

# STUDY OF THE EFFECT OF BACKGROUND MUSIC TEMPO ON A REST PHYSIOLOGICAL EVALUATION USING A MENTAL STRESS TASK

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## ABSTRACT

This research examined the effect of background music genre on the biological information of the worker. Participants were Four (4) non-English-speaking (Japanese) male university students. The e-Learning English test that focus on vocabulary and grammar as well as calculation is used as a mental stress task. The ratio of low- to high- frequency heartrate via power spectral analysis (LF/HF) as a physiological index for evaluation is also used. As a result of a two-way variance analysis, it is found that there is a significant difference between the tempo in Classical music and Jazz music. It revealed that the ratio of low- to high- frequency heartrate via power spectral analysis in playing classical music environments was smaller than in the Jazz music environment. It is suggested that classical music used in this evaluation has the effect of reducing the ratio of low- to high-frequency heartrate that is measured via power spectral analysis, and Classical music had the more effect of relaxing than Jazz music in rest environment.

**Keywords:** *Environment, Music, LFHF ratio...*

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## 1. INTRODUCTION

This study examined the effect of Beats per Minute (BPM) of background music on the biological information of workers and explored which music genre have these effects.

In daily living environments—for example, at the office, at home, and at commercial space like shopping mall or restaurant—it is too often that music is played in the background. It is known that background music is an important fact that complements the design of the spatial effect in those environments [1]. Especially in a commercial space, Milliman [2] showed that the customer's comfort or positive feeling that is caused via listening to the background music managed to improve the satisfaction and purchasing desire. If background music has a positive effect on efficiency and comfort, background music can be utilised to improve and enhance productivity and comfort. Such an effect can also be used to improve commercial facilities and the service industry. Presently, there are several studies on the effects of background music on work efficiency, but these studies did not show the distinct causal relationship between the two, and there is insufficient relational data.

Kampfe and Renkewitz [3], investigated 97 researches that have examined background music and work efficiency and analysed that the number of the result of specific effect was not very high compared with the result of non-specific effect.

Several studies depicted that the effects of background music are able to elevate the feeling of comfort and pleasant feelings at a home environment. Studies in psychology and social welfare have examined the structure of music, audio machines, and listening environment as factors leading to relaxation [4] [5]. These studies used physiological data given as biological information from the participants as an objective index. This study used the ratio of low- to high-frequency heartrates (LF/HF) as a physiological index for evaluation.

In this study, the effect of background music in a rest environment is examined. In addition to that, the difference of music genre whether Classical music and Jazz music is used is also examined. For an evaluation of background music effect in rest environment, the data acquisition is set after the mental stress task is held. As an index of evaluation, the ratio of low to high frequency heartrate via power spectral analysis (LF/HF) is used. Therefore, two mental stress task differences were evaluated between tasks.

## 2. METHOD

### 2.1. Participants

A number of Four(4) male participants (3 right-handed, 1 left-handed) were selected. These participants were non-English-speaking (Japanese) university students. The questionnaire revolves around topics pertaining to participants' expertise in music or the opportunity to learn about music including any instruments.

## 2.2. Apparatus

The Data that was acquired in the listening room. A lighting system that provided variable illumination and colour temperature is used to regulate explanatory variables aside from the music. The experimental sequence is considered the living environment. Therefore, the luminance is set at 1100lx, colour temperature at 3900 K, and room temperature at 20 degrees Celsius. In the experimental sequence, participants are attached to an electrocardiograph. The electrocardiograph used is the MEG-6108 (NIHON KODEN). Whereas, the Vital Recorder (KISSEI COMTEC) for data acquisition and the BIMUTAS2 (KISSEI COMTEC) are used for data analysis.

Music was played from a digital audio music player whereas a digital audio component system (SONY) is used for the music loudspeaker. 1 Classical music piece and 1 Jazz music from the Real World Computing Music Database (RWC-MDB) were selected [6]: Popular, Classical and Jazz music database [7]. A piano solo instrument composition music for regulation is also selected. Hence, the change in BPM and music length is measured using Audicity (Audicity Team). The format of the file uses a WAV formatted file for the evaluation experiment. The SL-4023SD (SATO TECH) is used as a sound level instrument. The average decibel level was set at 40.83 dB in the no music environment.

Table 1: Information about the music used in the present study

Title	Genre	Length	Category	BPM
Suite <Ma Mère l'Oye>	Classical Music	6 minutes 45 seconds	Piano Solo	60
For Two	Jazz Music	6 minutes 15 seconds	Piano Solo	58

## 2.3. Mental Stress Task

In this study, the aim is to evaluate a mental stress in the practical work environment, therefore 2 types of mental stress task are examined. At first, the subtraction task is used. Participants were calculated three columns of subtraction that is displayed on the PC monitor. A time limit of 10 seconds is set regardless whether all participants have answered or not. Second, the English e-Learning examination for non-native English speakers are used and participants who answered the English grammar questions displayed on PC monitor.

## 2.4. Procedure

The Data was acquired in the listening room (Figure 1). In the experimental sequence, the participants loaded the electrocardiograph and sat on the sofa. In order to avoid effects from the autonomic nervous system, participants were told not to eat or smoke within 2 hours prior to the experiment.

Type-2 electrocardiograph induction was used for right-handed participants and Type-3 for left-handed participants. Before the data acquisition, the electrocardiograph waveforms were monitored and confirmed that what was observed is a normal isotonic R waveform. In the acquisition sequence, after loading the electrocardiograph and adjusting for 1 minute, the resting state is measured in 5 minutes where the participants did not listen to music without a task and the state in which the participants did not listen to music with a 10 minutes subtraction task, and 30 minutes in E-learning task in succession and resting state 10 minutes in which participants listened to music with task. A 1 minute interval is set for each measurement.

From the electrocardiograph data, it is detected that the peak time of the R waveform and calculated the RR intervals. The RR interval data was resampled with 1.2 Hz via cubic spline interpolation. The Fast Fourier Transform (FFT) is used in order to resample the RR interval data and calculated power spectral density. Finally, the integrated value of Low Frequency (0.05 Hz~0.15 Hz) and High Frequency (0.15 Hz~0.4 Hz) and the LF/HF ratio were calculated as the index of the sympathetic nervous system. The lnLF/HF ratio was analysed and with a repeated 2 way ANOVA between 6 conditions (2 genre and 3 BPMs) and time series (3 points).

Table 2 Data acquisition sequence with subtraction task

Time (minutes)	Status
0 – 5	Pre Task
6 – 16	Task
17 – 27	Rest with listening Music Genre: Classical or Jazz BPM: 60, 120, 180

Table 3 Data acquisition sequence with E-learning task

Time (minutes)	Status
0 – 5	Pre Task
6 – 36	Task
37 – 47	Rest with listening Music Genre: Classical or Jazz BPM: 60, 120, 180

### 3. RESULTS

Figure 1 showed the LF/HF ratio in subtraction task with 6 conditions (2 genres and 3 BPMs). Every graph showed the lnLF/HF ratio within data acquisition sequences Pre Task, Task and Rest with listening music with 6 conditions. The result of repeated 2 way ANOVA between 6 conditions and 3 points of time series, there was a significant difference within conditions ( $F(5, 54) = 2.38, p < 0.05$ ), also there were not significant differences within time series and interaction. Figure 2 showed the LF/HF ratio in E-learning task. The result of repeated 2 way ANOVA between 6 conditions and 3 points of time series, there were no significant differences within conditions and time series.

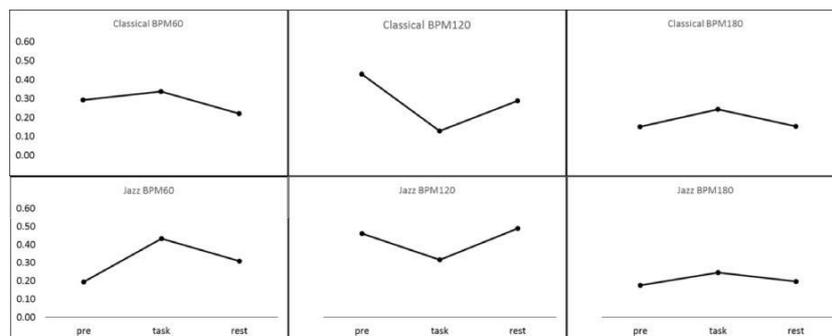


Figure 1: lnLF/HF ratio with subtraction task

( Pre = before task, Task = during task, Rest = after task. (n=4) )

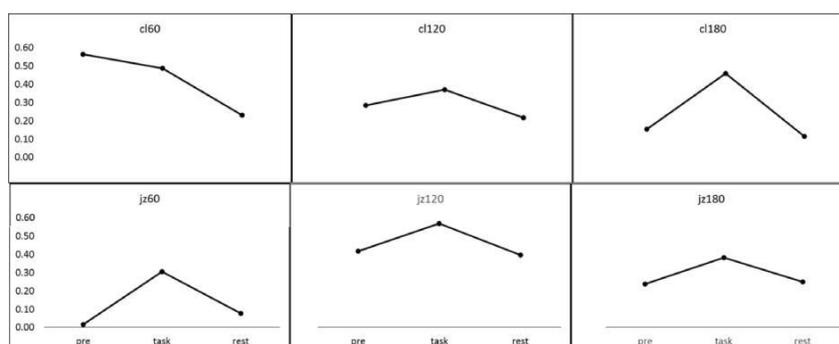


Figure 2: lnLF/HF ratio with E-Learning task

( Pre = before task, Task = during task, Rest = after task. (n=4) )

#### 4. DISCUSSION

This study examined the effect of background music on the LF/HF ratio of participants during rest with listening music after a mental stress task. The aim is to investigate the differences between genres; Classical music and Jazz music. The results while subtraction task was examined, there was a significant difference within 6 conditions (2 genre and 3 BPMs), on the other situation while E-learning task, there was no significant differences between conditions and time series. Also the LF/HF ratio during rest with a Classical music environment and Jazz music environment was lower than before the mental stress task-environment was held, and that especially in Classical music environment, the LF/HF ratio was a lot lower than Jazz music environment. Therefore, we suggest that the Classical music and Jazz music has the effect of reducing the LF/HF ratio.

Therefore, in order to regulate the features regardless of genre, the similar BPM (60) and an instrument composition which is a piano solo was used, but we did not regulate the musical rhythm and pitch, melody, and more musical features in this study. Therefore, there is a possibility of the impact of BPM is caused by other musical features.

## Acknowledgments

This work was partially supported by JSPS KAKENHI grants, “Effective Modeling of Multimodal KANSEI Perception Processes and its Application to Environment Management” (No. 24650110), “Robotics modeling of diversity of multiple KANSEI and situation understanding in real space” (No. 19100004), and a TISE Research Grant of Chuo University, “KANSEI Robotics Environment.”

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