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ABSTRACT

An investigation was conducted to identify the effects of exposure to selected entertainment environments on hearing threshold levels. Twenty-five normal hearing females were randomly assigned to one of the following five taped noise conditions: (1) a discotheque band, (2) a motor speedway, (3) a hotel dance band, (4) an amusement park, and (5) a control recording of low-level exposure. Pure-tone air conduction threshold levels were measured binaurally at 12 frequencies in three trials prior to exposure, 2 minutes after exposure, and 30 minutes after exposure. Temporary threshold shifts and recovery patterns of the five exposure conditions were compared by analysis of variance with repeated measures. The main effects of frequency and trials were significant (p less than .05). The findings indicated that exposure to selected entertainment noise created significant temporary hearing losses at certain frequencies; no losses were observed, however, which met damage-risk criteria. (Author)

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"The Relationship Between Exposure to Recreational Noise and Temporary Threshold Shifts in Women"

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ABSTRACT

An investigation was conducted to identify the effects of exposure to selected entertainment environments on hearing threshold levels. Twenty-five normal hearing females were randomly assigned to one of five taped noise conditions including: 1) a discotheque band, 2) a motor speedway, 3) a hotel dance band, 4) an amusement park, and 5) a control group of low-level exposure. Pure-tone air conduction threshold levels were measured binaurally at 12 frequencies in three trials prior to exposure, 2 minutes after exposure (TTS_2) and 30 minutes after exposure (TTS_{30}).

Temporary threshold shifts and recovery patterns of the five exposure conditions were compared by analysis of variance with repeated measures. The main effects of frequency and trials were significant ($p<.05$). The findings indicated that exposure to selected entertainment noise created significant temporary hearing losses at certain frequencies; however, no losses were observed which met damage-risk criteria.

Introduction

Like other forms of polution, noise can present some serious health problems. Until recently, noise had been considered merely as an annoyance or nuisance. However, it is now believed that noise can threaten human health both psychologically and physiologically. Dr. Aram Glorig, a noted researcher in bioacoustics, coined the term "sociocusis" to describe the fact that modern civilization imposes tremendous noise burdens on the human hearing mechanism, there-by accelerating normal hearing loss that occurs with aging.[2]

In recent years there has been increasing concern regarding the harmful effects that intense noises, including rock and roll music, can have on hearing; however, the influence of common noisy entertainment environments such as speedways, state fairs, and dance bands upon temporary threshold shifts has not been investigated. It was the purpose of this study to determine the effects of exposure to selected entertainment noise conditions and temporary hearing threshold shifts* in the hearing acuity of women.

*Temporary Threshold Shift (TTS): "A temporary hearing loss which occurs for a relatively brief period of time following exposure to noise."[1]

METHOD

The study involved 25 undergraduate women between the ages 17 and 22 who were students at Ball State University, Muncie, Indiana. Normal hearing of the subjects was determined by the administration of an audiometric examination. In addition, the subjects were required to meet the following criteria for inclusion in the study: (1) had no history of middle-ear pathology, (2) had never worked in a high level noise environment, and (3) had not listened to loud music played for at least 48 hours prior to participation

in the study. The subjects who met the established criteria were trained in the technique of operating a Rudmose automatic audiometer and practiced until they were able to make reliable tracings. All subjects volunteered for participation in the study and signed forms giving their informed consent.

Four entertainment environments and one control environment were selected as the noise exposure conditions. Tape recordings were made of the four entertainment noises using a Sony TDK Model C-90 tape recorder and magnetic tapes. A baseline tone of one minute in duration was recorded at the beginning of each tape to insure that subsequent playbacks would be at the same loudness as was the case in the true situation.

Pre-exposure air conduction thresholds were obtained for both ears for each subject using a sweep frequency Bekesy automatic technique with 12 frequencies between 250 Hz and 8000 Hz. The tone for testing was continuous and its loudness ranged between -10 and +95 dB. The order of testing of the right ear and the left ear for each subject in each experimental condition was randomized.

Upon completion of the pre-exposure audiometric examination, the subjects were randomly assigned to five groups and were presented a 45 minute tape of one of the four environmental noise condition or a control noise condition as follows: (1) a discotheque band, (2) an amusement park, (3) a motor speedway, (4) a dance band in a hotel, (5) a control recording of a low-level 30 dB 1000 Hz pure-tone. Post-exposure thresholds were then measured for both ears using the same technique and equipment as in the pre-exposure tests. The first post-exposure threshold was measured at two minutes after the cessation of exposure (TTS_2). The second post-exposure threshold was measured 30 minutes after the cessation of exposure (TTS_{30}). During the entire experimental period the subjects were isolated in a sound-treated audiometric testing room. All audiometric testing utilized earphones. The equipment was calibrated prior to the start of each testing session.

RESULTS

In the statistical phase of the study, four main hypotheses were examined by analysis of variance with repeated measures (using the Geisser-Greenhouse Conservative F Test of significance).[3] The four main effects which were analyzed in the study were: 1) differences among the five noise exposure groups, 2) differences between the left ear and right ear hearing threshold level of each subject, 3) differences among hearing thresholds at the 12 frequency levels, and 4) differences among the pre-exposure trial, the TTS_2 trial, and the TTS_{30} trial.

The results of this study indicated that significance was associated with the main effects of frequency and trials. Differences among the five noise exposure groups were negligible as were differences between the right and left ears and did not reach statistical significance. None of the interactions associated with the statistical design were significant, indicating that any differences noted were the results of the four main effects themselves rather than combinations of the main effects. These interactions were thus omitted from the summary table of the analysis of variance. The summary table appears as Table 1.

Tukey's HSD test was used to permit pairwise comparisons of means comprising each of the two main effects which were found to be significant. Table 2 presents the results of the Tukey test on the 12 frequency means. It will be noted that, in general, there were significant differences in the hearing thresholds at low frequencies (250-2000 Hz) and at moderately high frequencies (3000-8000 Hz).

The results of the Tukey HSD test computed for the main effect of trials are reported in Table 3. Significance was found between two of the three trials, with the largest existing between the pre-exposure trial and the TTS_2 trial. A smaller, though significant, difference was found between the TTS_2 trial and the TTS_{30} trial.

Several studies have utilized TTS_2 for measurements of potential hearing loss as a result of CHABA's Damage-Risk Criterion which relates to "equal temporary effect."[9] In essence, this means that a noise exposure is unsafe if upon testing the ear two minutes after the cessation of noise exposure, an average TTS_2 of 10 dB is exceeded at frequencies up to 1000 Hz, 14 Db at 2000 Hz, and 20 dB at 3000 Hz and above. Table 4 presents the average changes in hearing threshold between the pre test and TTS_2 of the subjects in this investigation. The average changes were computed for the 3 damage-risk frequencies and indicate that there were losses in hearing acuity, however; none approached the criterion of CHABA.

COMMENT

Investigators have only recently become concerned with rock and roll music as a potential hazard to hearing. The results of their studies continue to be somewhat inconclusive. Some researchers have found rock and roll sounds not to be harmful[4,5] while others suggest that these sounds can induce high enough levels of hearing threshold shifts that permanent hearing losses can occur.[6,7,8] There is virtually no literature available regarding the relationship between temporary hearing threshold shifts and exposure to other common types of entertainment noise.

Our data suggest that all of the entertainment noises can create some temporary hearing threshold shifts in participants and that recovery from relatively short exposure occurs rather rapidly. However, this finding should not be construed to indicate that longer exposure will not contribute to permanent hearing loss. From the results of the present investigation some specific conclusions can be drawn.

1. Hearing threshold levels of subjects are significantly different at moderately high and low test frequencies. This finding supports previous

research evidence that, regardless of noise exposure, the acuity of the human ear will vary at different test frequencies in audiometric examinations.

2. Exposure to certain entertainment noises can create a significant temporary hearing loss from which recovery occurs quite rapidly. None of the losses observed in this investigation approached damage-risk criteria.

Since the results of the present study supported the fact that short term exposure to noisy environmental sounds does cause significant temporary hearing losses, it is suggested that further research be conducted which comprises longer periods of exposure. The findings of such a study could be significant for the portion of the population who spend eight hours a day working in noisy environments and then participate in noisy forms of recreation.

Table 1. - Analysis of Variance for Main Effects

Source	SS	df	df+	MS	F
Conditions	2154.15	4	(1)	538.53	0.4732
Error	11067.78		(20)	553.38	
Ears	262.20	1	(1)	262.20	3.4877
Error	1503.61	20	(20)	75.18	
Frequency	15497.00	11	(1)	1408.81	18.7847*
Error	16499.60	220	(20)	74.99	
Trials	1873.03	2	(1)	936.51	11.1349*
Error	3364.25	40	(20)	84.10	

*Significant at the .05 level

+The degrees of freedom in parenthesis are the conservative ones suggested by Geisser and Greenhouse[3]

Table 2

Tukey's HSD Test on Significant Frequencies

Frequency Hz	F6	F4	F5	F3	F8	F7	F12	F11	F10	F2	F9	F1
F6 (2000)	-2.2267						3.78*	6.02*	6.47*	7.55*	7.93*	8.92*
F4 (1000)		-1.4467						5.24*	5.65*	6.77*	7.15*	8.14*
F5 (1500)			-1.3467					5.14*	5.54*	6.67*	7.04*	8.04*
F3 (750)				.0067				3.78*	4.19*	5.32*	5.69*	6.69*
F8 (4000)					.04533			3.34*	3.75*	4.97*	5.24*	6.24*
F7 (3000)						.6667			3.53*	4.66*	5.03*	6.02*
F12 (8000)							1.5533			3.77*	4.15*	5.14*
F11 (7000)								3.1933				
F10 (6000)									4.0215			
F2 (500)										5.3267		
F9 (5000)											5.7023	
F1 (250)												6.669

*Significant beyond the .05 level

Table 3. Tukey's HSD Test on Significant Trials

Trial Comparison	F-Ratio
Trial 1-Trial 2	2.47667*
Trial 1-Trial 3	.95167
Trial 2-Trial 3	1.52434*

* Significant at the .05 level

Table 4. Average Changes in Hearing Thresholds between Pre-test trial and TTS_2* at 1000, 2000, and 3000 Hz.

Group	1000 Hz	2000 Hz	3000 Hz
Discotheque	-3.4	+ .2	-4.8
Amusement Park	-2.8	-6.8	-9.0
Speedway	+ .8	- .2	- .6
Hotel	-3.8	-4.8	-4.8
Control	+1.4	+2.2	+ .2

*Average changes are reported in decibels. Changes preceded by a - indicate loss of hearing acuity; changes preceded by a + indicate an increase in acuity.

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