International Journal of Medical, Medicine and Health Sciences
ISSN: 2517-9969
Vol:6, No:9, 2012

# A Research of the Influence that MP3 Sound Gives EEG of the Person

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***Abstract*—**Currently, many types of no-reversible compressed sound source, represented by MP3 (MPEG Audio Layer-3) are popular in the world and they are widely used to make the music file size smaller. The sound data created in this way has less information as compared to pre-compressed data. The objective of this study is by analyzing EEG to determine if people can recognize such difference as differences in sound. A measurement system that can measure and analyze EEG when a subject listens to music were experimentally developed. And ten subjects were studied with this system. In this experiment, a WAVE formatted music data and a MP3 compressed music data that is made from the WAVE formatted data were prepared. Each subject was made to hear these music sources at the same volume. From the results of this experiment, clear differences were confirmed between two wound sources.

***Keywords*—**EEG, Biological signal , Sound , MP3

## I. Introduction

CURRENTLY, a format to minimize the degradation of sound quality and to realize small file size is always required by the spread of personal computers and portable music players. Many types of no-reversible compressed sound source, represented by MP3 (MPEG Audio Layer-3) are popular in the world and they are widely used to make the music file size smaller. The sound data created in this way has less information as compared to pre-compressed data.

Most of sound compress methods use hearing properties of human beings such as the difference in difficulty of hearing of the sound by the frequency and a low sound being masked by a loud sound. And it is said that these methods do not deteriorate the sound quality [1], [2]. However, the influence that these compressed music gives to a person may not be the same as the influence that uncompressed music gives to a person. There are many researches of the influence that music gives to the EEG of the human being [3]-[10]. However, there are few studies for compressed music sources. The objective of this study is by analyzing EEG to determine if people can recognize such difference as differences in sound.

In our study, WAVE formatted files recorded to a CD are assumed uncompressed music sources, and MP3 formatted files are assumed compressed music sources. A subject is made to hear WAVE formatted music and MP3 formatted music that is made from the WAVE formatted music on the same condition.And while a subject listen to these music 16 channels EEG of the subject are measured and analyzed.

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## II. The Measurement System

In order to realize our purpose, a WAVE data and MP3 data made from same music source are necessary. A CD was used as an original music source. And a WAVE file was extracted from the CD and this file was translated to a MP3 file. In the experiment, a subject was made to hear these music files. Headphones were used to listen to music. A block diagram of our measurement system is shown in Fig.1. As shown in this figure, while a subject listen to WAVE sound and MP3 sound, 16 channels EEG of the subject are amplified and filtered by our designed EEG amplifiers. These measured data are analog to digital converted with resolution of 16bit, and then recorded and analyzed in a PC.

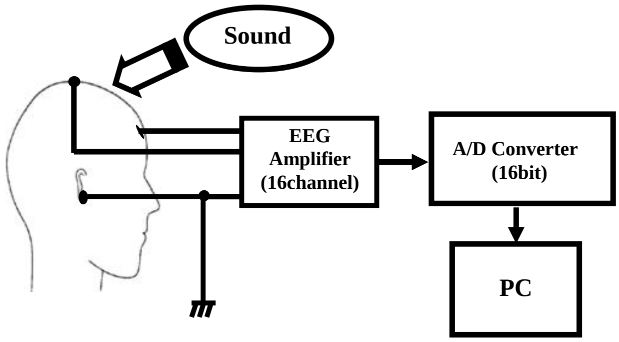



Fig. 1 A block diagram of the system

We think that in order to find differences between WAVE sound and MP3 sound, it is necessary to measure EEG from various places on the head. Therefore, we developed 16 channels EEG amplifier. In the experiment, 16 electrodes were set on the subject’s head according to International 10-20 method.

## III. Experiment

### A. Electrode Placement

As mentioned earlier, in order to measure EEG, our designed EEG amplifier is used. This amplifier can measure 16 channels EEG from subject’s head. In our experiment, we made Reference to the forehead midline section (Z), Common to the earlobe (A2), and EEG is measured from 16 electrodes which are set on the subject’s head according to International 10-20 method. The electrode placement is shown in Fig.2. In this figure, yellow colored positions are used.

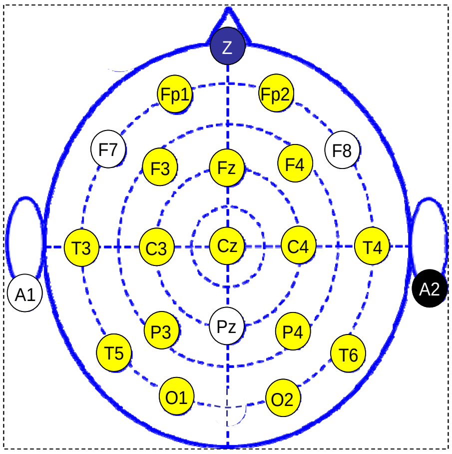
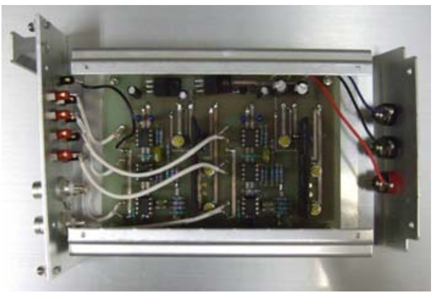



Fig. 2 The electrode placement

### B. EEG Measurement

Our designed EEG amplifier is shown in Fig.3. In this amplifier, EEG signal is amplified and frequency band of EEG is limited from 0.3Hz to 100Hz. And commercial frequency (50Hz) in the amplified signal is also eliminated by using a band elimination filter. The sampling frequency is 1kHz in analog to digital conversion and it's resolution is 16bit. In our experiment, EEG measurement is done in a shielded room in order to avoid induced noise.

(a) Appearance



(b) Introspection

Fig. 3 A developed EEG amplifier

### C. The Presentation of the Music

An electrostatic headphone (STAX, model SRS-2050A) was used to present a music source to a subject. Playable band of this headphone is 7Hz to 41kHz , and this band covers the audible band of the person sufficiently.

"C Jam Blues" by Red Garland Trio was used as music source in the experiment. In general, it is positioned to jazz music. In addition, the volume of WAVE sound and MP3 sound made equivalence, and experiments were carried out at the same volume for all subjects. In experiment, whether a sound to present was WAVE or MP3 was not informed to a subject, and these sounds were presented at the same position. After a subject listened to music at enough time, sampling of EEG was carried out for 4 seconds. Starting point of sampling was same in all experiments, and the order of the sound sources that were presented to a subject are selected at random. Fig.4 shows a picture of an experiment.

*The sequence of the experiment is shown as following.*

1. The subject rests quietly after electrode wearing.
2. Present a first music source (WAVE formatted or MP3 formatted) to a subject. And after having passed for three minutes, EEG was sampled for 4 seconds.
3. Keep the rest for 5 minutes after end of first music.
4. Present a second music source to a subject. After having passed for three minutes, EEG was sampled for 4 seconds.

Fig. 4 A picture of a subject under experiment

## IV. Results of Experiment

In the experiment, ten subjects (Healthy adult , Male: ten persons , Average age: 22.6 years old) were studied at the same condition. Fig.5 is a topographical view of the averaging results of the EEG of all subjects. This figure shows the mean value of EEG amplitude every 0.5 seconds according to progress of the time. In order to evaluate the results in the frequency domain, power spectrum of the averaging results was calculated by using Fourier transform. Results of this calculation are shown in Fig.6. This figure shows the mean of the power that is demanded every 3Hz along frequency.

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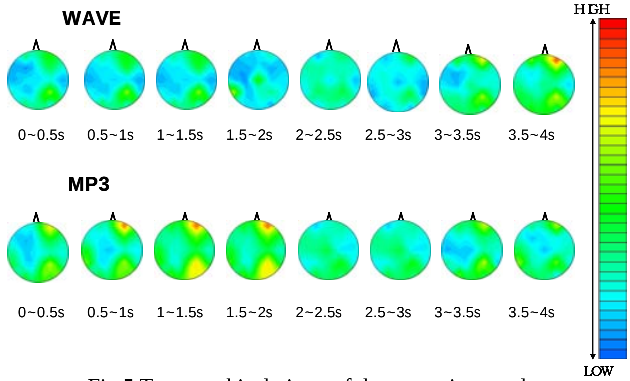



Fig.5 Topographical views of the averaging results

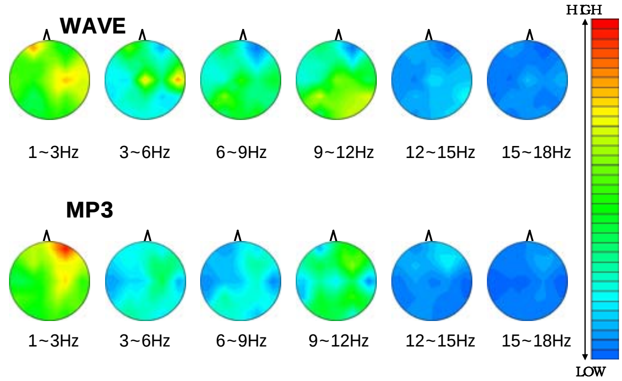



Fig. 6 Power spectrum of the averaging results

As shown in Fig.5, it is found that the EEG amplitude when subjects listened to MP3 sound is bigger than the EEG amplitude when subjects listened to WAVE sound generally. In order to confirm this view, the mean value of EEG amplitude of all subjects is calculated for each sound and t-test was performed. The result of this test is shown in Fig.7. And as shown in Fig.6, it is found that the power when subjects listened WAVE sound is bigger than the power when subjects listened MP3 sound from 3Hz to 12Hz. In order to confirm this view, the mean value of power of all subjects is calculated for each frequency band and each sound and t-test was performed. Results of this test are shown in Fig.8.

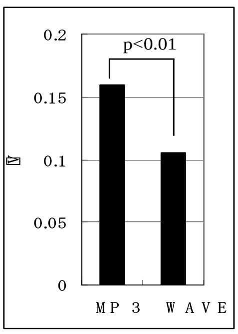
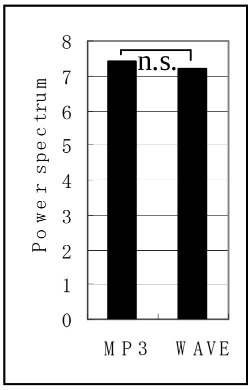
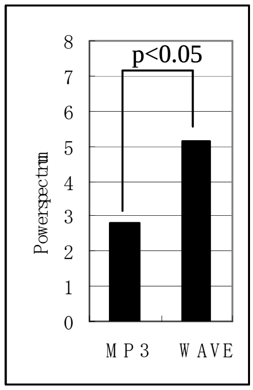


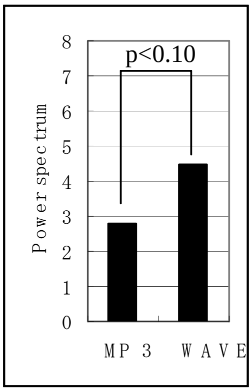

Fig.7 The mean of EEG amplitude of all subjects



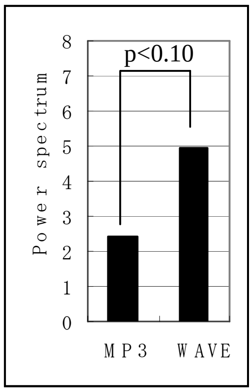

(a)1~3Hz



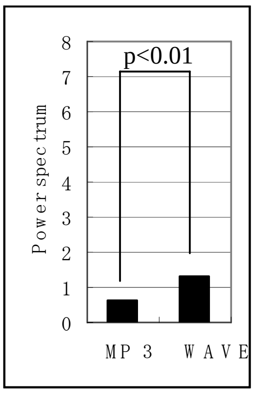

(b)3~6Hz



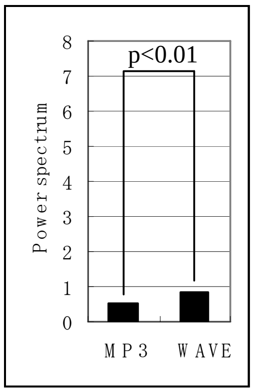

(c)6~9Hz




(d)9~12Hz




(e)12~15Hz




(f)15~18Hz

Fig. 8 The mean of power spectrum of all subjects (n.s.: not significant)

## V. Discussion

As shown in Fig.7, a remarkable difference is found in EEG amplitude and the EEG amplitude when subjects listened to MP3 sound is bigger than the EEG amplitude when subjects listened to WAVE sound. As shown in this figure, p value is smaller than 0.01 and it is confirmed that there is a meaningful difference in the amplitude. As shown in Fig.8, p values are smaller than 0.1, in all frequency band except the band from 1Hz to 3Hz, and it was confirmed that there is a meaningful difference in the mean of the power.

From these results, we think that the brains of subjects recognize difference between WAVE sound and MP3 sound even if subjects do not feel so. In other words, clearly some kind of differences between WAVE sound and MP3 sound exist even if we think that these sounds are same, and it is thought that these differences affect the brain of the person. Of course the kind of taste for the music of the subject and the kind of the music source to use have a big influence on results. In addition, the compression rate of MP3 encoding is one of the factors to affect the results of experiment. We think it will be necessary to study in consideration for these matters. And we also think it is necessary to consider why such results were obtained, in future.

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