PSYCHOACOUSTIC PARAMETERS AND EAR CANAL ROLE

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1 Introduction

According to definition, noise is an unwanted and unpleasant type of sound that could impact human activities and bring them into instability[1]. Exposure to noise associated with the injuries has become a public health issue in recent years. In addition to having adverse impacts on the hearing system, noise may also lead to other harmful health effects on the people, such as sleeping disturbance, impairment of cognitive performance in children, cardiovascular and pulmonary diseases, type 2 diabetes, adverse birth outcomes, and annoyance[2-4]. The effects of noise on humans depend not only on the physical characteristics of the noise, including the sound pressure level, frequency content and etc., but also on the physical, physiological, and psychological body systems reactions[5].

The ear is a sensitive organ of the human body that its structure in the process of the evolution and passing of the many years changed and at this time we can say the design of the human ear is one of nature's engineering marvels[6]. The ear has three regions called the outer, middle, and inner ear. The first two are solely concerned with sound transmission to the inner ear, which houses the transducer called the cochlea that converts fluid motion to action potentials. The auricle (pinna) and the ear canal, located on the outer side of the ear, collect and focus sound waves on the eardrum (tympanic membrane)[6].

Effects of ear canal on the sound pressure levels has been demonstrated by previous studies. Asady and et al. showed that ear canal could increase the level of sound pressure at different frequencies in both genders[5]. Also, Jia-Lin and et al. study showed that the sound pressure level difference between the outlet of external auditory canal and eardrum is different and these differences are more significant in the frequencies <=1500 Hz[7]. Djupesland and et al. study had same findings[8]. In all these studies which were performed in the field of acoustical roles of the human ear's different parts, the sound pressure level was the important parameter but it seems that no study was done on the psychoacoustical roles of the different parts of the human ear until now. The term psychoacoustics is generally defined as the study of listeners' responses to sounds. More specifically, psychoacoustics looks for statistical and causal relationships between certain physical properties of sounds and certain properties of human responses[9]. Same as the physical parameters of sound like sound pressure level(dB) psychoacoustic has its own parameters for calculation and measurements, most practical of them are loudness, sharpness, roughness fluctuation strength and tonality [10, 11].

So, the purpose of this study was to see that the psychoacoustic parameters including loudness, sharpness, roughness and fluctuation strength could changes significantly in the effects of human ear canal and gender had an important role on theses probable changes or not.

2 Method

White and sinusoidal noises each at 3 sound pressure levels (SPLs), including 75, 85, and 95 dBA, were used as the stimulus sound pressure levels (SSPLs). The speakers that were located in front of the participants had a distance of 1.5 meters from them and a height 87 centimeters from the lab ground. Labview software (V 2012), with the data acquisition card (DAQ) made by USA National Instrument Co (model MC-3642), was used for playing and measurement and calculating of the psychoacoustic parameters including loudness(phone), sharpness(acum), roughness(asper) and fluctuation strength(vacil). The psychoacoustic parameters were measured outside (cavum part of the external ear) and inside (at 2.0 cm depths from the entrance to the ear canal) of the right ear of each participant using the Moore method. This measurement was done with using of labview software. A circular-shaped microphone with a 2-millimeter diameter was used for this purpose. The time duration of 10 seconds (10 s) was considered for all the psychoacoustic parameters measurements.

3 Results

Out of 60 participants, 30(50%) was men. Most of them 41(68.3%) were BSc, eighteen (30%) MSc and one (1.7%) subject was PhD level student. The age means and standard deviation (Mean ± SD) of all participants was 22.77 ± 2.60 years old. Also, the mean and standard deviation (Mean ± SD) for height, weight and BMI (Body Mass Index) of all participants were 171.55 ± 9.65 cm, 64.30 ± 11.39 kg, 21.3 ± 2.95 respectively.

Comparison of the psychoacoustic parameters in the situation of the exposure to the different kind of noises and different sound pressure levels between two genders were not statistically significant (all P>0.05).

For sinusoidal noise the mean of all studied psychoacoustic parameters at the different SSPLs were the almost same, these findings were seen for the white noise too. The repeated measures ANOVA test results showed for both sinusoidal noise and the white noise in all three studied

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SSPLs the differences of four studied psychoacoustic parameters between outside and inside of participants ear were not statistically significant (all P values>0.05).

4 Discussion

Our findings showed that the human ear canal could not change the psychoacoustic parameters, and the gender had not effective role on this phenomenon in the other words the mean comparison of psychoacoustic parameters between outside and inside ear of both genders was not statistically significant. This finding was against of our hypothesis, that was the human ear canal like the sound pressure level in total or in the different frequencies could change the psychoacoustic parameters but this hypothesis was not supported by this study results. Actually, our hypothesis was according to the other study findings like Park et. al study showed in frequencies 3 kHz, 4 kHz, and 6 kHz and for people older than 30 years, hearing thresholds between both genders are statistically difference while this difference in the 4 kHz frequency was larger than other frequencies[12]. Also gender differences in the association between hearing loss and cognitive function was seen in the Huang and et al. study[13]. This kind of differences was seen in the Wasano and et al. study too[14]. We realized that both gender ear functions in the field of psychoacoustic are same and we can say that gender differences in sound perception is free from external hearing system differences. In other words, external hearing system of the humans dose not have any effects on the perceived sound quality and this parameter are more related to the sound pressure level, loudness, frequency content, level fluctuation, pure-tone components, and impulsiveness[15].

Also, our results showed that the psychoacoustical behaviors of the human ear canal does not change with change in the stimulus sound types and also sound pressure levels. It seems that changes of sound pressure levels at different frequencies in the role of human ear canal [5, 16] are not effective on the psychoacoustic parameters in other words psychoacoustical characteristic of the human ear canal are independent from the sound wave types and pressure levels. We did find the same articles to compare our findings with them.

5 Conclusion

It seems that human ear canal did not have any effects on the psychoacoustic parameters and as far as can be say that noise annoyance that is related to the psychoacoustics parameters[17] does not change in the role of human ear canal. Also, both genders ear canal behaves same in related to the psychoacoustic parameters.

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