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DIFFERENCE OF THE OPTIMUM LISTENING LEVEL AND THE PERCEIVED LOUDNESS OF REPRODUCED SOUNDS BETWEEN MEN AND WOMEN

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ABSTRACT

The optimum listening level (OLL) of reproduced music and natural environmental sounds were measured by a psychoacoustic experiment using the method of adjustment. The listening level of the music of male participants was generally higher than that of female participants. However, the gender difference was not found for OLL of the natural environmental sounds. Furthermore, the rating experiments of loudness of reproduced music, natural environmental sounds and noise were conducted to discuss the relationship between OLL and loudness perception. As a result, female participants tended to rate higher loudness scores than male participants for sounds of the same sound pressure levels. The gender difference of OLL of music was considered to be affected by the gender difference of loudness perception. The OLL was the same between men and women when OLL was supposed to be determined according to the memory of sounds, such as natural environmental sounds.

KEYWORDS: Optimum listening level, Music, Natural environmental sounds, Gender difference, Loudness

INTRODUCTION

Music consists of melody, rhythm and harmony [1] and the listening level of music also affects to its impressions. If there was difference in the optimum listening level (OLL) of music between men and women, men and women might get different impression to the same music. Furthermore, if men tended to listen to music at higher listening level, men could have a higher risk to lose their hearing ability than women.

In the present study, the measurement experiments of OLL using music and natural environmental sounds were conducted to clarify the existence of gender difference of OLL and

the effect of stimuli to determine OLL. Furthermore, the rating experiment of loudness of reproduced sounds was conducted to discuss the relationship between OLL and loudness perception.

MEASUREMENT EXPERIMENT OF OPTIMUM LISTENING LEVEL OF MUSIC AND ENVIRONMENTAL SOUNDS

Measurement of OLL of Music. The participants were 14 students (7 males and 7 females), aged 21 to 30. All of them had normal hearing and there was no difference in hearing ability between male participants and female participants. The sound stimuli were 6 music excerpts (approximately 90 s in duration) of the following genres; American Rock, Jazz, Japanese Rock and Punk (Tune 1: Numb by Linkin park, Tune 2: Sing Sing Sing by Benny Goodman, Tune 3: Linda Linda by THE BLUE HEARTS, Tune 4: Zetsubou Billy by Maximum The Hormone, Tune 5: Rock and Roll by Led Zeppelin and Tune 6: Space Sonic by ELLE GARDEN). These genres were chosen according to the results of our previous study [2] that the difference of OLL between men and women was not found when classical and pop music were used as stimuli. The participants listened to the stimuli via headphones and adjusted the sound volume of an iPod to OLL for enjoying each tune. Equivalent continuous A-weighted sound pressure level (L_{Aeq}) of each tune at OLL was measured using an artificial ear and a sound level meter.

The results of the measurement are shown in Figure 1. The effect of the gender was statistically significant ($F(11,72) = 13.2$, $p < 0.05$) by two-way ANOVA. The effect of the stimulus and the interaction between gender and stimulus were not statistically significant. The male participants tended to adjust OLL higher than that of the female participants.

Measurement of OLL of natural environmental sounds. The experiment was conducted in a semi-anechoic chamber. The participants were 14 students (7 males and 7 females), aged 21 to 31. All of them had normal hearing and there was no difference in hearing ability between men and women. The sound stimuli were 6 natural environmental sounds (Stimuli 1: sound of singing crickets, Stimuli 2: chirp of cicadas, Stimuli 3: croaking of frogs, Stimuli 4: bird chirping, Stimuli 5: murmur of brook and Stimuli 6: sound of waves). The duration of each stimulus was approximately 60 s. These stimuli were reproduced from a loudspeaker positioned at 2 m from the participants. The participants adjusted the sound volume of Windows Media Player of the Personal computer to OLL by dragging the mouse. L_{Aeq} of each stimulus at OLL

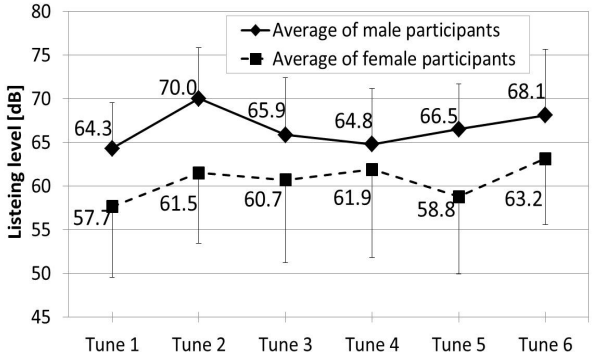

Figure 1. The average OLL of music of male and female participants.

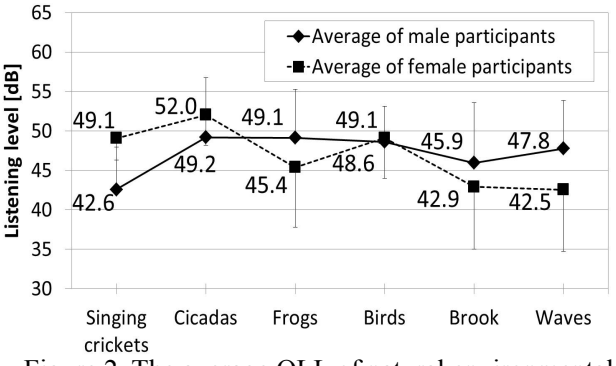

Figure 2. The average OLL of natural environmental sounds of male and female participants.

was measured using a sound level meter at the listening position of the participants.

The results of the measurement are shown in Figure 2. However, the effect of gender, the effect of stimulus and the interaction between gender and stimulus were not found to be statistically significant by two-way ANOVA.

THE RATING EXPERIMENT OF THE PERCEIVED LOUDNESS

The rating experiment of music. The experimental environment, the participants and the sound stimuli were the same to the measurement experiment of OLL of music. The sound pressure levels of each stimulus was adjusted to the average OLL of all participants; Tune 1: 61.0 dB, Tune 2: 65.8 dB, Tune 3: 63.3 dB, Tune 4: 63.4 dB, Tune 5: 62.7 dB and Tune 6: 65.6 dB (average condition), plus 5 dB to the average OLL (+5 dB condition) and minus 5 dB from the average OLL (-5 dB condition). The participants rated the loudness of the stimuli using the rating scale from 1 to 7 (1: very soft, 2: considerably soft, 3: slightly soft, 4: comfortable, 5: slightly loud, 6: considerably loud, 7: very loud).

The average evaluated values and their standard deviations for each sound pressure level condition are shown in Figure 3. The effect of the conditions of sound pressure level ($F(2,246) = 49.9$, $p < 0.01$) and that of the gender ($F(1,246) = 5.97$, $p < 0.05$) were statistically significant by two-way ANOVA. The interaction between gender and sound pressure level condition were not statistically significant. The female participants tended to rate higher loudness scores than the male participants for music of the same sound pressure level.

The rating experiment of natural environmental sounds. The experimental environment and the participants were the same to the measurement experiment of OLL of natural environmental sounds. The 4 natural environmental sounds of the measurement experiment (Stimuli 2, 3, 4 and 5) were used as the sound stimuli. The sound pressure levels of each stimulus was adjusted to -5 dB, average (Stimuli 2: 50.6 dB, Stimuli 3: 47.3 dB, Stimuli 4: 48.9 dB and Stimuli 5: 44.4 dB), +5 dB, +10 dB and +15 dB conditions in the same way to the case of music. The participants rated the loudness of the stimuli using the rating scale from 1 to 7.

The average evaluated values and their standard deviations for each sound pressure level condition are shown in Figure 4. The effect of the sound pressure level condition ($F(4,240) = 97.9$, $p < 0.01$) and that of the gender ($F(1,240) = 34.1$, $p < 0.01$) were statistically significant by

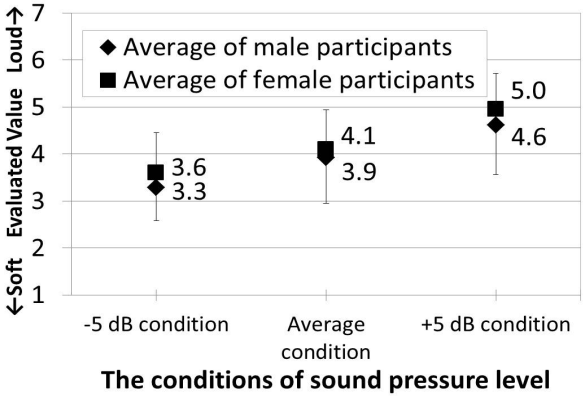

Figure 3. The average loudness scores of music for male and female participants.

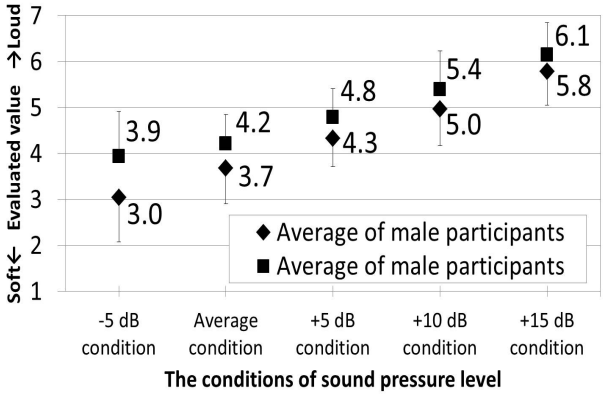

Figure 4. The average loudness scores of natural environmental sounds for male and female participants.

two-way ANOVA. The interaction between gender and sound pressure level condition was not statistically significant. The female participants tended to rate higher loudness scores than the male participants for natural environmental sounds of the same sound pressure level.

The rating experiment of noise. The rating experiment of noise was also conducted in the same way to that of music and natural environmental sounds. The sound stimuli were pink noise (15 s in duration) whose sound pressure levels were adjusted to 55 dB, 60 dB, 65 dB, 70 dB and 75 dB. The participants rated the loudness of the stimuli using the rating scale from 1 to 7 (4 is 'Neither').

The effect of the sound pressure level ($F(4,60) = 17.6$, $p < 0.01$) and that of the gender ($F(1,60) = 7.56$, $p < 0.01$) were statistically significant by two-way ANOVA. The interaction between gender and sound pressure level was not statistically significant. The female participants tended to rate higher loudness scores than the male participants for noise of the same sound pressure level as well as music and natural environmental sounds.

CONCLUSIONS

The difference of OLL of music between men and women was observed. However, OLL of natural environmental sounds of men and women was not statistically significant.

The female participants tended to rate higher loudness scores than male participants for music, natural environmental sounds and noise of the same sound pressure level. The existence of the difference of loudness perception between men and women was suggested. The difference of loudness perception was thought to be one of the factors that cause the difference of OLL of music between men and women. If men and women required a similar loudness for music, men might raise the listening level higher than women did.

When OLL was seemed to be determined by the preference of the listeners, men tended to adjust the listening level higher than women. However, when OLL was supposed to be determined according to the memory of the sounds, such as natural environmental sounds, the difference of OLL between men and women was not observed.

ACKNOWLEDGEMENT

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