Correlation of Music Recognition Level and Tonality Recognition

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***Abstract*—This paper discusses correlation of the music recognition level and tonality recognition. We analyze tonality recognition with questionnaire survey of the music major students and students except for the music major. We use method of the feature extraction of the music according to the adjective image chart, because it is superior than the feature extraction of the music by the factor analysis. It is shown that the music major students and the students except for the music major show the almost same reaction for the correlation between music and color.**

1. Introduction

A lot of people are experiencing that we are obtaining various information there by listening to music. In general, it will be appropriate to think that sympathy and the impression obtained by listening to music are depended by the amount of information obtained by listening to it. In a word, the amount of information obtained at that time lowers inevitably if the ability to recognize music is low. Therefore, it is thought that a lot of musical nuances will not be able to be felt. However, the following problem is instituted. That is, is it correct to think the recognition level of music to be proportional to the amount of information that we obtain from music? For instance, the solfege is generally used as an index of an ability necessary to recognize music. However, there is a problem that the recognition level of music changes relatively depending on the level of the ability of solfege.

We execute the same questionnaire survey as general students who have not received the professional education of the same age music as the student at the music university with high solfege ability. From the result, the difference of the recognition of music by the level of the solfege ability (recognition level of music) is considered.

In this paper, the result of the questionnaire survey concerning the recognition of tonality that is influenced the solfege ability most is considered.

In, Section-2, details of questionnaire survey are described. In Section-3, the recognition of tonality and the analysis result of the music image are described by using the feature recognition method [1] by the adjective image chart that we developed. In Section-4, the difference of recognition to tonality by the difference of the music experience obtained from the experiment result is described.

It is shown that an interesting result of the influence that the difference of a musical experience gives to the recognition of tonality is obtained by our verification.

Also, three sample tunes used for the questionnaire survey are given in the Appendix.

2. Details of questionnaire

2.1 Process of questionnaire

We executed the questionnaire survey twice in the following manner.

The 1st questionnaire

(1) The object of the 1st questionnaire survey is as follows.

- Group-A (general students)
  15 students in the fostering and welfare specialized schools (women)
- Group-B (music major students)
  8 students at Kunitachi Music College (women)

(2) Contents of the questionnaire survey are as follows.

- Three sample tunes are used for the questionnaire which are given in the Appendix, composed by one of the authors.
- All the registers of the sample tunes are got within one octave.

Sample tune-1 : C Major / C dur.
Sample tune-2 : D ♭ Major / Des dur.
Sample tune-3 : E ♭ minor / es moll.

We play Sample tune-1, Sample tune-2 that is transposed from Sample tune-1, and Sample tune-3 (see Appendix). Detailed contents of the questionnaire are given in Section-2.

When the questionnaire survey was actually done, the followings were noted.

(a) One of the authors performs the sample tunes that are recorded under the same condition.

(b) The questionnaire survey does in each group of three or four people. The order of reproducing the sample tune is changed by the group.

The 2nd questionnaire

(1) The object of the 2nd questionnaire survey is as follows.

- The questionnaire survey of the second times executed only the student of Group-A（general students). 33 students in the fostering and welfare specialized schools (women). However, the object person of the questionnaire survey of the first time and the second times does not overlap, that is, object person's school year is different.

(2) Contents of the questionnaire survey are as follows.

- Three sample tunes are used just like the questionnaire survey of the 1st, and other conditions are all the same as the questionnaire survey of the 1st.

2.2 Question items of questionnaire survey

In the questionnaire survey, the following three methods

were done.

(A) Free adjective selection: The image of the corresponding sample tune is filled in by a free selection of the adjective.

(B) Free color selection: The imagined color is freely described, when the person for the questionnaire listens to the sample tune.

(C) The person for the questionnaire describes tonality of the performed sample tune.

More detailed contents of the above three are given as follows.

Method-A : The feature extraction method of the music developed by the authors is used. In this method, the feature can be extracted by a free selection of the adjective. Here, 56 adjectives are used as choices (Table.1).

Method-B : The color imaged is freely described, when the object person listens to the sample tune. This means that it is a method of replacing the image of tonality by the color. In addition, it can have the advantage that can be compared with method-A by such a method.

Method-C : This is a method for the check on object person's musical sensitivity (solfege). In this time questionnaire, we would call the absolute pitch hold person who correctly answered the tonality of all the sample tunes.

As a result of the questionnaire survey, the object persons of the group for the general students have neither the absolute pitch holder nor the relative pitch holder in both the first time and the second times questionnaire surveys. As a result, it was clarified that the absolute pitch holder had six people in the group of the music major students, and two people existed the relative pitch holder.

3. Analysis of the questionnaire result

3.1 Characteristic extraction system

The characteristic extraction system [1] has the following two stages.

1st stage : We extract a representative adjective from the adjective that is used to the color image chart [2] and prepared as the choice. As a result, 56 adjectives are selected for choices of the questionnaire survey.

Table 1. The 56 adjectives of random selected

Pretty	Childlike	Cheerful	Carefree	Enjoyable
Pleasant	Lively	Flashy	Busy	Active
Bold	Passionate	Dynamic	Intense	Gorgeous
Amorous	Charming	Luxurious	Strong	Wild
Oldie	Gallant	Dignified	Tasteful	Sacred
Solemn	Mechanic	Precise	Urbane	Chic
Chick	Docile	Generous	Natural	Elegant
Graceful	Upper classes of	Feminine	Modest	Refined
Clearly	Youthful	Quickly	Modern	Nice
Healthy	Fresh.	Sensitive	Refined	Plain
Peaceful	Cute	Calm	Familiar	Romance
Refreshing				

We were able to carefully select 56 adjectives as is shown in Table 1. The adjectives that were selected must exist in all the range of the graphs on an equal basis in the adjective image chart (Fig. 1). Needless to say, those are arranged on an equal basis in the graph.

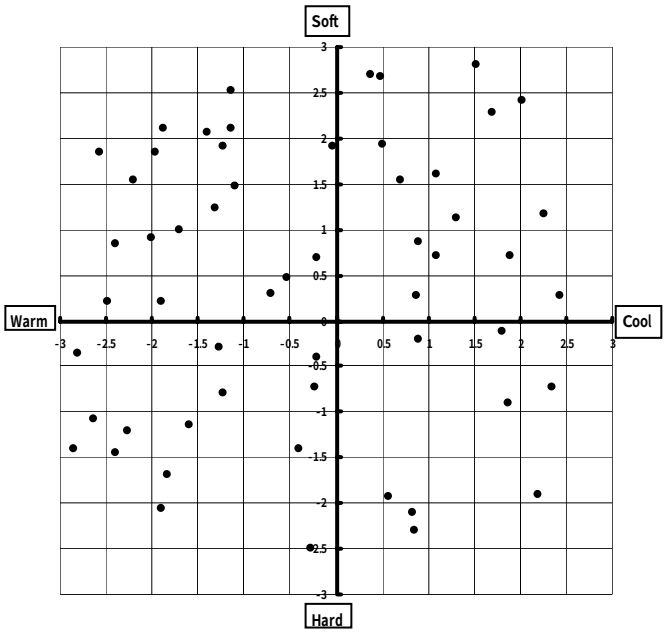


Fig.1 The Plot of the 56 sdjectives

2nd stage : In the next stage, (x,y) coordinates are given to 56 extracted adjectives. In each coordinates point, the selection frequency of the adjective is shown with a balloon. We do analysis by using this plot figure. It is able to express the approximation of the image of the adjective. Therefore, it is possible that the chart figure grasps the characteristic of music. The chart figure is possible that it grasps the image roughly.

This chart figure is conforming to the adjective image chart. We set up the axis of chart figure as follows. X-axis and Y-axis correspond to Warm-Cool and Soft-Hard, respectively.

3.2 Plot of the result of Method-A

Each figure of the adjective images that was processed by our system is shown as Fig.2 to Fig.8.

The size of the balloon of the adjective image chart is showing the relative size in each chart. Accordingly, the size of the balloon is not showing the absolute value of each adjective.

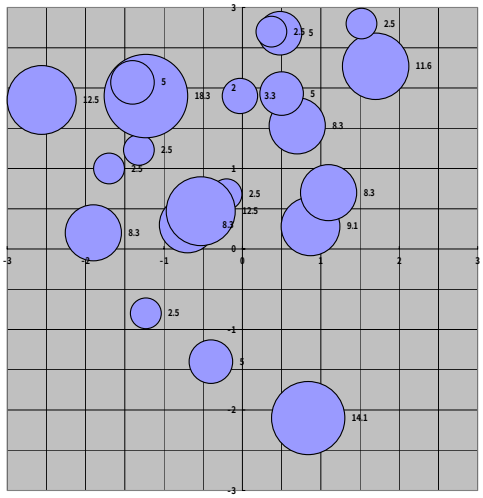


Fig.2 1st questionnaire in C major for the general student.

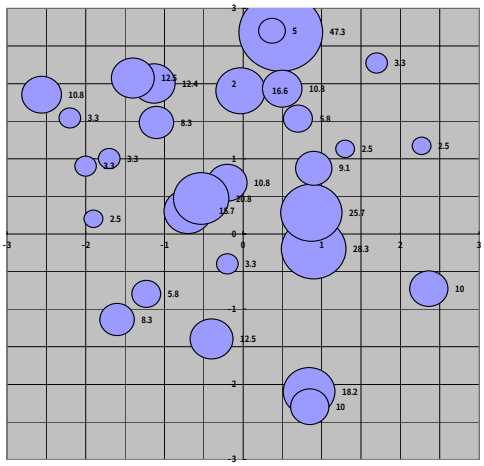


Fig.5 2nd quesnnairtioe in D ♭ major for the general student.

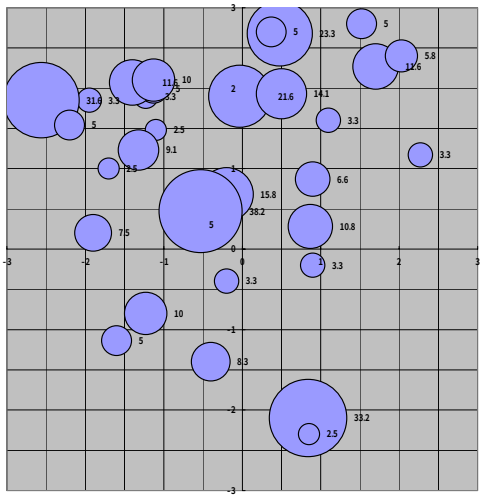


Fig.3 2nd quesnnairtioe in C major for the general student.

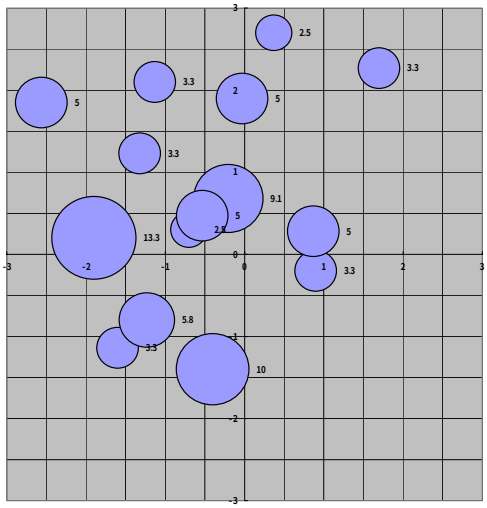


Fig.6 Questionnaire in D ♭ major for the music major student.

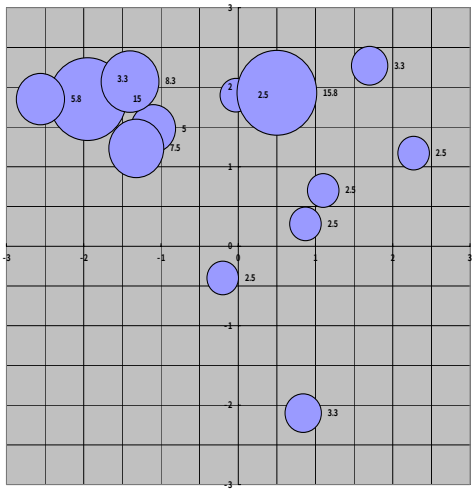


Fig.4 Questionnaire in C major for the music major student.

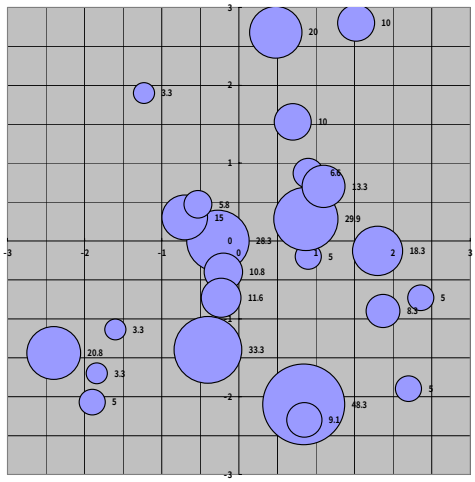


Fig.7 2nd quesnnairtioe in E ♭ minor for the general student.

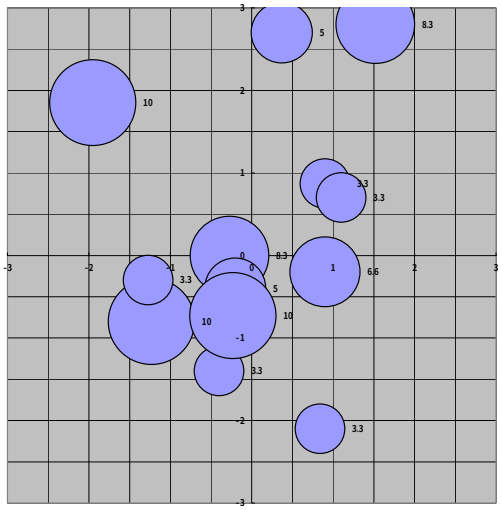


Fig.8 Questionnaire in E ♭ minor (music major student).

3.3 Analysis as a result of Method-A

Trend analysis for the group of general students

(1) Because the object people of the general student are all student at the same school, the recognition level and solfege ability of music are almost thought to be the same. Because object person's of questionnaire survey of the first time and the second times school year is different, the situation is quite different. It is about twice that the number of object people is the second times when Figure 1 and Figure 2 are compared compared with the first time, so that the number of balloons or more increases. That is to say, the tendency to which the image diffuses is seen. However, the entire tendency does not turn. As a result, it turned out to show a certain constant tendency.

(2) Figure 3 and Fig. 5 are the data of the same person for the questionnaire. The difference of the 1st (Cdur) and the 2nd (Des dur) tonality is clearly shown. Of course, the 3rd tune (E ♭ minor) shown in Fig. 7 has the great divergence compared with other cases (tendency to concentrate on the 3rd and 4th areas in the image chart.). They understand the difference between major key and the minor key well. However, none of judgments of tonality were answered for Method-C. It was a situation in which even the meaning of the question was not able to be understood. That is, they did not become the group of the music major students like that though it, the solfege ability was high and listened to the difference of the interval.

(3) It is easy for a personal preference to be controlled as for the adjective selection rate in the questionnaire survey when the object person is not a music specialist [3]. This was forecast at first that the diffusion of the image is admitted from the group of music major student in the group of the general student though.

Trend analysis for the group of music major students

(1) Because the first tune (C dur) shown in Fig. 4 is the C major key (C dur) with an easy judgment of tonality, all members are answering Method-C correctly. Their images have concentrated as understood from this fact.

(2) The diffusion of the image has occurred about the D ♭ major (Des dur) as shown in Fig. 6. When we determine the tonality of the 2nd tune without seeing the score, there is a possibility that the confusion of the C ♯ major and D ♭ major. Because, C ♯ major is that the same tone in a different name of D ♭ major. In the same tonality of the different name (it is called enharmonic tonality), there is an image diffuses. It may be a natural case that the dispersion of the image breaks out there.

Table2 Result of the 2nd tune tonality determination

Tonality	Selection
D Major	4
C major	3
Other(Mistake)	1 (D Major)

(3) There is a big difference in the image in the 1st tune/C major and 3rd tune/es minor. It is an area in Fig. 4 in the adjective image chart corresponding to "Romantic", "Pretty", and "Natural". As for the plot data of Fig.8, "Gorgeousness", "Dandy", and the classified area are centered in the adjective image chart. Thus, a constant tendency was often found to the selection of the adjective.

3.4 Result of Method-B

The result of the group of the general students is shown about the color selected by Method-B and the result of the group of the music major students is shown in Table 3 and Table 4, respectively. There was a person who had written the subtle change in the color in the object person in the questionnaire survey. As for them, the image is integrated and evaluated basically. For instance, as follows was done. "Thick green" is "Green" and " Beautiful red" is "Red. "

Table3 Result of the 1st time color evaluation for the general students.

Sample Number	Color evaluation (15 person)
1st Tune (C Maior)	Pink－3 Light blue－3 Green－3 Red－3 Other ：Yellow Sanguine Silver
3rd Tune (es minorl)	Gray－10 Dark Red－2 Other： Black White Dark blue

Table4 Result of the 2nd time color evaluation for the general students.

Sample Number	Color evaluation (33 person)
1st Tune (C Maior)	White－8 Yellow－6 Pink－4 Light blue－4 Yellow green－2 Other：Green Fresh Color Blue Red Silver Purple
3rd Tune (es minorl)	Gray－10 Blue－6 Black－5 Yellow green－3 Yellow－3 White－3 Other：Light blue Gold Dark blue Brown Red Green

Table5　Result of the 1st time color evaluation for the music major students.

Sample Number	Color evaluation (8 person)
1st Tune (C Maior)	Light blue－3　White－2 Other：Red　`Pink　Black
3rd Tune (es minorl)	Purple－2　Fresh Color－2　Gray－2 Other ：Brown　Green

3.5　Analysis as a result of method B

(A) There is strong correlation in result of Method-A and Method-B. The result of Method-A of the 1st tune of the music major student is focusing on "Romantic", "Pretty" and "Natural" areas. Also the result of question A of the 1st tune of the music major student is focusing on "Gorgeous", "Gallant" areas. Moreover, the third has concentrated on "Gorgeousness" and "Dandy" areas. However, Both groups of the general student and the music major student of the color selected by Method-B most is very near the image of the arrangement of color pattern of three colors provided in each area in the color image scale. Here, because a color and slight nuance is not expressible by the print, the color image scale is shown next for deep understanding. The following will be appeared in the color image chart [2].

「Romantic」

It is soft, the dream of it and a gentle image. Summarizing light soft color and white subtly the atmosphere of the fairy tale is created.

「Dandy」

There is style high atmosphere. We feel composure. The masculine refinement is the image of a basis. It is an arrangement of color with the pitch that centers on the cold color group of a hard sense. The image of the adjective diffuses, and the tendency cannot be found by the plot of the group of the general students (Fig. 1 and Fig.3). However, it is understood that the color selected by Method-B is corresponding compared with the tendency that the group of the music major students showed.

(B) When we try to examine it about all the Sample tunes. Many similarities exist in the groups of the general students and the music major students in the color selection of Method-B. There is a difference in the ability of solfege to it is not related. The selection trend of the color is resembling.

4. Conclusions

4.1 Reaction of the group for the general student

The difference is understood though the group of the general students cannot distinguish tonality of Method-A. However, the clear trend cannot be found to the image compared with the group of the music major students. For the people who are not the musicians like being also in our early research [1,3], there are a lot of reactions that the individual variation is violent, and is rare. Thus, it may be difficult to fix the image for music that it is simple and a rhythmical change is scarce.

However, a constant tendency was able to be found to the selection of the color about Method-B though an ability holder an absolute pitch and a relative musical sensitivity was none at all. The color tendency agrees with the tendency to Method-A of the group for the general students. Authors also felt the surprise for this result. How are they ascertaining the difference of tonality? A constant color tendency was able to be found though the recognition level to tonality was low.

4.2　Reaction of the group for the music major student

The music major students are the persons who are holding absolute pitch and also relative sound impression. Even if it is the questionnaire with regard to a very simple musical piece (cadentz: the repetition of the chord called Ⅰ-Ⅳ-Ⅴ-Ⅰ), it became clear that the music major students can extract a musical image accurately. Also, even the trend was able to read it. It is conjectured that it is because the image to the tonality is established.

4.3 Summary

The experience of music is shallow and training to the musical sensitivity is not performed to general students. However, it was clarified that recognition to general students' tonality did not change greatly compared with the student of the music major. The authors remembered surprising that as for the group of the general students, it is outline recognition, the image of tonality is distinguished and the recognition is not too different from the group of the music major students with high knowledge of music.

Moreover, it is interesting that it is especially a result for it to understand the color corresponding to music. Because new directionality to the clarification of the feature recognition of the music done in the brain to the problem was suggested.

The authors plan to research concerning recognition how to understand various information in music based on this result.

References

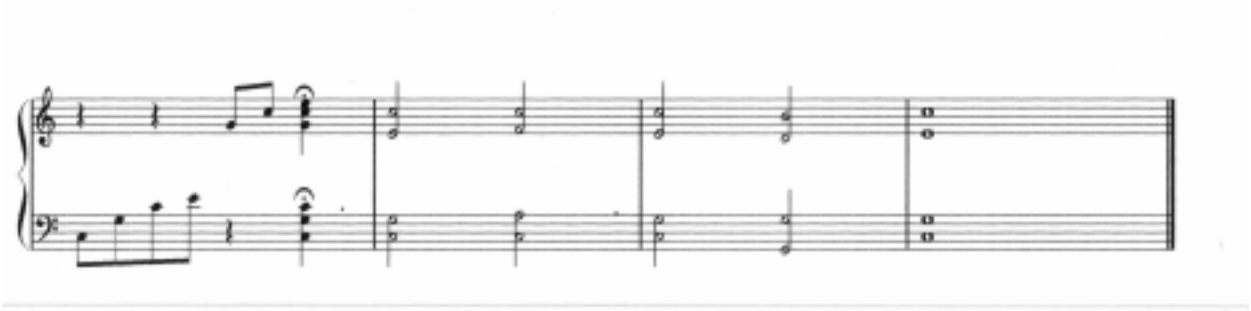
[1] Kazuhiro Yamawaki and Hisao Shiizuka, Feature Extraction of Music with Adjective Image Chart, *IPSJ SIG Technical Report*, 2002-MUS-47-17, pp. 105～109, (2002)

[2] Japanese color design research institute Co. Ltd., Color image dictionaries, p. 96, *Kodansha Ltd. Publishers*, Tokyo (1993)

[3] Kazuhiro Yamawaki and Hisao Shiizuka, Individual Differences on Feature Recognition of Music, *6ｔｈ Asian Design Conference , E-47,* (2003).

Appendix

(1) Sample tune-1 in C Major/Cdur.



(2) Sample tune-2 is transposed from Sample tune-1 to D ♭ Major.

(3) Sample tune-3 in E ♭ minor/es moll.