AN ACOUSTICAL STUDY OF IPOD USE BY UNIVERSITY STUDENTS IN QUIET AND NOISY SITUATIONS

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1. INTRODUCTION

Exposure to loud noises in high doses can cause permanent damage to the cochlea and central auditory pathways resulting in noise-induced hearing loss (NIHL) (Fabiani, Mattioni, Saponara, & Cordier, 1998). Even though people may realize that excessive noise is dangerous, most do not have knowledge of what levels of sound are hazardous and so it is immensely important for professionals to educate the public about noise-induced hearing loss (Clark, & Bohne, 1999). Furthermore, even if people are informed about hazardous levels in terms of numerical decibel levels descriptions, they may not be able to relate decibel levels to their everyday experience. Therefore it is important to relate everyday auditory experience to the numerical quantification of noise.

The current experiment is part of a larger study and focuses on the acoustical measurement of iPod outputs, measured at user settings. By measuring the typical outputs at user settings, we attempted to determine what actual decibel levels young people choose while listening to their devices, how much they change the volume settings depending on the ambiant noise, and in consequence, whether typical use of these portable audio devices may pose an actual risk to hearing health.

2. METHOD

Listeners adjusted an iPod to their preferred listening level for two samples of music in five background conditions.

Participants

Twenty four university students volunteered for this study. All were between 18 and 25 years of age and had hearing thresholds below 20 dB HL from 0.25 to 14 kHz. Most students earned 1 course credit in Psychology 100 for their participation in the study and a few volunteered without compensation because of their interest in the topic. Informed consent was obtained from all participants.

Stimuli

Two samples of music were used. Each sample was representative of a particular genre, either Hip-Hop or Electronica. These genres were chosen because they are very popular with undergraduate students. A typical 30-second segment of each song was presented in each condition and was used to calculate the dBA level output at each user's preferred settings. The Hip-Hop segment had more low-frequency content, whereas the Electronica segment had more high-frequency content.

Each sample of music was tested in five background conditions: quiet, multi-talker babble at 50 and 70 dB SPL, and traffic noise at 50 and 70 dB SPL. The levels of the background noise were chosen to typify mildly and moderately adverse conditions that might be encountered in everyday situations.

Equipment

All testing was conducted in an IAC double-walled sound-attenuating booth. The background noise was delivered over two loud speakers, positioned at 45^0 on either side of the listener. The delivery of sound was controlled using a TDT System III. Music was presented to all listeners from the same black 30-GB iPod Video, with standard earbuds. At the beginning of each condition, the equalizer settings were set to the default position. At the beginning of each session, a calibration test was done in which the output was measured with volume set to maximum and the equalizer to the default position. The output from the iPod was measured by placing the ear-buds in the ears of a Bruel and Kjaer dummy head model Type 4128 C001, fitted with microphones and a Zwislocki coupler in both ears. The output to the ears of the dummy head was measured using a Bruel and Kjaer PULSE Sound Analyzer 9.0, Labshop.

Procedures

Participants completed the experiment in one of four orders. In two orders, Electronica was tested first and Hip-Hop second, and the types of music were reversed in the other two orders. Within each music type, half of the time traffic noise was tested first and multi-talker babble was tested second, and the types of background noise were reversed otherwise.

Participants sat on a chair located centrally in the sound booth facing the back wall with the loud speakers located in the back left and right corners of the room The participant was instructed that he or she would listen to a set of ten music clips, five from the genre of Electronica and five from Hip-Hop. For each clip, the experimenter asked the participant to listen and adjust the iPod to his or her preferred listening level for the particular listening environment (quiet, babble, or traffic noise). No hints about how to adjust the device were given but the experimenter did show the participants how to adjust the iPod volume and equalizer controls.

After the participants were satisfied with their adjustment in each condition, the experimenter noted the volume setting on the screen of the device with reference to a pre-marked scale from 0 (minimum) to 4 (maximum). The earbuds were then placed in the ears of the Bruel and Kjaer dummy head and the 30-second clip was analyzed using the PULSE Sound Analyzer to determine the average output level in dB(A) for each ear at the user's preferred settings.

3. RESULTS

On average, listeners adjusted the iPod to 67.6 dBA, but their preferred listening level depended on ear, and the type of music and background noise (see Figure 1).

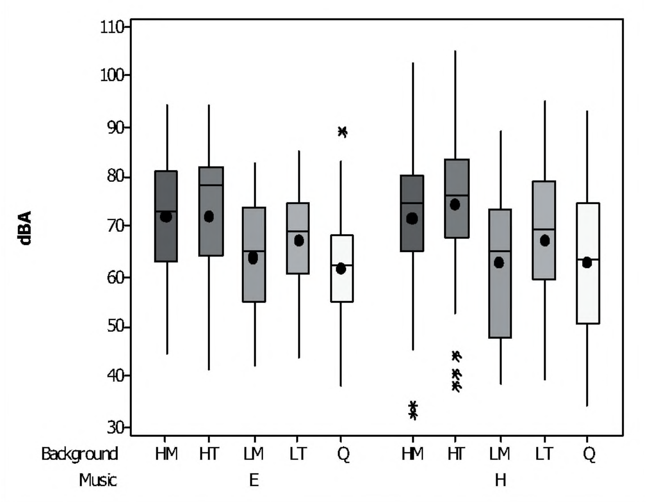

Figure1. Box and whisker plots showing the means (black dots), medians (centres of box), inter-quartile ranges (box ends), and minimum and maximum values (ends of whisker lines) for dBA outputs measured when the iPod was adjusted by listeners to their preferred settings for Electronica (E) and Hip-Hop (H) music under five background conditions (HM = high,-level multi-talker babble, HT high-level traffic noise, LM = low-level multi-talker babble, LT = low-level traffic noise, Q= quiet). Results for the two ears are averaged. Outliers are indicated by *.

Output was lowest when there was no background noise (62.1 dBA) or when there was a low level of multi-talker babble (63.4 dBA). Output was greater when there was a low levels of traffic noise noise (67.2 dBA). Output was greatest when there was high level noise, with little difference between multi-talker babble noise (71.7 dBA) and traffic noise (73.3 dBA). Curiously, mean output was 2.7 dB greater for the right than for the left ear.

These descriptions were confirmed by an Analysis of Variance with three between-subjects factors: Ear (right or left), Music (Hip-hop or Electronica), and Background (quiet, low-level multi-talker babble, high-level multi-talker babble, low-level traffic noise, high-level traffic noise). There were significant main effects of ear $F(1, 23) = 35.2$, $p < .01$), and background, $F(4,92) = 21.3$, $p < .01$. A Student-Newman-Keuls test of multiple comparisons confirmed that there was no significant difference between the outputs preferred in the quiet and low-level babble, but that the outputs in these conditions were significantly lower than in low-level traffic noise, and that the outputs in.the high-level noise conditions were significantly greater ($p = .05$).

4. DISCUSSION

It has been suggested that the maximum output of an iPod can reach 115 dBA (e.g., Spencer, 2006); however, the present study found that most university students preferred to listen to the iPod at a lower output level that would not be considered to be hazardous even if worn for 8 hours per day. Not surprisingly, the preferred output increased when the background noise was higher. Importantly, there was a large range of preferred outputs. The maximum output level that any individual listened to was 105 dBA which could pose a risk if listening time were not limited. In fact, over a third of the participants (n=9) selected a volume setting in at least one condition that exceeded 85 dBA, a level of noise that would trigger intervention in an industrial setting assuming an 8-hour daily exposure time. Health education should target individuals who are at risk so that they learn how to use their portable audio devices more safely. Such education should stress that listening in quieter environments and for limited durations will minimize risk.

ACKNOWLEDGMENTS

We wish to thank Sun Xiaoming for technical assistance.

REFERENCES

Clarke, W. W, & Bohne, B. A. (1999). Effects of noise on hearing. *J of the American Medical Association.*, 281(17), 1658-1659.

Fabiani, M;Mattioni, A, Saponara, M, & Cordier, A. (1998). Scandinavian Audiology, 27(Suppl 48), 147-153.

Spencer, J. (2006). Behind the Music: IPods and Hearing Loss. The Wall Street Journal Online, http://online.wsj.com/public /article/SB113685799723842312dZrxb_eZm44vfy74topaLm4 evP8_20070110.html?mod=tff_main_tff_top.