CHARACTERIZATION OF OCCUPATIONAL SOUND EXPOSURE OF PROFESSIONAL INVOLVED IN HIGHLY AMPLIFIED MUSIC REPRODUCTION

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Exposure to highly amplified music among listeners has not been demonstrated as a serious threat for hearing [1-3]. However, risk assessment for the professionals involved in the production and reproduction of highly amplified music has, as yet, received little attention. The present investigation aimed at characterizing the sound exposure within different professional categories, to estimate their risk of hearing loss and to explore the possibilities of limiting such a potential risk.

Methods

Participants

Two or three individuals were recruited to represent each of the following professional categories: sound engineer, sound technician (soundman) and disc jockey. They had to meet the following recruitment criteria: a minimum of 5-year experience and being currently employed by a well known entreprise in the trade.

Procedure

The participants were first interviewed individually concerning their work organization and the various factors governing their sound exposure. The interviews were tape-recorded and transcribed for analysis purposes. A second visit was later organized to record typical sound exposure conditions. Five 10-s samples of sound judged as being representative of each work activity were recorded using a BK-2231 sound level meter and a Sony PCM-1000 digital recorder. The samples were later assessed using a BK-2123 analyzer.

Results

The findings show that exposure could vary quite considerably from one week to another for sound engineers inparticular. Scenarios of representative exposure patterns were defined, and the level of exposure was computed accordingly. Sound engineers who work on tours are involved in an average of 6 shows a week during typically 3 weeks per month. An average exposure for each show was estimated at 2 hours for setting up and 3 hours for the show itself. For the sound technicians, a typical week was estimated to involve 50 hours during disc recording. Disc jockeys typically work 5 hours a day, 3 days a week.

The resulting L_{Aeq40h} are given in Table 1 for the three types of occupation. They ranged from 94 to 99 dB for the sound engineers. L_{Aeq40h} amounted to 89.5 dB for the recording technicians and to 93-94 dB for the disc jockeys. Based on ISO-1999.2 [4], significant hearing losses are predictable in the high frequencies even among individuals with an average sensitivity to noise-induced hearing loss.

Predictions indicate that the average hearing loss could amount to nearly 30 dB at 4 kHz after 10 years of work as a sound engineer (Table 1). Lesser degrees of loss are predicted for the sound technicians who are exposed to less powerful sound sources. Disc jockeys fall into an intermediate risk category.

Table 1. Estimated weekly exposure level (L_{Aeq40h}) and corresponding median permanent threshold shift at 4 kHz after 10 years (PTS_{50} - 10y) according to ISO 1999.2 [4] for 8 professionals involved in highly amplified music reproduction.

Occupation	L_{Aeq40h} dB	PTS_{50} - 10y dB
Sound engineers		
#1	99.0	28.8
#2	93.8	17.7
#3	94.2	18.4
Sound technicians		
#1	89.6	10.6
#2	89.5	10.5
Disc jockeys		
#1	94.3	18.6
#2	93.2	16.6
#3	94.9	19.8

During the interviews, the participants all mentioned that they felt signs of hearing impairment. One stated: "We all have more or less the same thing, this little dip around 6-8 k; but, apparently, this is normal...". Another said: "We are somewhat like miners who know they have lung problems or truck drivers who all have back problems. It is part of the job".

Furthermore, the actual sound levels during work sessions were high enough to induce temporary threshold shifts, which may impair work performance. An illustration is given below for a sound technician (Figure 1). The spectrum of the sound measured at the ear level during base tracks recording is depicted.

Also shown in Figure 1 is a reference curve for the mean lower limit of sound pressure level that will not induce temporary threshold shift. This so-called "effective quiet" curve [6] is derived from the mean free-field hearing threshold levels [5] elevated by 70 dB. It has been shown that exposure during 30 to 60 minutes at sound levels that are 80 dB above threshold induces 15 to 17 dB TTS_2 on an average [7]. Based on the data presented in Figure 1, a sound tehcnician with average sensitivity to TTS would sustain a 15 dB threshold shift at 0.5 and 0.6 kHz and over 20 dB shift at 4 kHz after 30 to 60 minutes of recording. Knowing that the daily work schedule in this trade often extend over 8 to10 hours, this means that asymptotic threshold shifts may be sustained while master tapes are being recording. This situation is paradoxical as TTS is associated with reduced frequency and temporal resolution [8]. Furthermore,

sound levels such as those depicted in Figure 1 are by themselves highly challenging in terms of frequency resolution. In other words, the professional is working in a paradoxical situation where hearing acuity is both highly sollicited and deteriorated by the very signals that are being processed.

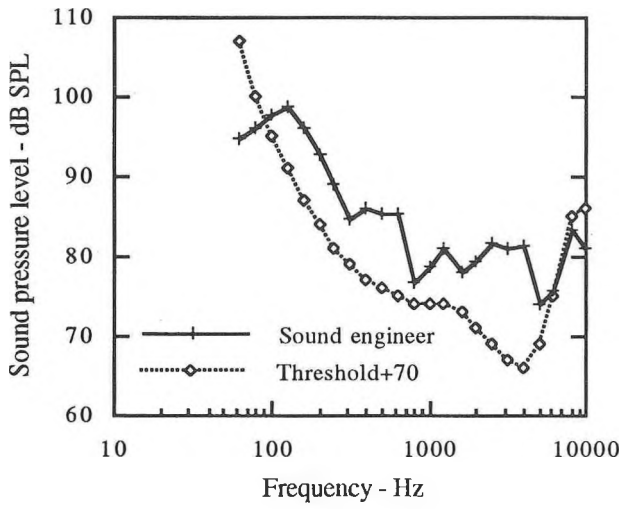

Figure 1. Spectrum of the music recorded at the ear level of a sound technician during base tracks recording, compared with free-field normal hearing thresholds [2] plus 70 dB.

Discussion

The above findings indicate that sound exposure among professionals involved in the production or reproduction of highly amplified mucic represent a potential damage risk to hearing as well as ergonomic problems. Possible means to reduce such exposures were identified.

For sound engineers, the major sound source is usually the percussion. A partial enclosure could possibly be used to reduce the contribution of this sound source. Controllers with digital interfacing and samplers could also be considered. The distorsion that is systematically sought for by guitarists could be obtained at lower sound levels using less powerful amplifiers. The monitor for this sound could be installed in a room behind the stage. Intra-aural monitors could also be used, provided that their sound power is limited to safe levels.

The disc jockeys are using a monitor that inform them of the sound environment on the dance floor. The acoustic monitor could be substituted by a visual monitor, such as a spectrum analyzer.

In both of the above cases, the potential solutions to sound overexposure would represent highly significant work organization changes. For this reason, their trial and implementation would require both a strong motivation on the part of the professionals involved and the active participation of the latter in the actual design and testing of the new procedures.

The problem of sound overexposure in the music industry is not restricted to the three job categories included in the present investigation. Musicians are at serious risk as well [9] and the recent introduction of intra-aural monitors on the market may not solve this problem if they do not meet the constraints involved in accurate sound monitoring with limited exposure. Furthermore, people who work in settings where highly amplified music is attended to may also be at serious risk of temporary and permanent hearing loss. This includes waiters and barmen in clubs and discotheques where occupational health standards do not appear to be enforced.

References

1. Axelsson, A. Lindgren, F. Pop music and hearing. Ear and Hearing, 1981, 2: 64-69.
2. Medical Research Council Institute of Hearing Research. Damage to hearing from leisure noise. Brithish Journal of Audiology, 1986, 20: 157-164.
3. Carter, N., Murray, N., Bulteau, V. Amplified music, recreational noise and hearing in people aged 16-21 and 28-33 years. Australian Journal of Audiology, 1985, 7: 79-83.
4. ISO-1999.2 Acoustics - Determination of occupational noise exposure and estimation of noise-induced hearing impairment. Geneva: International Strandardization Organization, 1990.
5. ISO-R226, Acoustique - Lignes iso-soniques normales pour sons purs écoutés en champ libre et seuils d'audition binauriculaires en champ libre. Genève: Organisation internationale de normalisation, 1961.
6. Melnick, W. Hearing loss from exposure to noise. In Harris, C.M. (ed.) Handbook of Acoustical Measurement and Noise Control. New York: McGraw-Hill, 1991, ch. 18.
7. Botte, M.C., Baruch, C., Dancer, A. TTS as a function of exposure frequency. Journal d'Acoustique, 1990, 3: 53-57.
8. Hétu, R. Mismatches between auditory demands and capacities in the industrial work environment. Audiology, 1994, 33: 1-14.
9. Axelsson, A., Lindgren, F. Does pop music cause hearing damage? Audiology, 1977, 16: 432-437.