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A Dimensional Study on the Emotion of Musical Pieces Composed for Video Games

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ABSTRACT

In recent years, the hardware and software of video games has been developing incredibly, and it is strongly needed to establish a scientific logic to efficiently design music for video games. As the first step for constructing the scientific design of game music, the emotion of game music was investigated. In the present study, we conducted an experiment using 100 pieces of game music. Seven listeners listened to each of the pieces and rated the emotional features in it using 29 adjective scales. The scores were averaged over listeners and used in principal component analysis. The results showed that the two-dimensional space accounts for 78 % of data variance. The two dimensions were labelled "pleasantness" and "excitability", respectively, from the scales having high loadings on the dimensions. The pleasantness and excitability corresponds well to the two dimensions of valence and activity which illustrates classical music. The results show that the dimensional structure of the emotion of game music is consistent to that of classical music.

INTRODUCTION

In recent years, the hardware and software of video games has been developing incredibly. This led to rapid increase in cost and time for creating high-quality contents for video games. It is also the same for composing music for video games. Musicians and sound engineers create musical pieces for various scenes in a game based on their artistic sense and experience. Producers and directors also decide a piece of music among various alternatives, based on their sense and experience, for a scene. Therefore, it is strongly needed to establish a scientific logic to efficiently design music for video games. As the first step for constructing the scientific basis for designing game music, the emotion of game music is investigated in the present study.

Musical emotion is expressed in various adjectives such as cheerful, tender, majestic, etc. This implies that musical emotion is illustrated by a multi-dimensional space. Many psychologists examined how this space is constructed. They typically used the following methods: Listeners were presented various musical stimuli, and rated the emotional features using a set of SD (Semantic Differential) scales for each stimulus. Sometimes subjects were requested to imagine a musical tune, instead of listening to that tune. Then the rated scores were analyzed using factor analysis or principal component analysis. Using the methods described above, researchers showed various numbers of dimensions, ranging from two to eight, to illustrate musical emotion. For example, Taniguchi used 90 excerpts of classical music works as stimuli, and showed that the emotional space of them was constructed by five or eight factors [1]. On the other hand, Hevner showed a simple two-dimensional space spanned by "valence" and "arousal" factors. She selected short pieces of music and manipulated their mode, melodic direction, harmony, and rhythm, systematically [2]. In another study, she also manipulated tempo and pitch level [3]. These variants as well as original versions were presented in her experiments. The two-dimensional space of musical emotion was almost identical to the circumplex model of general emotion, which was shown by Russell [4]. Shubert [5] points out that the "valence" and "arousal" dimensions agree in principle with two of the three dimensions of semantic space proposed by Osgood et al. [6]; "evaluation" and "activity".

Most of the dimensional studies described above concentrated on classical music, and only a few studies illustrated the musical emotion in popular music using multi-dimensional spaces. Iwamiya and his colleagues conducted a series of perceptual experiments using popular music, in the contexts of music videos [7], car audio [8], and computer-graphics with music [9]. They illustrated the impression of music using three-dimensional spaces. Yamada, Fujisawa and Komori also investigated musical emotion in the context of a video racing game, and showed that the musical emotion of popular music was illustrated by a three-dimensional space [10]. However, the number of pieces of popular music used in the studies was small. Yoneda and Yamada conducted an experiment using 100 pieces of popular music. The set of the pieces reflected the current Japanese popular music scene. The results showed that the emotional space of the Japanese popular music is spanned by three dimensions; "evaluation", "potency" and "activity" [11].

As described above, the musical emotion has been clarified by dimensional studies for classical and popular music. However, the dimensions of the emotion for game music have not been tried clarifying. Game music has distinct features from classical and popular music. Video games tend to play short pieces of music, repeatedly. Moreover, some of them do not have a clear melodic structure, rather sound as background sound effects. Therefore, it has to be clarified whether the emotion of game music shows different dimensional structure from classical music, or not.

EXPERIMENTAL METHOD

In the present study, a perceptual experiment was carried out to clarify the dimensional structure of the game music. Seven students from the Kanazawa Institute of Technology participated in the experiment as listeners. Their ages ranged from 21 to 24 years old.

We provided 100 pieces of game music for the experiment. They were collected from commercial release game sound track CDs, which were from well known video games. During the experiment listeners were not allowed to vary the volume setting of the music player (SONY RDR-HX50). Therefore, the listening level varied with pieces. The musical stimuli were presented through headphones (STAX Lambda-professional) in 68-82 dB (LAeq).

The play time of the pieces ranged from one to seven minutes. The order of the pieces was determined randomly for each listener. Each piece was presented once. After listening to each piece, the listeners were requested to rate the emotional features using the 24 seven-step bipolar scales listed in Table 1, e.g., “very positive”, “fairly positive”, “slightly positive”, …, “very negative”. The order of the scales was determined randomly for each combination of a piece and listener.

The whole experiment was divided into ten sessions, for each session the listeners listened to ten pieces and rated them. A 10-minute rest period divided sessions. Each listener performed three to five sessions a day and finished the whole experiment in 2-3 days.

RESULTS AND DISCUSSION

Numbers 1 to 7 were given for each of the seven categories on the SD scales, then the mean value was calculated from the listeners’ responses for each combination of scale and stimulus. Then principle-component analysis was performed for these mean scores with Varimax rotation. The results showed that the two-dimensional space accounted for 78 % of data variance. Table 1 shows the resulting factor loadings for the 24 SD scales. The two dimensions were labelled "pleasantness" and "excitability", respectively, from the scales showing high loadings on the dimensions. The pleasantness and excitability corresponds well to the two dimensions of valence and activity which illustrates classical music. In Fig. 1, each piece is plotted on the two-dimensional space spanned by the “pleasantness” and “excitability”.

The results show that the dimensional structure of the emotion for game music is consistent with that of classical music.

It is known that the degree of excitability of music strongly correlates with tempo, i.e., a fast tempo results in excitement and, *vice versa*. Therefore, the tempo of each piece was measured in BPM (beats per minute), then using the tempo measured as the dependent variable, with factor scores on the “pleasantness” and “excitability” dimensions as independent variables, the multiple-regression analysis was performed. The resulting coefficient of determination was smaller than 0.60. This implies that the emotional feature for game music cannot be simply explained only by the “tempo” parameter.

Finally, we observed the distribution of the pieces for different game categories. Figure 2 shows the distribution of the pieces for roll-playing games. Figure 2 indicates that the pieces which show a wide range of emotional features are used in roll-playing games. Figure 3 indicates that a “pleasant” and “exciting” musical peace tends to be used in action games. Figure 4 show the distribution of the pieces for the series of the “Biohazard” of horror games. Figure 4 indicates that the series tend to use “unpleasant” music.

CONCLUSION

In the present study, it is shown that the emotional space of game music is constructed by two dimensions, “pleasantness” and “excitability” which are consistent with classical music. Moreover, it is shown that tempo parameter does not show a high correlation coefficient to the emotional space.

In the next stage, we will try to reveal the correlation between the emotional features and various physical parameters, e.g., sound levels, spectral centroid *etc*., for the goal of establishing a scientific logic to design music for video games.

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Table 1 Semantic differential (SD) scales and factor loadings of them

SD scales			Factor	
			Pleasantness	Excitability
Dark	-	Bright	0.956	0.002
Heavy	-	Light	0.869	-0.267
Tense	-	Relaxed	0.703	-0.655
Pleasant	-	Unpleasant	-0.948	0.125
Warm	-	Cold	-0.899	0.085
Clear	-	Unclear	-0.896	0.127
Cute	-	Uncute	-0.893	0.341
Fresh	-	Sordid	-0.886	0.321
Delightful	-	Dull	-0.872	-0.330
Cheerful	-	Gloomy	-0.802	-0.120
Clean	-	Dirty	-0.774	0.320
Weak	-	Strong	-0.255	0.862
Tranquil	-	Restless	-0.284	0.849
Loose	-	Tight	-0.299	0.826
Monotonous	-	Varied	0.248	0.581
Excited	-	Unexcited	0.104	-0.946
Showy	-	Humble	-0.199	-0.903
Agitated	-	Calm	0.118	-0.899
Pwerful	-	Powerless	0.288	-0.881
Speedy	-	Slowly	-0.065	-0.860
Hard	-	Soft	0.545	-0.759
Mixed	-	Neat	0.482	-0.716
Wide	-	Narrow	0.162	-0.679
Impressive	-	Unimpressive	-0.420	-0.533
Contribution Rate			0.393	0.389

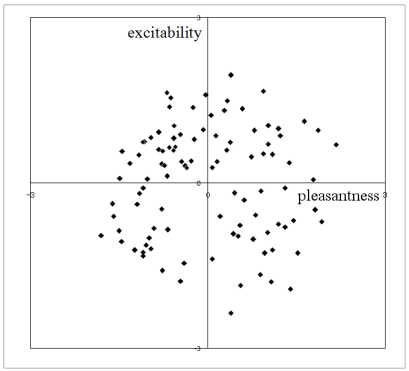

Figure 1 Emotional space for game music

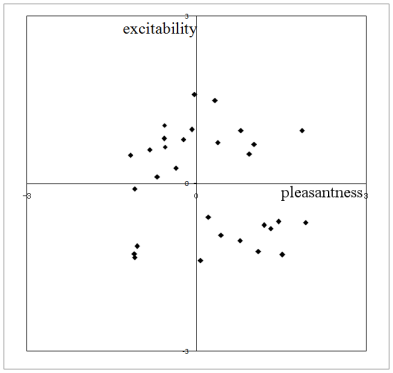

Figure 2 Distribution of musical pieces for role-playing games

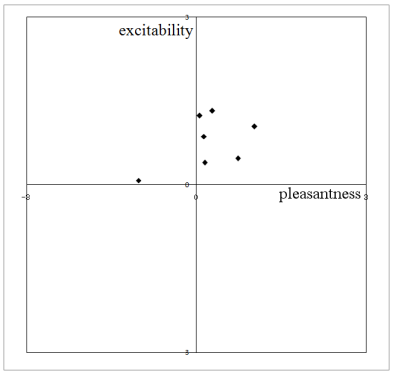

Figure 3 Distribution of musical pieces for action games.

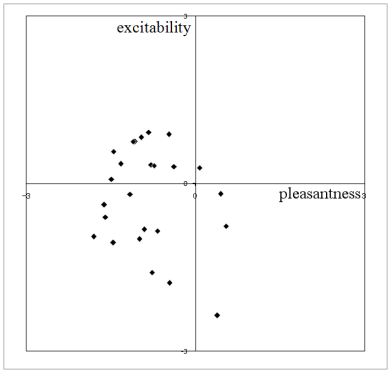

Figure 4 Distribution of musical pieces for the series of horror games, Biohazard series.