions. In the first session, the same excerpts as those used in previous experiment were presented in a similar free categorization task. But their duration was reduced to 1 s. After that, one week later, listeners were asked to perform the classification task with the original duration condition of about 30 s. The material and apparatus were identical to those described above.

Participants: Forty participants performed the task. Twenty had no musical experience and twenty had musical training and instrumental practice.

2.1. Results and discussion

In the 1-s duration condition, participants distinguished 6.7 groups on average made of 4.3 excerpts per group on average while in the 30-s duration condition, they classified 7.4 groups on average made of 4 excerpts per group on average. The number of groups performed did not vary according to duration condition. The number of changes in grouping was analysed for both duration conditions. This number was 16.6% and 19.6% on average for musicians and nonmusicians respectively. This difference did not reach statistical significance. This suggests that reducing the duration had only a weak effect on the precision of the emotional categorization performed.

The important question of the emotional judgement stability between subjects was examined by performing the correlation between the emotional similarity matrices obtained for the 30-s duration condition from experiment 2 and the same condition from experiment 1 both for musicians and nonmusicians. The correlation coefficient is relatively high for musicians ($r(349) = .88$, $p<.001$) and moderate for nonmusicians ($r(349) = .73$, $p<.001$). This indicates a good consistency between listeners, regardless their musical expertise.

Another crucial question concerns the stability of emotional judgements as a function of duration condition. Correlation analyses performed between the emotional similarity matrices obtained for the 1-s condition from experiment 2 and the 30-s condition in session 1 of experiment 1 reveals a moderate value ($r(349) = .71$, $p<.001$) for musicians but a lesser coefficient ($r(349) = .51$, $p<.001$) for nonmusicians. This suggests that the reduction of the excerpts duration has a small effect on nonmusicians' categorizations. The same pattern of results is observed by the correlation analysis between the matrix obtained for the 1-s and 30-s conditions from experiment 2.

Given these findings, the MDS was performed separately on data for musicians and nonmusicians for the 1-s duration condition. Figure 2 illustrates the three-dimensional space obtained for musicians in the 1-s condition. This shows the two first dimensions (valence and dynamic) previously obtained in experiment 1. In this condition, the locations of the excerpts with high dynamic level (the right side of the space) are very similar to those observed in the two-dimensional space from experiment 1. However, one can see a flattening phenomenon on the valence dimension for the excerpts with a low dynamic level. It seems to indicate an inability to distinguish low dynamic level excerpts on the basis of their valence. Regarding the musical parameters of these indeterminate valence-low dynamic excerpts, one clearly detects a typical feature like a very slow tempo with a small information density that probably does not provide sufficient information to decide whether the excerpts evoke a positive or negative emotion. Conversely, the high dynamic level excerpts (which are continuously ordered on the valence dimension) have a greater information density that presumably allows listeners to better recognize the emotion because of the sufficient amount of specific features linked to positive or negative musical emotional valence.

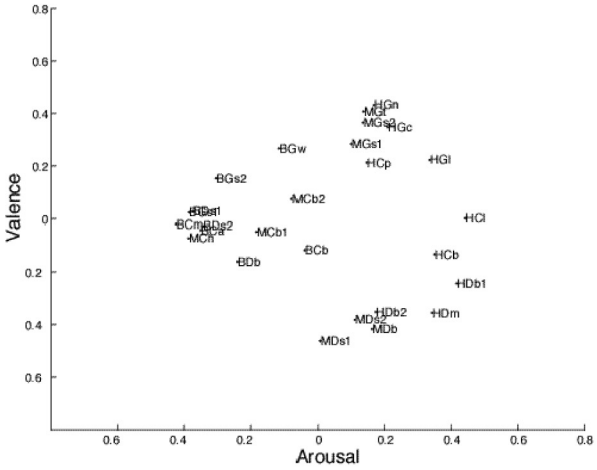

Figure 2: Three-dimensional space representing the two first dimensions corresponding to the arousal and the valence of musical excerpts classified by musicians in the 1-s duration condition.

The two-dimensional spatial representation for nonmusicians does not show this flattening phenomena. Surprisingly, nonmusicians show a larger distinction within the low dynamic level excerpts on the valence dimension that do not strictly follow the spatial locations obtained in experiment 1. This discrepancy remains difficult to explain without a fine-grained analysis of the musical parameters and a study of the excerpts to detect which were the most affected by the time reduction for musicians and nonmusicians.

In any case, these findings suggest that musicians are able to classify musical emotions regardless of the duration of the excerpts. This ability is particularly observed for the part of the emotional space where the high dynamic level excerpts are ordered continuously along the valence dimension. This limitation suggests that the degree of information density in the 1-s excerpts is needed to extract emotional information such as the valence.

3. CONCLUSION

In the first experiment, correlation and MDS results respectively reveal a great stability of emotional judgement within listeners and a very subtle categorization of musical emotion on the usual dynamic and valence dimensions that go beyond the simple

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category related to basic emotions such as serenity, sadness, happiness, and anger. This ability to subtly group the excerpts according to the emotion evoked is separate from musical expertise and accounts for a continuous psychological dimension of musical emotion.

Results from the second experiment attest the between-subject emotional judgement stability and prove that musical emotion is a conceivable object of investigation for researchers interested in processing of emotion. The examination of the influence of changes due to duration shows that nonmusicians' categorizations are more affected than are the musicians'. The latter group succeeds in distinguishing musical emotions particularly for the excerpts that posses enough information density to allow the extraction of emotional valence.

Such findings raise two main questions. The first concerns the role of musical expertise on the ability to make an emotional judgement with less elaborate musical excerpts and the second concerns the nature of the processes involved in this emotional evaluation. Possibly, the musicians are able to activate their explicit knowledge about musical structures to complete partial information derived from the 1-s excerpts while nonmusicians base their judgements merely on the available sound. Concerning the nature of processes involved in categorization, the present results suggest that 1 s is enough to distinguish excerpts along the dynamic and valence dimensions only if their content gives sufficient cues to evaluate emotional valence. The fact that musical expertise and information density contained in the excerpts determine for one part the subtle extraction of emotional information would support the cognitive view according to which emotional judgements are mediated by the processing of musical features.

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