RO-010

Experiments on Music Therapy Support System

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1. INTRODUCTION

Recently, it is recognized that music is applicable in the field of medical. Music is expected to support a patient's mental and medical treatment. Recent technology makes it very easy to get a musical piece through the internet. This makes the music therapy more popular. We are trying to develop a music therapy support system using the latest technology and confirming the effectiveness of our system.

Most of the current music search systems use the attributes of music, like title, singers, players and other static information. There are no famous music search systems using the biological information of the user. We assume that there exists the relation between the listener's heart beats and his favorite songs.

In the process of our system development, we want to recognize the relation between music genre and the effectiveness as music therapy. We compare the effectiveness of healing music (Mozart effect) and favorite music.

In this paper, (1) we propose a new music recommendation system using heart beats, (2) we conduct an experiment research about music genre. We believe our system may support music therapists who need to find suitable music for their patients.

2. RELATED WORKS AND METHODOLOGY

2.1 Music Recommendation System

In recent years, there are many music distribution internet sites. Users can search their desired music using the attributes of the songs in these sites.

Some of such sites have a recommendation system. It recommends some pieces of music according to the user's search history and/or his music libraries. One of the most famous systems is 'Genius' in Apple iTunes Store[1]. As Apple iTunes Store has a lot of user data, they can analyze music preference tendencies and recommend some set of music according to their data. Most of such recommendation systems use the simple idea: 'If you like song A and most of other users who like song A like song B, you must like song B'.

With this method, as the result is led by statistical analysis, an unnatural result may be brought in some cases.

2.2 Ventricular Rate and Music

Music has various influences on person's psychology. If you listen to the gloomy music, you will get tired. If you listen to the bright music, you will get happy[2][3] . It is known that, when the walking speed matches the tempo of music, the effects of pleasure and peace of mind can be obtained[4] .

In the research area of music therapy, it is known that people feel comfortable and relaxed when his heart rates and the tempo of the music he is listening synchronize [5]. Hotta analyzed the effect of the music tempo to the listeners' heart rates[6]. Hao presented a music recommendation system which would change the listeners' heart rate to normal range[7]. There is no major research to recommend music according to the listeners' heart rates. Our research is to construct a new music recommendation system using the heart rates of the users and the tempo of the music.

2.3 Brain Wave

A brain wave is an electrical impulse in the brain. The brain wave has divided into four types such as α wave, β wave, θ wave, and δ wave. α wave is observed when the person is relaxed, concentrated and sleeping lightly.

The brain wave shows the state of the consciousness of the person. Though it is difficult to control your consciousness, it is known that music can induce the brain wave when he needs concentration.

We use the brain wave, especially α wave, to check the mental condition of the users when they are listening to the music.

3. EVALUATION SYSTEM DESIGN

3.1 Search Policy

We install the following 4 methods to search a piece of music using the heart rates in the evaluation system.

(1) Average Rates Method: Use the average heart rates. This is used to find the preferable music for daily life.

(2) Current Rates Method: Use the current heart rates. This is used for the current situation.

(3) Specific Focused Method: Specify the other conditions, like gender, nationality or music genre before the search.

(4) BPM Recommend Method: Use recommendation system using BPM (Beat per Minute). This idea means: 'If you like the music with BPM A and most of other users who like the music with BPM A like the music with BPM B, you must like the music with BPM B'.

3.2 Implementation of Evaluation System

Fig.1 shows the configuration of the evaluation system.

The heart rates are measured using a commercial digital sphygmomanometer and the user input it to the system. The search function decides the appropriate BPM and search music in BPM DataBase. The relation between the heart rates and BPM is described in chapter 4.

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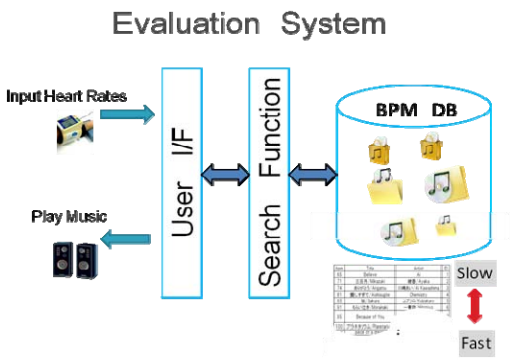

Fig. 1　System Configuration of the evaluation system

Fig.2 is the basic flow of the system.

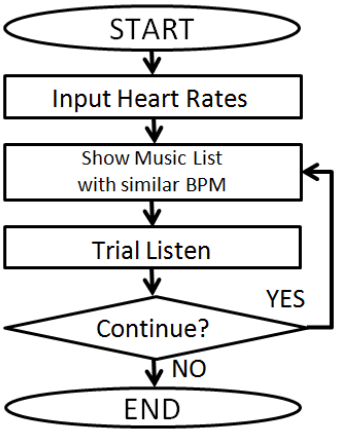

Fig. 2　Basic Flow of the proposed system

After a user inputs necessary information, the system shows the music list with similar BPM. The user can try to listen the recommended music.

3.3　BPM DataBase Management

Fig.3 shows the flow chart of the BPM DataBase management function.

When new piece of music is added, BPM of the piece is checked and saved into the database with other static information.

When the information of the user changes, that information is saved into the database.

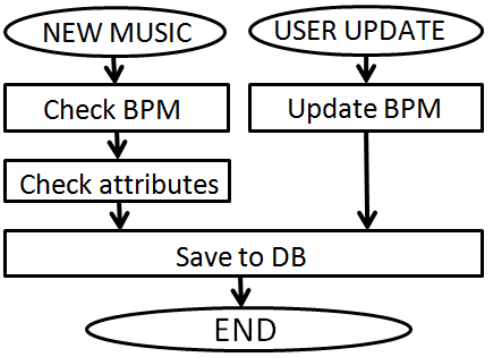

Fig. 3　Basic Flow of BPM DataBase Management

3.4　Music Search

Fig.4 is the start screen shot of the music search function. The user is asked to input his heart rates (average or current) and his music preferences. Then the system searches the favorite pieces of music and show the result list to the user.

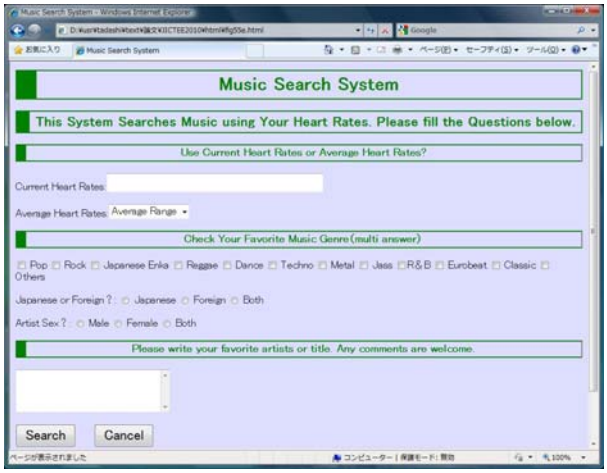

Fig. 4　Music Search Screen

Fig.5 is the screen shot of the search result.

Fig. 5　Search Result Screen

The system shows the list of music with similar BPM.

3.5　Trial Listen

After the list of music is shown, the user can select one music piece from the search result list. The detail information of the selected piece is displayed. The user can try to listen to that piece .

4. SYSTEM EVALUATION AND DISCUSSION

4.1 Preliminary Experiment

Before we evaluate the proposed system, we collected the data to find the relation between people's heart rates and his favorite music.

For eight subjects, we examined his heart rates and his taste of the music.

The subjects of this experiment are men and women from the teens to 50's.

bpm	Title	Artist	ID
65	Believe	Ai	1
71	三日月/Mikazuki	綾香/Ayaka	2
74	ありがとう/Arigatou	川嶋あい/Ai Kawashima	3
81	愛しすぎて/Aishisugite	Chemistry	4
85	桜/Sakura	コブクロ/Kobukuro	5
91	もらい泣き/Morainaki	一青窈/Hitotoyo	6
95	Because of You	浜崎あゆみ /Ayumi Hamazaki	7
100	プラネタリウム/Planetarium	大塚愛/Ai Otsuka	8
105	piece of a dream	Chemistry	9
110	Sweet Impact	BoA	10
115	Million Films	コブクロ/Kobukuro	11
120	少年ハート/Shonen Heart	HOME MADE 家族 /HOME MADE Kazoku	12
124	宝島/Takara Jima	コブクロ/Kobukuro	13
130	DAN DAN 心惹かれてく /DAN DAN Kokoro Hikareteku	FIELD OF VIEW	14
135	ヒトリノ夜/Hitori No Yoru	ポルノグラフィティ /Porno Graffitti	15

Fig. 7 Music Title and BPM

(1) Heart Rate: Their heart rates are measured using the commercial digital sphygmomanometer. The data of blood pressure is not used in this experiment.

(2) Music BPM: We prepared 15 pieces of Japanese popular music. The BPM of each piece are measured with iBPM Counter [8]. Fig.7 shows all the music title and it's BPM.

(3) Music Preference: Each person listens to all the sample music. Then they decide if they like or dislike the music. Fig.8 shows the results. From this experiment, it was confirmed that there exists some correlation between the heart rates of a person and the tempo of his favorite pieces of music.

From this result, the relation between the heart rates and BPM is plotted on the Fig. 9. The experimental system uses this result to decide the favorite BPM ranges from the heart rates. The upper and lower boundaries of the favorite BPM range are calculated using the least squares methods from the boundary data.

4.2 Evaluation

In order to evaluate our proposed system, we executed the following 2 experiments.

(1)Experiment 1

The subjects are the same as the preliminary experiment's case. We prepared 20 pieces of Japanese popular music. This music set is different set of the preliminary experiment's case.

Examinee			A	B	C	D	E	F	G	H
Heart Rates			73	75	76	87	89	91	101	113
bpm	Title	ID								
65	Believe	1								
71	Mikazuki	2								
74	Arigatou	3	✓							
81	Aishisugite	4	✓							
85	Sakura	5	✓	✓	✓					
91	Morainaki	6	✓	✓	✓	✓				
95	Because of You	7	✓	✓	✓	✓				
100	Planetarium	8	✓	✓	✓	✓	✓			
105	PIECE OF A DREAM	9	✓	✓	✓	✓	✓			
110	Sweet Impact	10		✓	✓	✓	✓		✓	
115	Million Films	11		✓	✓	✓	✓	✓	✓	
120	Shonen Heart	12				✓	✓	✓	✓	✓
124	Takara Jima	13				✓		✓	✓	✓
130	DAN DAN Kokoro Hikareteku	14						✓	✓	✓
135	Hitori No Yoru	15						✓	✓	✓

✓ means favorite

Fig. 8 Music Preference Result

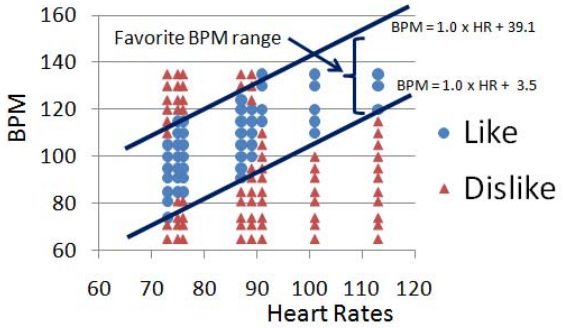

Fig.9 The relation between the heart rates and BPM

We executed 2 different cases.

Case 1): Recommend some music according to his favorite BPM range

Case 2): Recommend some music randomly

Each subjects answer if they like or dislike the recommended music.

Fig.10 shows the result of this experiment. When we use our system, around 60% cases out of all, the subject says he likes the recommended music a lot. This is more than twice of the number of random recommendation.

The number of 'dislike' case is 10% for our proposed system and 29% for random recommendation.

From this result, we have confirmed the effectiveness of our proposed music search system for some extent.

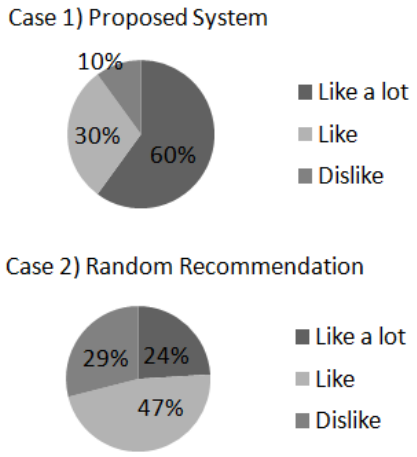

Fig. 10 Result of experiment 1

(2)Experiment 2

In order to confirm the result without the subject's assumption, we measured the brain wave of the them, especially α wave. α wave shows the person's status through 4 indices: relaxation, concentration, drowsiness and tension. Each index is expressed numerically from 0, the lowest, to 100, the highest. The total result is shown from overall numbers. Fig.11 shows the result of this experiment.

Mr.I (Favorite BPM: 155~195)

BPM	BRAIN WAVE
80	Low concentration, High tension
155	concentration
160	relax, concentration
175	concentration, no drowsiness
186	High concentration, no drowsiness
195	concentration

Favorite BPM

Mr.J (Favorite BPM: 121~160)

BPM	BRAIN WAVE
95	Low concentration
121	almost concentration
130	almost concentration
141	almost concentration
155	concentration
160	concentration

Favorite BPM

Fig. 11 Result of experiment 2

When the subjects are listening to the favorite BPM music, their brain wave shows 'concentration'.

4.3 Discussion

We propose our new music recommendation system using the heart rates and the tempo of the music piece. According to our experiment, there surely exists the relationship between heart rates and music tendency.

We also found the following observations.

(1)The effectiveness of our proposed system varies in person. It is very effective for one person, but no for another.

(2)Even if the BPM of the piece of music matches his favorite BPM range, some subjects don't like the piece because of the following reasons:

- dislike the voice
- dislike the atmosphere
- dislike the introduction sound

4.4 Future Works

In this research, we use only BPM to search music and sample music set are only Japanese popular music. In order to make sure that our idea is effective in a wider area, we should extend our system to use other information, such as music genre, artist, composer etc. And we need to use a wide variety of music genre data.

In order to use this system for music therapy, we may arrange the algorithm to search music according to the objective. For example, if you want to relax the patient, you may need slower music (or other conditions which is unknown now).

5. EXPERIMENT FOR MUSIC GENRE

From the previous test case, we have one question that what kind of music genre is suitable for music therapy. We used the favorite music of the subject for music therapy. On the other hand, a kind of healing music, usually classic music composed by Mozart, is said to be good for music theapy. We tried to measure the effect of healing music and favorite music.

5.1 Experiment Policy

In this experiment, we measured the effect of the music to ease the mental stress of the subjects. The subjects receive stressful stimulus. Then they listen to the music, healing music or their prefered music. Their stress level is measure before and after the stimulus and after listening the music.

5.2 Stress level measurement tool

The stress level of subjects is measured using the salivary amylase monitor. We use the 'Cocoro Meter' produced by Nipro Corporation (Fig. 12).

Fig.12 Cocoro Meter

Cocoro Meter measures the salivary amylase to estimate the mental stress. Recent research shows the amount of salivary amylase is a good scale to show mental stress rating [9][10].

The rough relation between the amount of salivary amylase (KU/L, kilo unit per litter) and the mental stress is shown in Table 1.

salivary amylase (KU/L)	mental stress
0 to 30	none
31to 45	small
45 to 60	medium
over 61	big

Table 1 Stress Rating

According to the salvary amylase, mental stress rating is classified to 4 classes

5.3 Experiment Steps

This experiment is conducted according to the following steps (Fig.13).

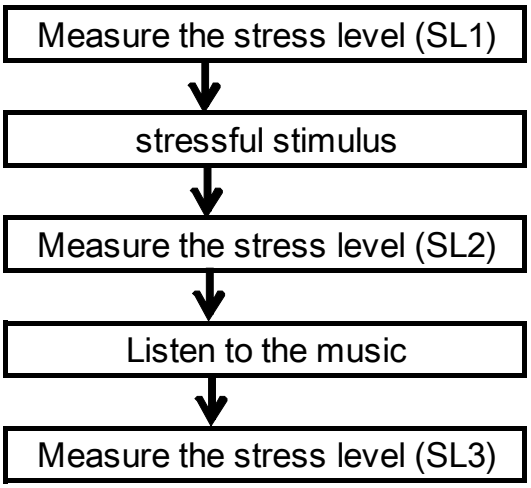

Fig.13 Experiment Steps

1) Measure the stress level with Cocoro Meter. This stress level is called as SL1.

2) The testee receives the stressful stimulas, with both physical stimulas and spoken words for 10 minutes.

3) Measure the stress level. This stress level is called as SL2.

4) listen to the music for 10 minutes

5) Measure the stress level. This stress level is called as SL3.

The experiments were conducted to 3 testees (2 female, 1 male). Each testee chose their prefered music.

5.4 Results

The followings are the results of this experiment.

1) Testee A
Sex: Female
Case A-1 (healing music)
Music: Clarinet Quintet in A major K.581 2nd mov. Larghetto by Mozart
Stress level results: SL1 = 72 , SL2 = 88 , SL3 = 42

Case A-2 (prefered music)
Music: “THE MEMORY MAKES ME SMILE” by BACK LIFT
Stress level results : SL1 = 53 , SL2 = 72 , SL3 = 47

2) Testee B
Sex:Female
Case B-1 (healing music)
Music: Piano Sonata No.20, K.466 2nd mov. Romance by Mozart
Streess level results : SL1 = 53 , SL2 = 68 , SL3 = 41

Case B-2 (prefered music)
Music : “Guiding Star” by TASMANIANBABY
Stress level results : SL1 = 54 , SL2 = 73 , SL3 = 64

3) Testee C
Sex: Male
Case C-1 (healing music)
Music : Serenade No. 10 in B flat major, K. 361, "Gran Partita" 3rd mov. Adagio by Mozart
Stress level results : SL1 = 31 , SL2 = 89 , SL3 = 59

Case C-2 (prefered music)
Music : “Closing” by over arm throw
Stress level results : SL1 = 55 , SL2 = 51 , SL3 = 41

5.5 Discussion

Over all result are shown in Fig.14.

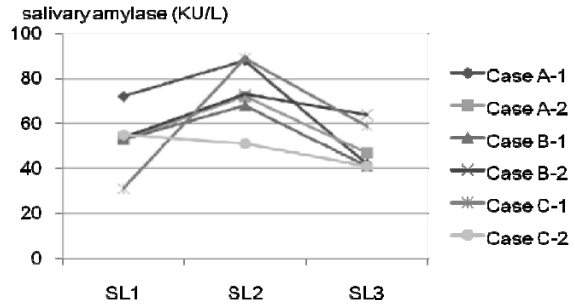

Fig.14 Overall Results

Each result for each subjects are shown in Fig.15 , Fig.16 and Fig.17. For every cases, listening to the music is effective to decrease the subject's mental stress.

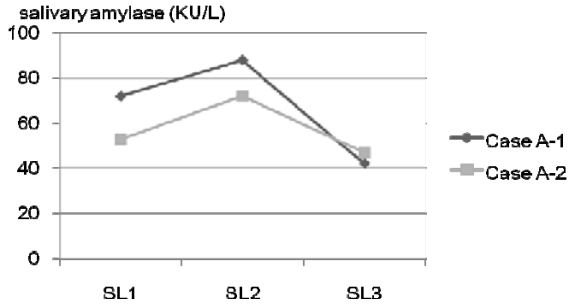

Fig. 15 Result for Subject A

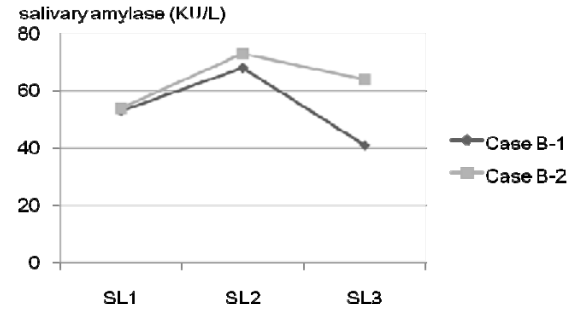

Fig. 16 Result for Subject B

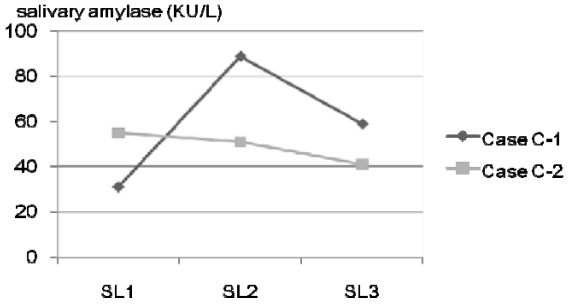

Fig. 17 Result for Subject C

For each subject, the scale number of decrease with healing music is better than that with favorite music. Although the combination of each music is different, this is true for every cases.

In case C-2, SL2 is less than SL1. This shows, even after stressful stimulus , the amount of salivary amylase decreased at least in this case. We have to examine other coditions, like average data of the amount of salivary amylase, the subject's condition before the test etc. for more reliable data.

With this case study, we observed

1) Listening to the music is effective for the mental stress decrease.
2) Although both healing music and the favorite music is effective, healing music is more effective.

6. CONCLUSION

In this paper, we proposed the music search system using the heart rates. The experimental system showed the effectiveness of our approach. Then we compared the effect between the healing music and favorite music. The result showed that healing music (classic music by Mozart) is effective than user's favorite music. We are going to develop a next music therapy support system using this result and collect more data to make sure our approach is effective in the future.

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