EFFECTS OF NON-OCCUPATIONAL NOISE EXPOSURE ON A YOUNG ADULT POPULATION*

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ACKNOWLEDGEMENT

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The efforts of LT. James White, USN, USNAS, Millington, Tennessee, in securing access to and scheduling US Navy personnel as subjects were particularly appreciated and critical to successful completion of the project. Miss Donna Astor, who drove the subjects to and from the examination site, Miss Joy Frank, who scheduled the subjects, Mr. Alan Helt, Luther Hutcherson, and Edward Koshland who helped analyze the data and prepare the illustrations, all contributed significantly and deserve thanks. Acknowledgement is also made of the many

efforts of Mr. Tom Sheib, USPHS, National Institute of Occupational Safety and Health, our contract monitor, for his many efforts in behalf of this study. Finally, Mrs. Jean Conley, who saw the preparation of the manuscript through the draft stages to its final form, did a truly great job under less than adequate conditions. Thanks, then, to all of the above, and let it be clearly understood that the errors that will be found are those of the author and are in spite of, and not because of, any one else.

EFFECTS OF NON-OCCUPATIONAL NOISE EXPOSURE ON A YOUNG ADULT POPULATION

The labor pool from which industry obtains most of its "new hires" is generally aged 18-21. Until recently, at least, it has usually been assumed that persons in this age range were physically normal, with normal health, reflexes, vision, hearing, etc. The validity of this assumption is increasingly under attack on many fronts, particularly with regard to hearing. In the past, occupational hearing loss was considered to account for most of the non-disease related hearing losses to be found. Today, we are increasingly aware of non-occupational activities that are at least potentially hazardous to hearing. For example, the music played and listened to by today's youth has been documented to be a hearing hazard by some researchers. Lipscomb (1969) studied effects upon hearing of exposure to modern "rock" music, and reported a significant loss of hearing in those exposed. Others have reported findings similar to those of Lipscomb. In view of the fact that Rintleman and Borus (1968) found that the average time spent by the musicians practicing and playing was 11.5 hours per week, and that SPLs ranging from 105-115 dBA have been documented (Ayley, et al., 1969, Dey, 1970, Flugrath, 1969, and Lebo, 1968) it should come as no surprise that hearing losses would occur. Cohen, et al., 1970, report temporary

threshold shifts (TTSs) following exposure to teenage band music by both musicians and dancers. These TTSs followed 1.5 to 3 hours exposure to music of 105 or 112 dBA. These observed levels of rock music for the usual times of exposure considerably exceed the guidelines for exposure of workers in industry formulated by the U. S. Department of Labor and incorporated in the Walsh-Healy Act and later in the Occupational Safety and Health Act (OSHA) of 1970.

The motorbike and motorcycle have come into extensive use in the last decade, primarily among younger people, and constitute an additional non-occupational noise hazard to the ears of those who are to be the new work force for industry. Motorcycles and motorbikes, depending upon their size, the surface on which they operate, the speed at which they are operated, and upon their maintenance and condition, expose the operator and/or rider to levels in the neighborhood of from 92-125 dBA according to the U.S. Environmental Protection Agency as seen in the Report to the President and Congress on Noise (EPA, 1971). Information in the above cited report would suggest that auto or drag racers would be exposed to perhaps 87-98 dBA. Such levels over prolonged periods of time might also prove hazardous to the hearing of the participant.

The effects on hearing of weapons firing of all types have been well documented. Even the .22 caliber weapon

produces impulses potentially hazardous to hearing, with Benson (1971) finding peak levels from .22 caliber blank firing in the order of 158 dB instantaneous peak with durations of 30-35 micro-seconds. Obviously, larger caliber weapons would generate even higher sound levels.

In view of the numerous non-work activities youth of today engage in that are at least potentially hazardous to hearing, and suspecting that high frequency hearing migh be a more sensitive indicator of trauma from noise, it would appear worthwhile to study and compare the conventional and high frequency hearing of 18-21 year old persons, male and female, those with normal hearing, "normals", (in order to establish a high frequency reference group), sport shooters, rock band members, "chronic" rock spectators, auto and drag racers, and motorcycle and motorbike riders.

METHOD

Subjects were obtained from students attending Memphis State University as well as from the Naval Air Technical Training Center, Naval Air Station, Memphis, and on a volunteer basis from other local sources such as the Memphis Federation of Musicians (for rock band members) and Lakeland and Riverside Speedways (for auto and drag racers). Notices were sent out outlining the needs for subjects and defining the various categories, i.e., normal, rock spectator, etc., (see Appendix I). Then all who believed they

were eligible were asked to submit their name, age, category of exposure, and a telephone number at which they could be reached. They were then scheduled for an interview and if they did indeed meet the requirements of one of our exposure categories, they were transported to LeBonheur Hospital, Memphis, Tennessee, where each person was given a gross otoscopic examination to minimize the possible influence of physical or medical variables, i.e., wax impaction, active disease, excess scar tissue, fluid behind the tempanic membrane, etc. All those who passed the otologic screening test were then taken from LeBonheur Hospital to the Memphis Speech and Hearing Center where an extensive personal history of noise exposure and other hearing related data was filled out (see Appendix II). Upon completion of the hearing data sheet for each subject, hearing was tested. Testing was done by automatic audiometers, with testing in the conventional range (500-6,000 Hz) done using an ARJ-4A audiometer manufactured by Tracor, Inc., and high frequency (4,000-18,000 Hz) audiometry accomplished using an ARJ-4HF audiometer, also made by Tracor, Inc. Every subject was tested first on the ARJ-4A, which tested hearing in the conventional range (500-6,000 Hz), then on the ARJ-4HF audiometer which tested frequencies from 4,000-18,000 Hz. This order of test was followed in order that subjects would have practice at the easier task

of tracking conventional range signals before the more difficult job of tracking higher, less easily heard frequencies. The transducer used with the ARJ-4HF audiometer and its method of placement in the ear of the S are described in Zislis and Fletcher (1966) and Fletcher (1965) and the information will not be repeated here. All hearing testing was done by one of two audiology graduate student assistants with all otologic examinations performed by Dr. Charles Gross, MD, Chief, Otolaryngology, University of Tennessee Medical Center, or one of his residents. Calibration of the audiometers was checked daily by the assistants using the biological check technique, with the ARJ-4A audiometer recalibrated in the middle of the study because it was found to have gotten out of calibration. Both audiometers were new and in good calibration at the beginning of the study. The ARJ-4A (conventional audiometer) was calibrated to ANSI 1969 standards. Even though the high frequency audiometer (ARJ-4HF) tested hearing at 4,000 and 6,000 Hz, all data to be reported at 4,000 and 6,000 Hz will be those obtained using the ARJ-4A, with all data at or above 8,000 Hz secured using the ARJ-HF. Robertson (1972) found that reliability at 4,000 and 6,000 Hz was higher using the ARJ-4A, therefore the method providing data with higher reliability was chosen. All hearing testing was conducted in the Audiology suite at the Memphis State University Speech and Hearing Center in an IAC sound room meeting appropriate ANSI standards for threshold audiometry. Upon completion of the

hearing test, results of the test were explained to the S and they were paid and transported back to Memphis State University Campus if they desired.

RESULTS

Upon completion of data collection, all audiograms were scored, and the data collated and entered on summary sheets. The raw data were checked by means of the sign test (Siegel, 1956) to determine whether or not the two ears differed in acuity. This test showed that of the 56 conditions examined, only 10 differed at the 5% level, and of these 10, in six cases the right ear was slightly better, in four the left ear slightly better. In view of the very small differences noted, and the use to be made of the data, hearing levels for the two ears were combined and all data to be presented will be in terms of ears, not subjects.

Figs. 1 and 2 present the norms found for the 18-21 year old non-noise exposed (Normals) males and females in this survey. Compared to the hearing of the males, the high frequency hearing of the females is noticeably better, particularly in the frequency region from 8,000-18,000 Hz. It is logical to assume that the difference in male and female high frequency hearing is due to the greater noise exposure even normal males receive than do females. Male children, for example, are more likely to fire cap pistols, shoot off firecrackers, occasionally shoot weapons of various

sorts, use power tools, or in general be around higher noise levels than are females. These findings of the superiority of females with regard to high frequency hearing support the earlier results of Zislis and Fletcher (1966) and of Northern, et al., (1972). In general, the data for the male and female normals used as a control or reference in this study do not reflect as good hearing as do the data found by Zislis and Fletcher, particularly at the higher frequencies. For that matter, hearing in the conventional range common to both studies was better in the subjects tested by Zislis and Fletcher than was that of the subjects of this study. These results could be due to the fact that the subjects in the Zislis and Fletcher study were slightly younger, or perhaps were from a less noise exposed population. The latter explanation seems more valid in that ambient noise levels have been on the increase, as well as it being rather apparent that, with increasing access to relatively good paying jobs, our young people are more affluent and spend more recreational time exposed to various noises generated by the recreational activity (such as cycling, boating, shooting, etc.).

Figs. 3 through 8 present the hearing by age and exposure category. In all of the figures but Figs. 7 and 8, the 0 hearing level is the male normal data for that age group. This was used because nearly all the persons in each exposure group were male and therefore the male norm was most appropriate.

However, because Figs. 7 and 8 display the results of the female Rock Spectators, the appropriate female norms were used for that 0 hearing level.

Probably due to unfortunate sampling errors, or perhaps to inaccuracies of statements from the Ss themselves, Fig. 3 shows that the high frequency hearing of all the 18 year old exposure categories is better than that of the supposedly non-exposed normals. Relatively speaking, Drag Racers were worst, followed by Cyclists and then Shooters. In Fig. 4 we see that Cyclists are worst in both conventional and high frequency losses, followed by Drag Racers. The other categories are very close to the normals. Results for the 20 year olds, Fig. 5, reveal that Cyclists had the poorest hearing, closely followed by Rock Band Members and male Rock Spectators. For some reason, Drag Racers came off rather well in this age group. Among the 21 year olds, (Fig. 6), the worst hearing was found among Cyclists, with no one else really distant from normal across the frequencies studied. Figs. 7 and 8, for the female Rock Spectators, show considerable losses for the 18 and 19 year olds, essentially no loss for the 20 year olds, and moderate losses for the 21 year olds. At first it is hard to see why the age by exposure category covered in Figs. 3-6 did not reveal noticeable hearing losses among male Rock Spectators, while these data for female Rock Spectators do show losses. But the male norms are used for

the early figures while the female norms are used for these figures, with male norms consistently showing less acuity. Also, it could well be that the exposure of the female Rock Spectators combines with their relatively better hearing and compared to the relatively less exposed female norms, produce more noticeable hearing loss by contrast.

The standard deviations of all means for all frequencies, age groups, both ears, and all exposure groups were calculated and presented in Table I. In essence, these data show that male normals have significantly larger standard deviations than do female normals at age 18, 19, not at 20, 21 (based on the sign test of the significance of differences, 1% level of confidence or higher). At 19, male normals do not differ significantly from 18 year old normals, while female normals have greater deviations than 18 year old normals. At age 20, male normals have smaller deviations than 18 year old counterparts. At 21, males are not significantly different from females with regard to the size of standard deviations, the males do not differ from the 18 year olds, while the females have significantly larger deviations than do 18 year old female normals.

At age 18, motorcyclists, sport shooters, drag racers, and male rock spectators do not differ significantly from the 18 year old normals, while rock band members have significiantly smaller deviations than do normals. Female rock

spectators were found to have significantly larger deviations than their normal comparison group.

At 19, sport shooters, drag racers, rock band members, and male rock spectators did not differ significantly from normals in standard deviations while motorcyclists had significantly smaller deviations than did the normals. Female rock spectators did not differ significantly from female normals, but did have smaller deviations than male rock spectators.

For the 20 year olds, all exposure categories had significantly larger deviations than did the normals except the female rock spectators, who did not differ from the normals nor from the male rock spectators.

Data for the 21 year olds showed that motorcyclists and drag racers had significantly larger deviations than 21 year old male normals, sport shooters and male rock spectators did not differ significantly from normal, while rock band members had significantly smaller deviations than male normals. The 21 year old female rock spectators did not differ significantly from 21 year old female normals nor from 21 year old male rock spectators. In summary, these data seem to support the hearing level data presented earlier. It would seem logical that the size of the standard deviation of the scores obtained under our various conditions should give some indication of the processes going on. If

humans differ in susceptibility to noise exposure, and also in amount of noise exposure, it would appear legitimate to expect hearing level scores to become more disparate with time plus continued exposure and the selective decreases in hearing level that would ensue. That, in turn, should result in larger standard deviations, as it indeed did in many cases.

Examination of the noise exposure histories of the subjects of this survey suggested that age and noise exposure were so confounded as to negate the true trends, i.e., if 18 year old Rock Band Members as a group had more years playing rock music (and therefore greater exposure) than 21 year old members, results would appear to be in conflict in that 18 year olds could be as bad or worse than 21 year olds. In order to test whether this had occurred, all data for a given noise exposure category were pooled, regardless of age, and then, on the basis of data in the noise exposure history, divided into four degrees of exposure (comparable to the four age groups) with approximately equal numbers of Ss in each group. This was an admittedly arbitrary and inexact procedure, done only to see if there were obvious discrepancies. Those data were examined for comparison with their comparable age group, with the least admittedly exposed group compared to the 18 year olds, and so on with the most exposed group

plotted against the 21 year olds. There were no consistent or large differences between the age groups and the noise exposure groups so we can conclude that age and noise exposure are very highly correlated in our survey. Thus, in general, 18 year olds have less noise exposure (and therefore better hearing) than do 21 year olds and exposure differences, where they occur, are random rather than consistent and apparently did not affect the results of this survey.

As the high frequency audiometer was designed, 70 dB (regarding the biological baseline determined by Rudmose) was the maximum hearing level that could be tested. Even in the normal groups, many persons approached that level at the highest three or four frequencies. For that reason, potentially significant differences in hearing level could easily be obscured because with most people at or near (or even beyond) the maximum hearing level measurable, changes could not be detected due to the fairly large standard deviations found for those frequencies. For that reason, the data were analyzed to determine simply what percent of the Ss responded to (heard) a given frequency. These data are seen in Figs. 9 to 12. As seen in those figures, the data essentially repeat the hearing level data, with progressive declines in the percent of subjects responding as a function of frequency of test tone and severity or

duration of exposure. The females in general, tended to respond better at the high frequencies than the males, and usually 100% of the subjects were able to hear up to 6-8 KHz, then a progressive decline in percent responding was noted.

It is interesting to note that these data show most clearly the sensitivity of high frequency hearing to acoustic insult. The hearing levels of all the subjects of all the noise exposure categories are almost indistinguishable one from the other in the frequency range usually tested by conventional audiometry, i.e., 500-6,000 Hz. However, differences in all or nearly all of the categories could be detected at the higher frequencies covered by the Rudmose ARJ-4HF audiometer. This would seem to suggest that any serious effort toward early detection of noise induced hearing losses would of necessity utilize high frequency audiometry. These findings are consistent with those of Jacobson, Downs, and Fletcher (1969), who found that high frequency hearing in patients on ototoxic drug therapy began to show demonstrable decline up to 108 days before losses could be detected by conventional audiometry. They also are supportive of the findings of Fletcher, Cairns, Endicott and Collins (1967), who found significant high frequency hearing losses in meningitis patients who had been classified as seriously ill, while those who had had a less serious course of the illness did not have significant

losses as compared to a control population. These losses found in the seriously ill meningitis patients were not detectable in the conventional frequency range.

In summary then, the effects of Auto and Drag racing, Sport Shooting, and Motorcycling appeared to induce noticeable high frequency hearing losses among those participating, compared to a normal or non-noise exposed population. The effects of rock music on both players and participants were less noticeable or not seen at all. The relatively small losses seen among Sport Shooters are undoubtedly due to the fact that shooters recognize the danger to hearing and nearly all of them report that they use ear protectors to some degree while shooting. Certainly Cyclists' hearing would be worse except for the fact that they are required to wear helmets by law in most, if not all, states while operating the cycles upon public roads. These helmets provide a very minimal amount of hearing protection, but with the levels of noise that are found at the ear of the cycle operator, even small amounts of attenuation of the sound can afford significant protection of hearing to the wearer. If some slight additional increase could be made to the sound attenuation qualities of cycle helmets, cyclists could be almost completely protected from the noise of their vehicle at no observable decrease in operational safety. The small losses observed in Rock Band Members and Spectators as

compared to Normals were not really expected. It was difficult obtaining Rock Band Members for one thing, primarily because many of those contacted were busy in off school time playing engagements, cutting records, or rehearsing, so that the ones we were able to schedule and test seemed to be the less busy (and therefore less exposed?) ones. As for the Rock Spectators, their pattern of exposure is evidently such that they are able to recover from any temporary losses following exposure before re-exposure and thus avoid noticeable permanent losses of hearing. Most of the Rock Spectators admitted not only to 2-3 rock concerts attended per month, but also to several hours per day listening to stereo or high-fi rock music at rather high intensities.

DISCUSSION

This study has found Motorcycling to be the most serious hearing hazard of all the categories of non-occupational noise exposure examined in this survey. Drag racing seems to be next most hazardous, with Sport Shooting only slightly less hazardous, followed by playing in rock bands, then being a chronic spectator at rock concerts and listening to rock music by stereo or radio. Actually, there appeared to be no difference between our so called "normal" population and our rock spectators. Knowing the levels and durations of exposure these persons

receive in that pastime, it is almost unbelievable that no clearly observable losses could be found. For example, Wood and Lipscomb (1972) show that tape recordings of rock music, played through stereo receivers, driving stereo earphones, easily exceeded established damage risk criteria. Close examination of the percent response data, shown in Figs. 9 to 12 clearly shows that, using percent response to high frequency signals data as a criterion rather than the less sensitive hearing level data, rock spectators hearing is less good than that of normals and females are better able to respond to those frequencies than males. Obviously, then, rock music is injurious to the chronically exposed, with this damage best illustrated by percent response to high frequency signals.

It is not terribly surprising to find motorcycling the most hazardous to hearing of all our exposure categories. Cyclists start cycling at an early age and seem to cycle more rather than less as they get older. Certainly it is no surprise that continued exposure for two or more hours per day for 4-8 years to the noise generated by even the less noisy motorcycles will produce observable decrements in hearing. Nor is it any real surprise to find drag racing produces losses. It <u>is</u> a shock, however, to find Sport Shooting less hazardous than either cycling or racing. In explanation for this, we offer that

shooters have long been aware of the danger to hearing of firing noise, and our age group of shooters has seen and talked to older shooters who have lost considerable hearing, so they are aware of the problem and protect their ears by use of appropriate ear protective devices such as muffs or plugs. Also, ear protective devices are better than they were in the past as well as more available and, even in some instances, cheaper. There are in addition, some rather believable possibilities to account for the relatively small hearing losses noted for Rock Band Members and for Drag Racers. Many times, in trying to schedule known Rock Band Members or Drag Racers, we were told they were out of town playing an engagement, or driving at some track, and repeated calls received the same answer. It would appear that those who are at the upper levels of experience and skill, if they desire, can spend a great deal of time at this activity and make reasonably good money. Therefore, it could well be that our sample is missing many, if not most, of those at that level - those who would be expected to have suffered the greatest exposure and therefore the largest losses.

It is clearly evident from this study that great care must be taken in considering the results of field hearing surveys such as this one. It would appear that a major weakness is that we must rely upon the S to tell us of his

exposure and that the S is incapable of quantifying his exposure to any degree even approaching precision. It is not at all unlikely either that some Ss could falsify exposure information, although there was no perceptible encouragement of any kind for them to do so. Another problem, discussed above, is that of obtaining representative samples of the categories studied. In this survey, evidence suggests that at least our sample of Rock Band Members and Drag Racers was not representative.

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FIGURE 1. MALE NORMALS BY AGE

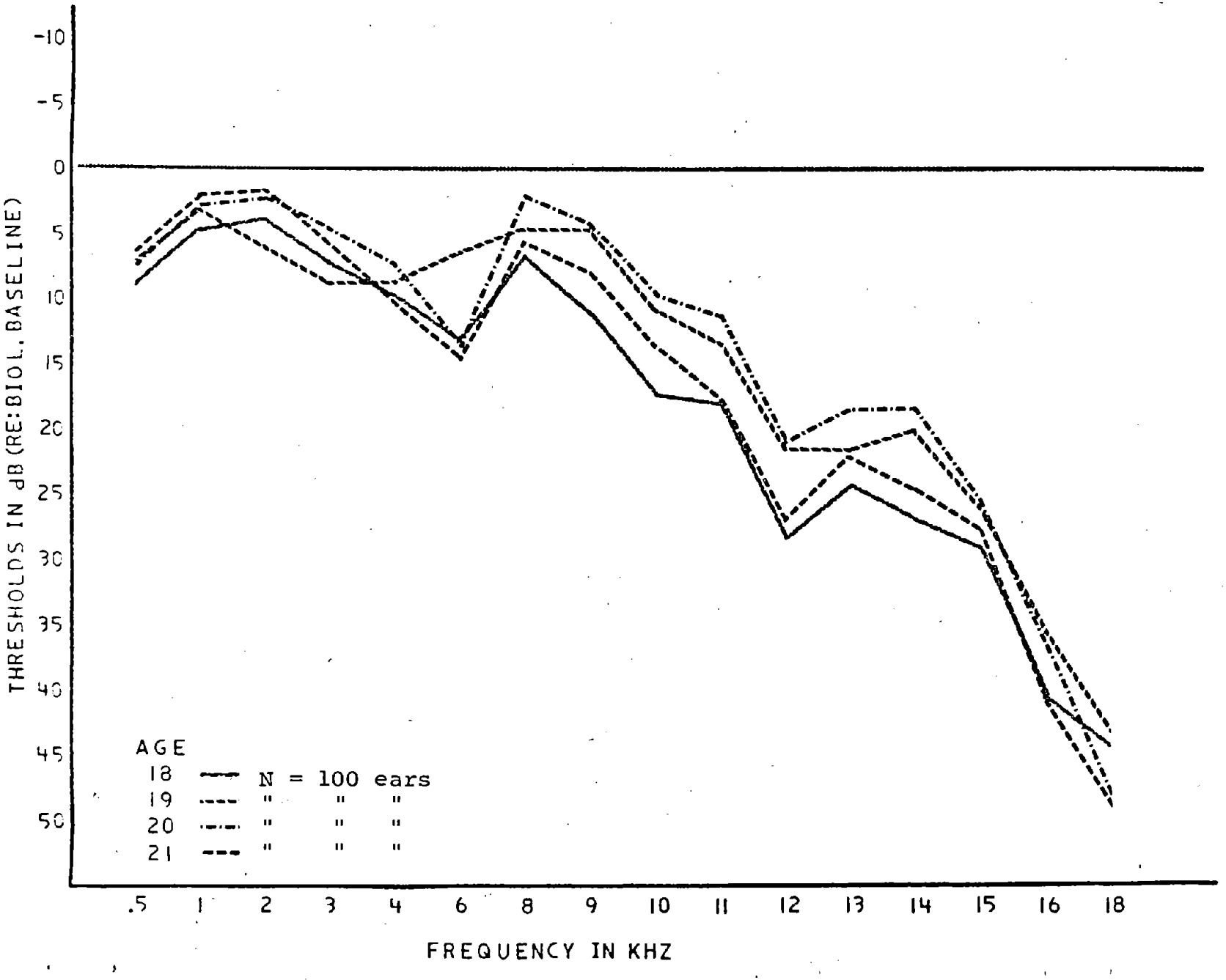

FIGURE 2. FEMALE NORMALS BY AGE

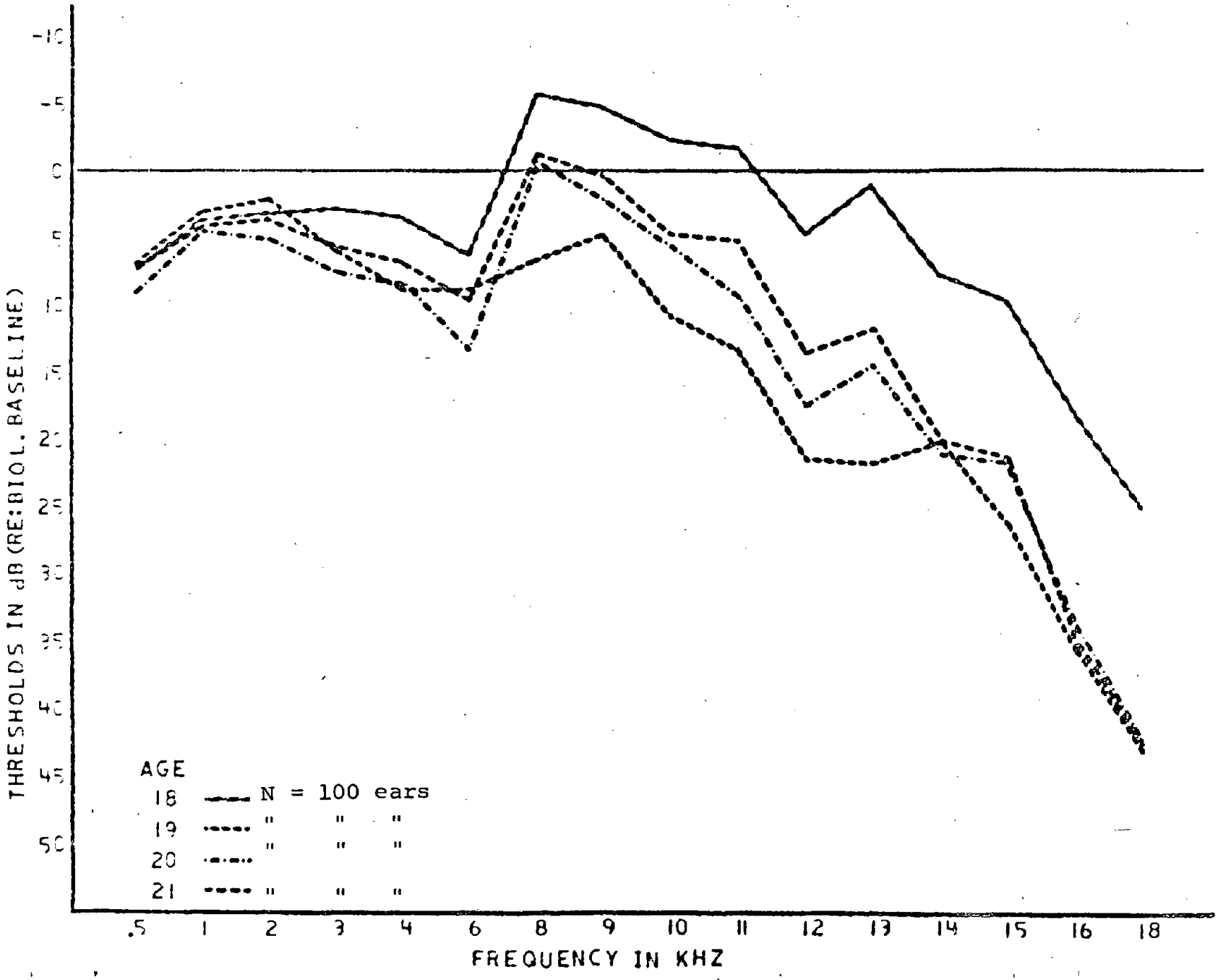

FIGURE 3. HEARING BY EXPOSURE CATEGORY—AGE 18

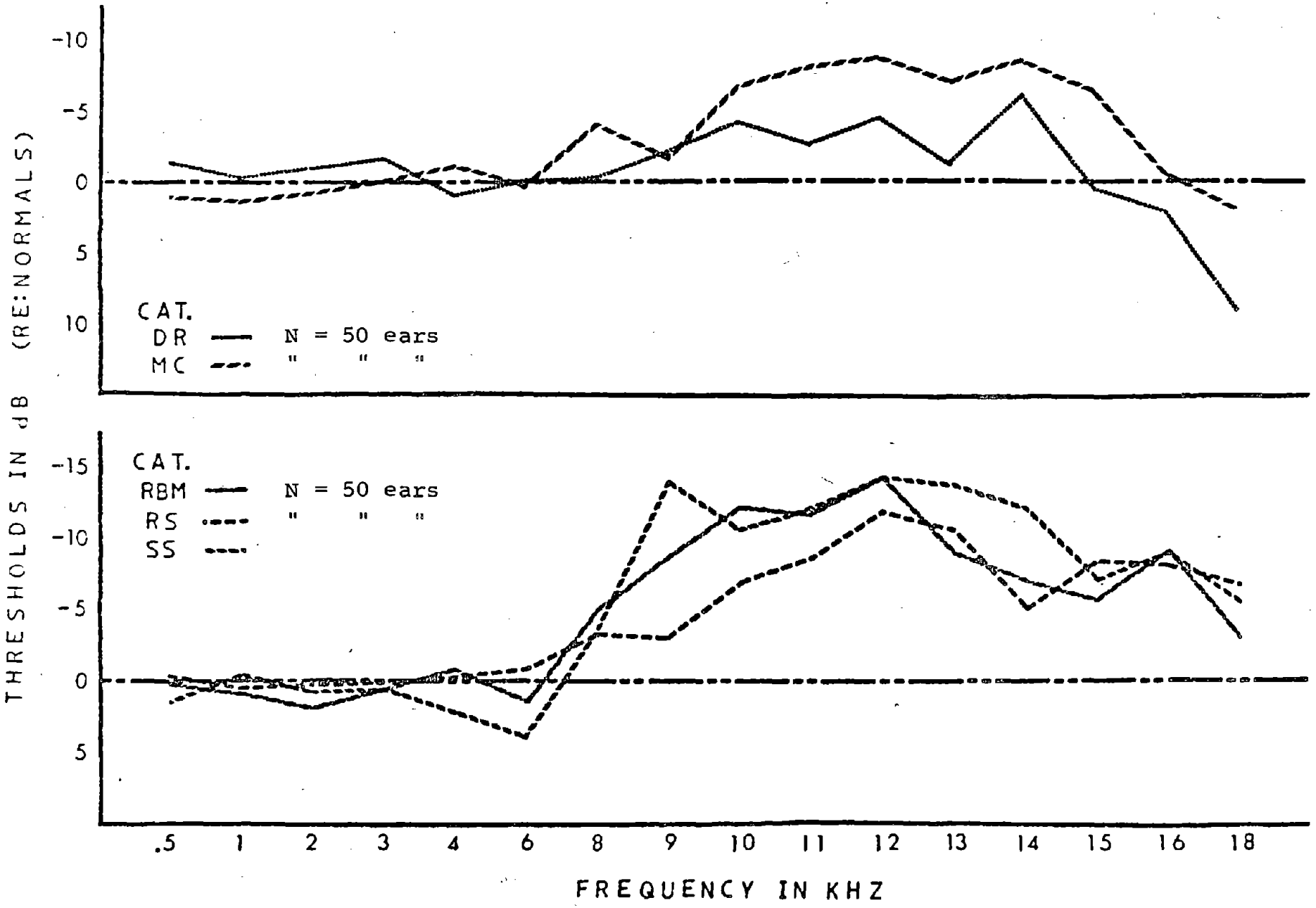

FIGURE 4. HEARING BY EXPOSURE CATEGORY—AGE 19

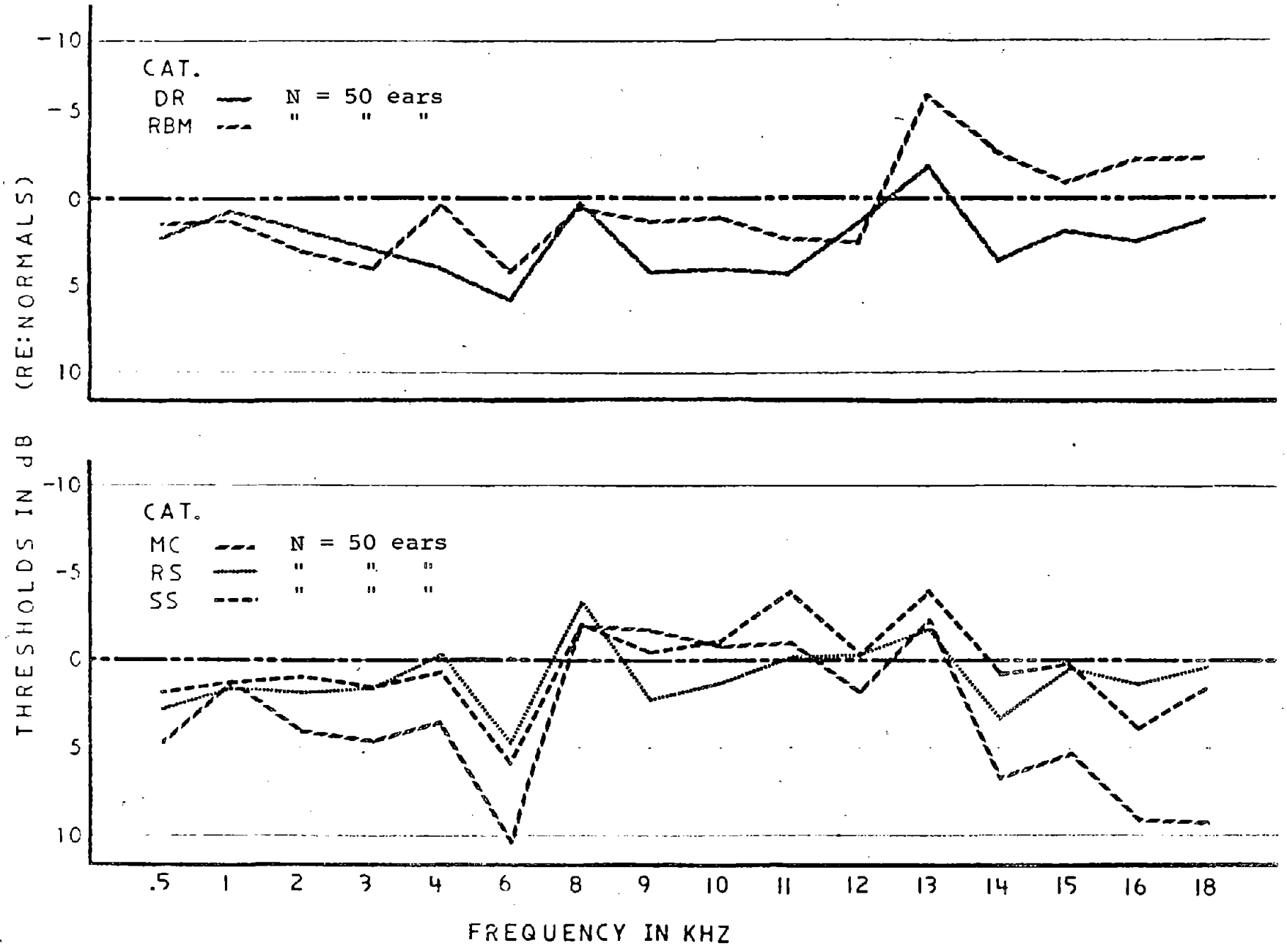

FIGURE 5. HEARING BY EXPOSURE CATEGORY—AGE 20

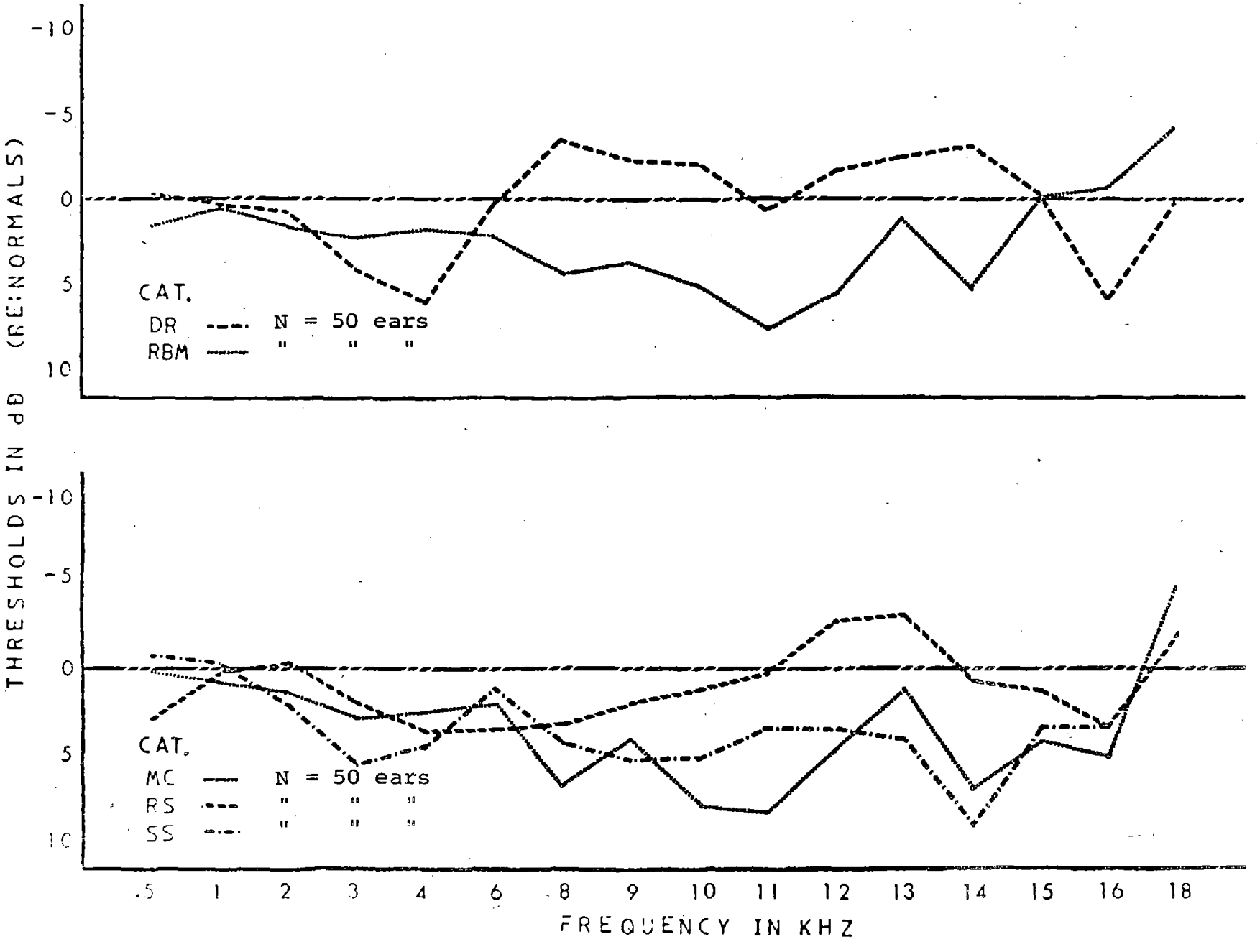

FIGURE 6. HEARING BY EXPOSURE CATEGORY — AGE 21

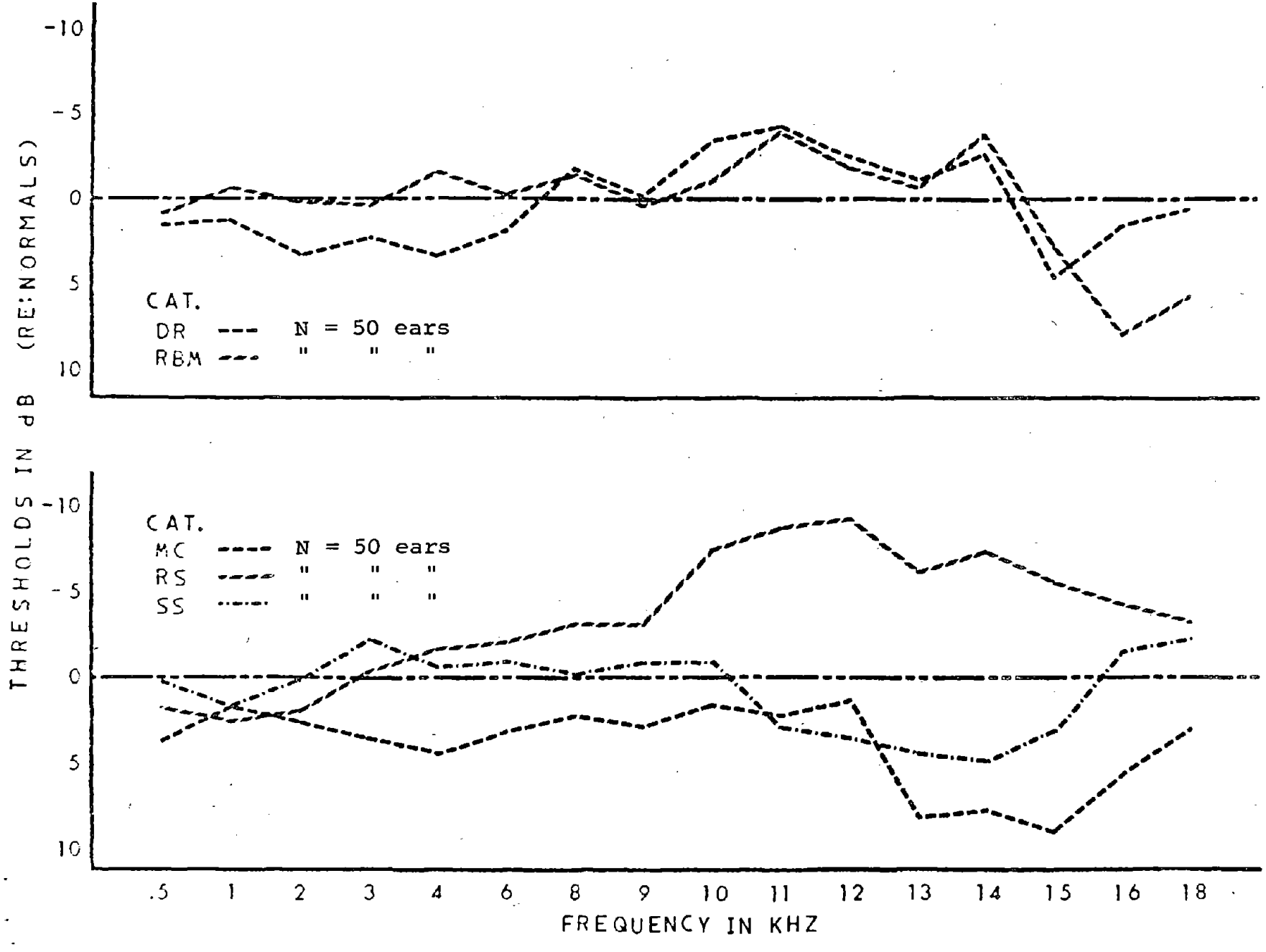

FIGURE 7. HEARING LEVELS FEMALE ROCK SPECTATORS (RE: FEMALE NORMALS BY AGE)

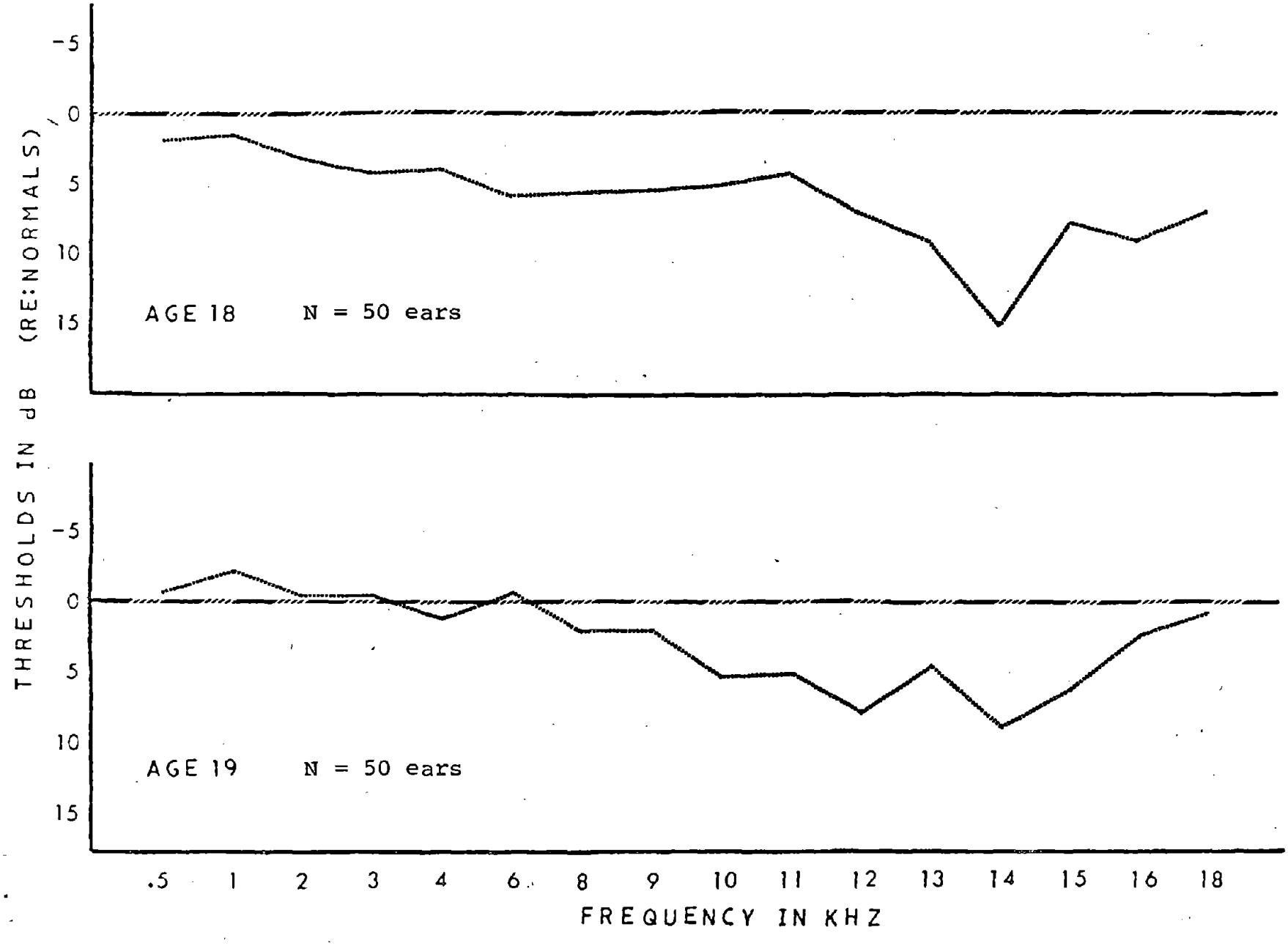

FIGURE 8. HEARING LEVELS FEMALE ROCK SPECTATORS (RE: FEMALE NORMALS BY AGE)

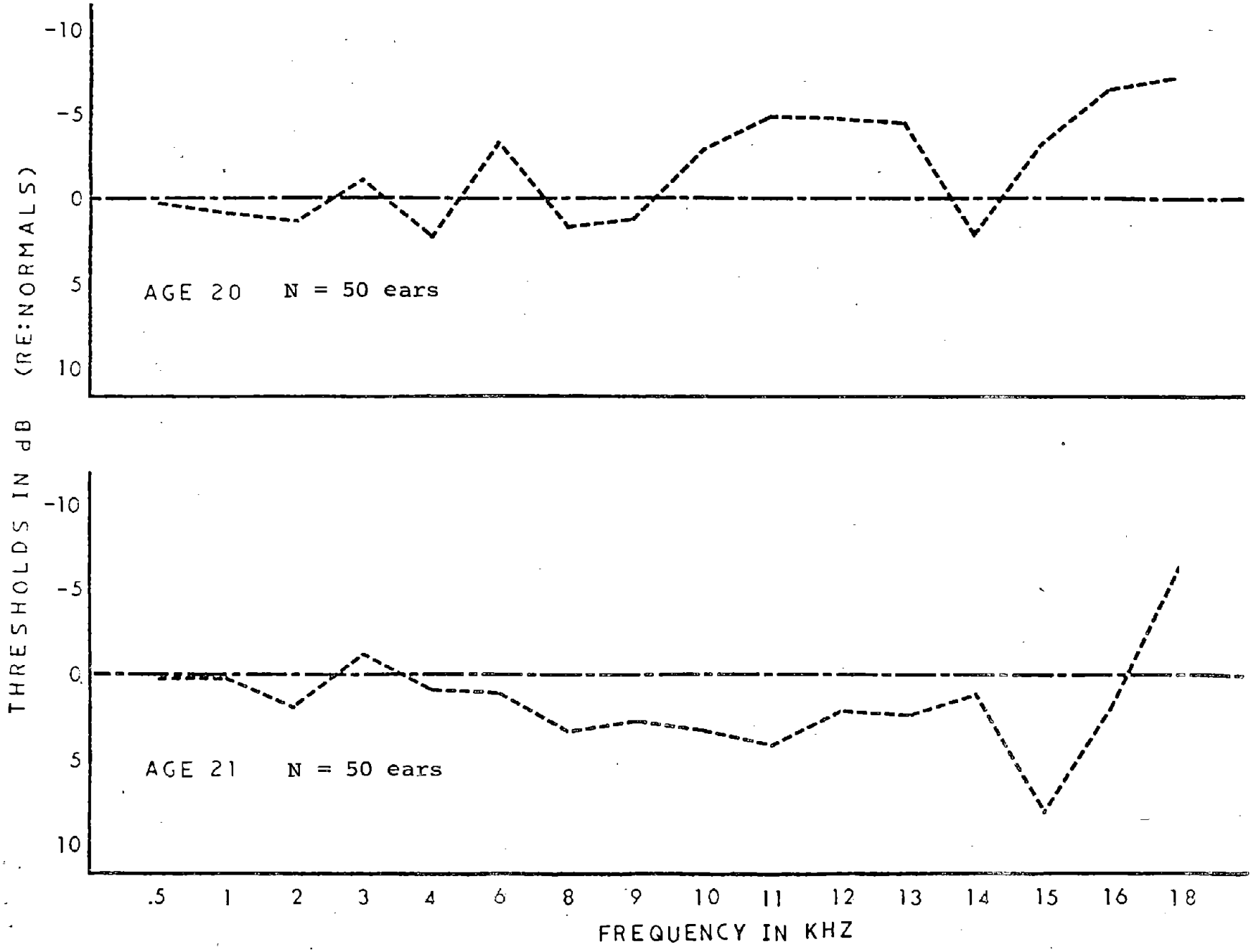

FIGURE 9. PERCENT RESPONSES BY EXPOSURE CATEGORY

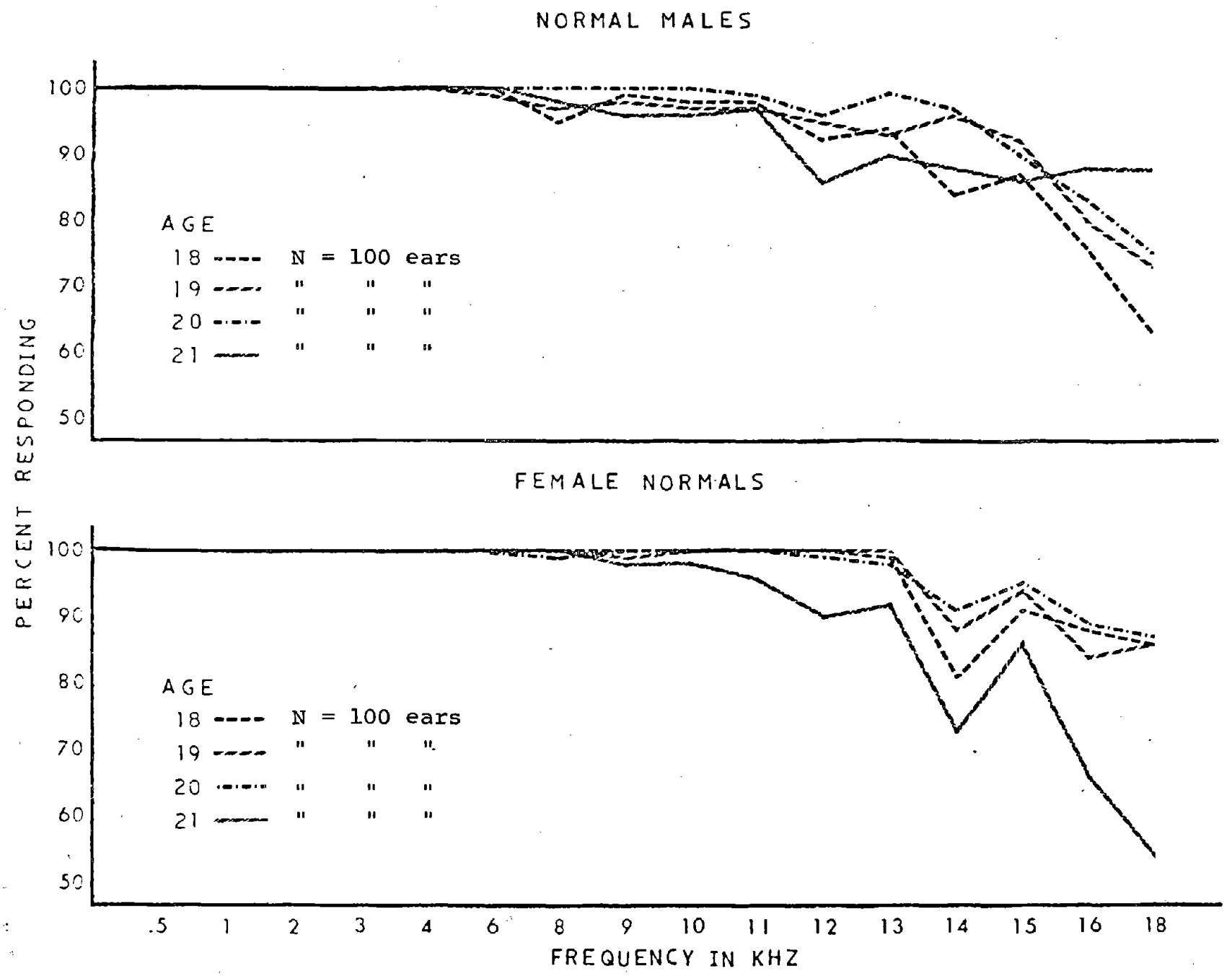

FIGURE 10. PERCENT RESPONSES BY EXPOSURE CATEGORY

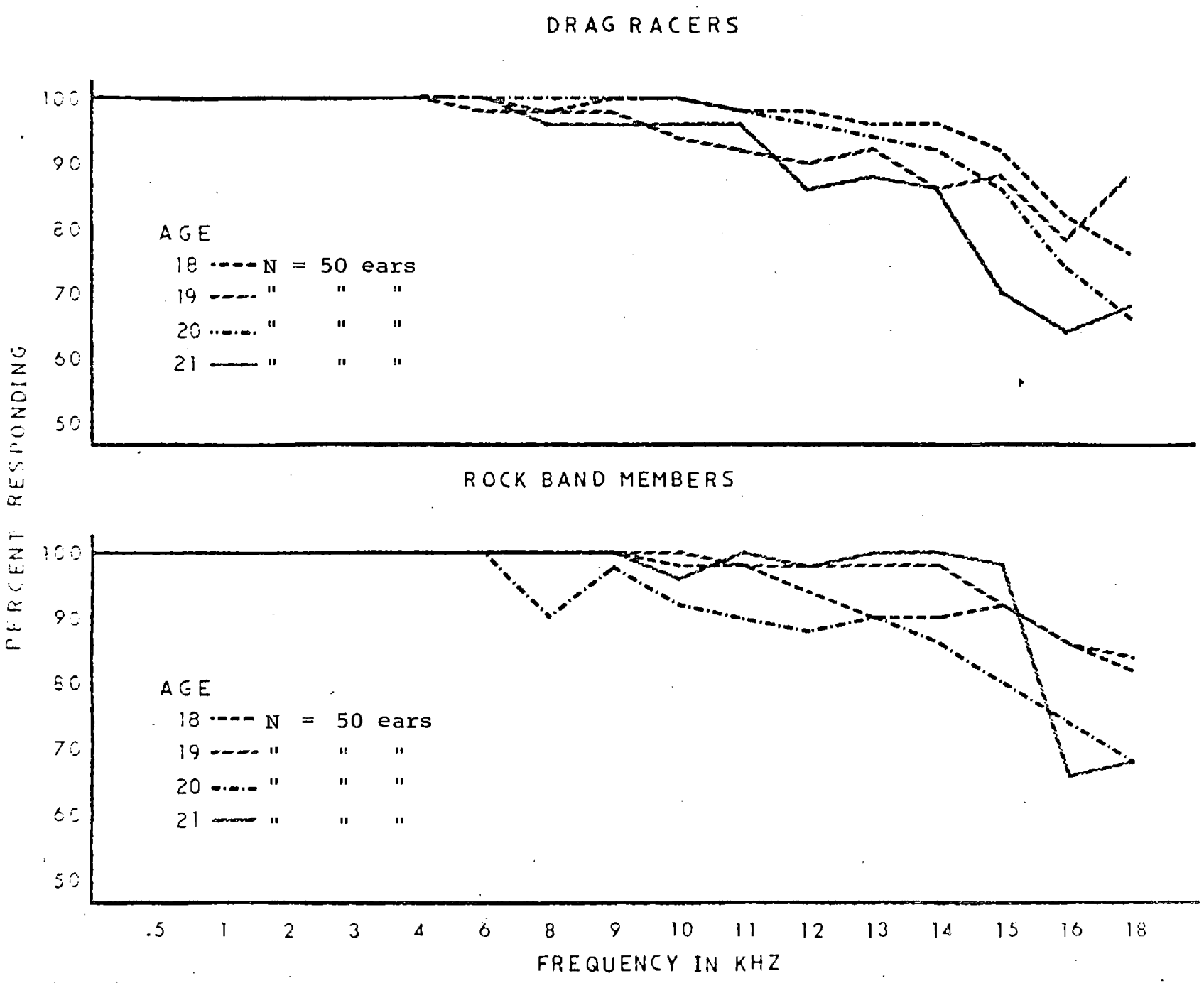

FIGURE 11. PERCENT RESPONSES BY EXPOSURE CATEGORY

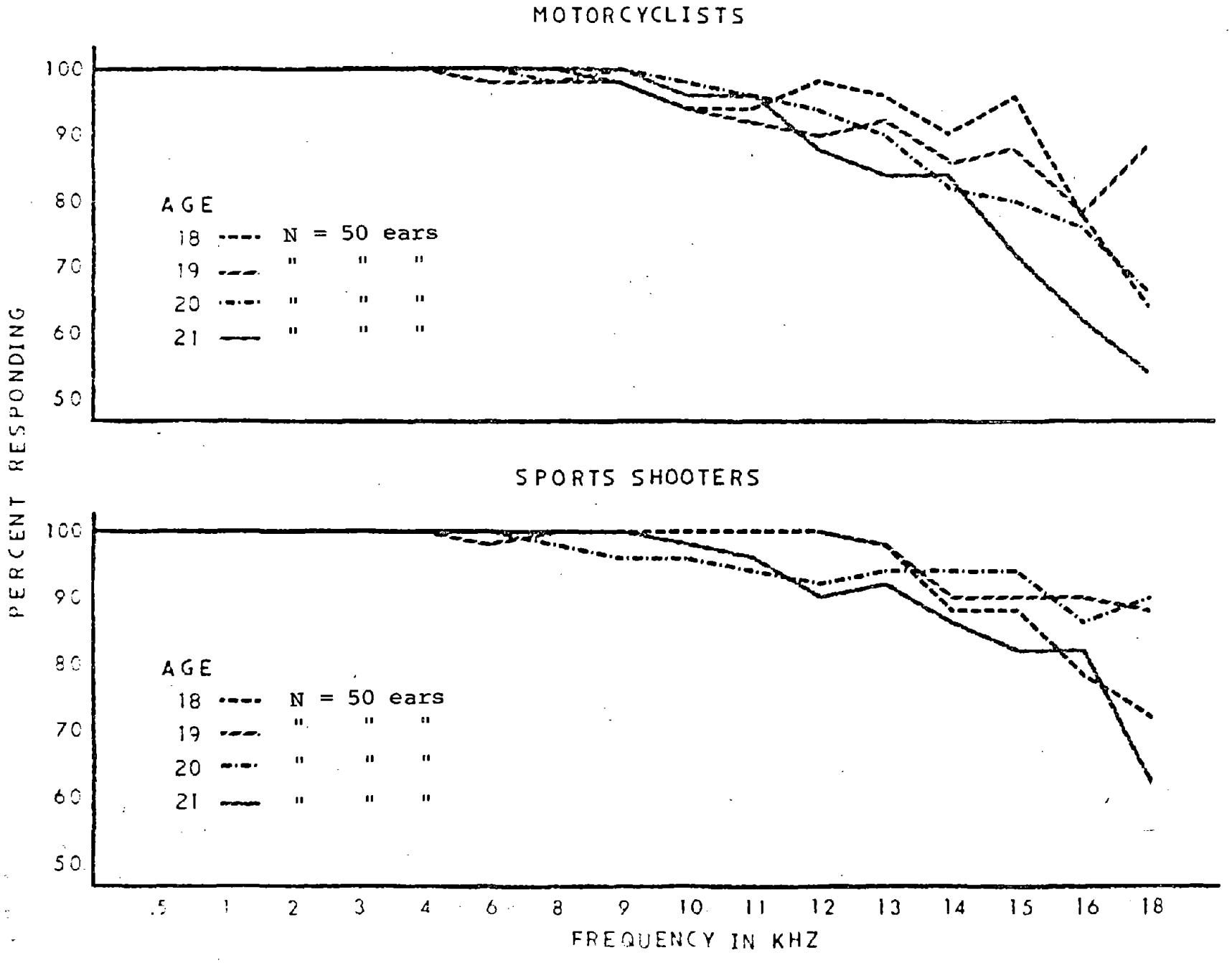

FIGURE 12 PERCENT RESPONSES BY EXPOSURE CATEGORY

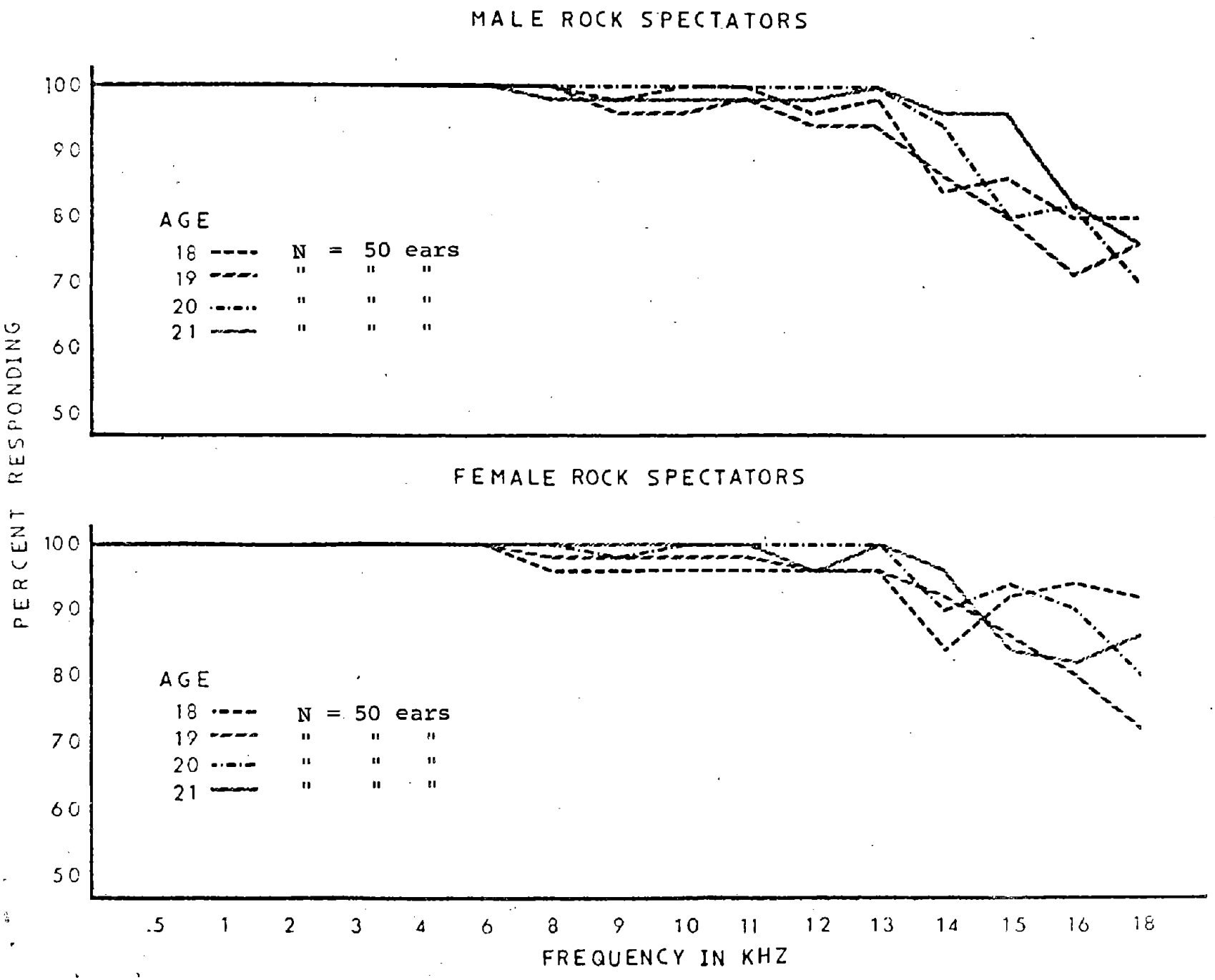

TABLE I - STANDARD DEVIATIONS OF MEAN HEARING LEVELS -ALL AGES, EXPOSURE CATEGORIES, AND ALL FREQUENCIES, BOTH EARS.

	Ear		RIGHT															LEFT													
	Frequency (in KHz)		.5	1	2	3	4	6	8	9	10	11	12	13	14	15	16	18	.5	1	2	3	4	6	8	9	10	11	12	13	14	15	16	18
AGE	CATEGORY																																	
18	Male-Normal	N=50	6.46	5.33	7.27	10.20	10.14	11.97	23.46	24.52	24.54	24.35	27.80	25.62	29.82	31.44	28.67	26.29	6.77	6.15	6.24	6.61	11.01	10.09	21.88	19.20	20.70	21.65	25.42	23.03	26.80	25.03	24.46	25.50
"	Female-Normal	N=50	4.50	4.17	5.06	3.41	3.67	5.27	17.27	17.02	19.09	27.03	17.28	18.11	23.95	20.68	24.14	20.50	5.87	4.15	4.47	4.57	5.12	7.64	18.71	17.35	17.95	18.30	22.63	20.33	26.82	24.28	24.02	20.92
"	Motorcyclists	N=25	7.46	7.23	5.37	7.87	8.09	15.31	23.92	22.12	24.86	25.26	24.21	22.25	24.70	23.84	29.52	21.86	8.21	7.40	6.43	7.10	9.17	13.34	22.98	26.17	24.30	24.67	26.32	23.03	28.46	19.87	22.72	24.04
"	Sport Shooters	N=25	4.80	4.52	5.85	4.89	13.71	11.49	19.07	21.71	17.87	21.14	20.31	27.18	32.07	31.79	35.48	33.50	9.21	5.62	6.29	7.95	12.14	12.76	19.73	18.51	17.53	20.09	20.40	22.25	29.53	31.56	31.11	27.85
"	Drag Racers	N=25	6.43	4.75	4.34	5.84	8.38	11.38	24.27	24.75	21.32	26.01	28.38	26.98	27.99	27.28	24.04	17.09	5.08	5.97	5.38	5.75	11.22	11.79	18.82	19.83	19.58	19.73	26.33	22.39	23.61	23.55	26.01	15.80
"	Rock Band Mem.	N=25	7.19	7.40	7.99	7.82	9.12	11.64	22.09	18.87	21.14	24.17	27.29	27.80	29.74	27.76	22.34	20.52	7.30	6.27	7.32	7.71	7.65	9.32	16.14	17.97	16.36	16.23	19.40	22.23	24.30	24.14	23.10	20.58
"	Male Rock Spect.	N=25	7.56	6.42	6.56	8.19	10.63	14.20	17.55	18.63	18.32	18.70	23.03	22.96	26.67	29.24	27.99	23.28	5.50	6.66	6.55	7.73	12.19	12.13	22.24	27.18	23.04	24.54	29.01	28.37	34.02	35.45	33.26	30.42
"	Female Rock "	N=25	8.73	7.38	10.10	12.19	14.11	15.00	21.22	19.31	22.58	23.57	22.89	27.82	31.75	28.23	27.39	22.81	8.28	7.94	12.74	12.28	12.64	17.20	16.79	17.16	20.88	21.51	22.71	24.67	27.41	27.19	27.05	18.91
19	Male-Normal	N=50	5.53	4.53	5.40	7.98	12.39	14.45	23.99	22.33	24.58	26.74	29.89	27.76	28.22	30.67	28.08	27.55	5.44	4.46	3.28	10.14	10.85	14.29	20.71	20.53	20.74	24.61	27.16	25.48	26.54	26.44	26.94	29.60
"	Female-Normal	N=50	5.21	3.23	4.94	5.94	5.44	8.59	19.17	19.31	19.40	21.04	23.64	23.26	26.08	26.11	28.66	22.04	9.04	6.62	4.98	5.70	5.73	7.72	19.63	21.94	19.50	20.11	24.88	23.27	32.14	26.69	26.40	24.79
"	Motorcyclists	N=25	4.93	3.29	5.03	7.34	9.21	8.07	22.97	22.16	22.35	22.81	26.10	23.98	30.07	27.33	23.80	16.86	6.15	4.23	5.60	8.06	10.82	13.43	17.26	17.02	16.13	18.97	20.93	20.20	24.72	24.03	23.59	19.87
"	Sport Shooters	N=25	6.16	4.01	3.71	9.51	9.92	11.98	22.36	23.47	24.03	25.62	28.68	27.91	26.30	30.22	31.66	29.29	8.24	6.10	5.72	6.32	7.05	11.27	21.86	19.18	18.91	20.76	21.97	21.59	26.40	27.10	31.55	27.54
"	Drag Racers	N=25	5.80	4.28	4.21	6.80	16.63	17.30	24.71	22.41	25.16	28.35	28.77	28.05	30.50	30.31	31.45	25.16	6.19	4.43	5.06	8.96	14.96	15.26	21.73	19.20	19.27	19.52	21.95	21.53	29.20	26.74	25.25	21.49
"	Rock Band Mem.	N=25	7.67	6.55	7.53	8.32	13.82	12.70	22.97	22.33	20.99	23.48	27.66	28.76	31.14	30.53	29.16	30.49	6.19	8.97	8.20	12.49	15.83	14.88	26.26	25.84	22.20	23.51	23.93	22.49	26.08	27.61	27.64	23.89
"	Male Rock Spect.	N=24	6.04	4.51	6.87	8.75	9.72	13.39	20.76	21.70	22.49	24.56	26.73	25.50	27.34	25.46	25.58	21.78	6.61	5.88	4.92	5.62	8.31	9.23	20.41	21.53	20.96	24.60	28.00	26.80	31.88	33.16	32.95	30.77
"	Female Rock "	N=24	4.64	4.25	4.95	5.35	5.34	7.74	18.68	19.60	18.81	19.27	25.34	28.18	31.70	31.51	30.01	22.64	6.12	6.24	6.32	5.05	6.76	7.63	20.89	19.58	20.68	20.18	24.31	20.89	29.50	26.82	26.89	22.14
20	Male-Normal	N=50	4.41	3.04	2.76	4.54	5.58	11.25	17.60	16.17	17.89	21.41	25.11	20.82	23.53	24.81	26.18	22.62	6.17	4.75	3.84	7.79	10.17	12.78	16.77	17.30	19.33	21.56	23.84	20.02	22.13	26.49	26.75	21.27
"	Female-Normal	N=50	5.07	5.62	6.19	8.23	8.17	11.03	19.57	19.66	20.53	21.79	23.52	26.08	28.20	24.59	22.91	20.87	6.40	5.88	7.15	7.90	8.14	9.09	15.27	15.18	18.57	19.11	20.78	21.60	23.70	21.06	24.22	21.29
"	Motorcyclists	N=25	5.93	4.03	5.31	9.57	11.64	10.94	24.32	23.88	22.00	26.69	27.59	23.91	28.91	28.67	24.51	26.61	6.41	5.46	6.31	10.00	13.36	11.94	16.97	19.80	22.45	23.68	25.87	28.46	31.41	29.12	28.12	25.43
"	Sport Shooters	N=25	5.04	3.68	5.60	14.71	13.48	12.01	28.08	24.22	24.14	27.12	30.22	28.68	24.67	27.25	25.26	20.21	4.25	4.92	7.88	14.33	14.20	15.03	20.23	22.72	24.76	28.12	27.31	27.05	30.96	24.13	24.02	20.48
"	Drag Racers	N=25	7.86	4.75	4.45	11.44	12.58	10.42	18.89	21.74	20.35	21.56	23.03	27.21	29.32	31.52	24.82	18.93	6.54	5.52	5.34	8.84	13.03	10.76	12.96	17.12	19.75	22.68	26.14	26.39	26.46	27.46	29.83	27.76
"	Rock Band Mem.	N=25	6.42	4.10	6.86	6.86	5.46	11.96	28.11	24.79	27.12	31.07	31.14	28.70	31.29	30.31	28.65	29.25	7.09	5.17	9.84	8.63	10.19	13.06	27.36	23.23	25.41	27.56	27.15	25.87	29.09	29.52	29.39	26.91
"	Male Rock Spect.	N=25	5.56	3.21	4.78	6.76	13.37	11.74	22.02	22.25	24.56	23.68	30.11	25.31	27.38	27.67	28.79	26.68	7.79	4.93	3.99	9.00	11.11	13.63	18.61	18.25	17.78	21.26	24.91	22.50	27.45	28.71	28.27	27.72
"	Female Rock "	N=25	3.39	3.22	5.79	4.78	5.70	4.88	25.65	25.72	20.38	23.22	27.08	27.94	32.12	26.88	28.88	25.50	5.19	6.55	9.84	12.45	11.99	6.77	15.70	18.70	20.91	23.45	24.34	19.83	32.04	24.88	21.98	26.86
21	Male-Normal	N=50	5.02	3.32	3.74	9.31	11.54	10.46	22.42	21.77	24.11	23.20	26.62	25.36	27.97	24.46	24.10	19.74	5.70	4.11	3.93	7.63	13.46	15.17	21.50	24.37	23.28	24.25	26.26	25.77	27.84	29.54	25.31	20.99
"	Female-Normal	N=50	5.37	3.55	3.87	6.72	6.48	8.05	20.91	19.76	18.98	20.41	25.50	24.26	33.59	27.80	26.69	21.89	9.47	8.34	7.28	7.64	7.10	8.53	16.28	17.71	18.53	20.35	24.02	23.72	29.09	26.82	26.54	19.79
"	Motorcyclists	N=25	3.54	5.07	8.73	12.78	15.20	21.20	20.46	21.92	26.70	27.45	30.89	28.62	30.76	33.82	27.86	25.07	5.81	5.94	8.86	7.97	13.47	12.48	20.88	20.28	23.33	25.24	30.68	28.13	29.37	30.15	28.82	21.99
"	Sport Shooters	N=25	4.81	4.06	3.24	3.82	7.82	9.09	18.25	20.85	24.57	23.99	28.07	27.79	30.75	28.56	26.60	28.86	6.92	5.05	3.86	6.55	8.44	16.47	21.82	21.49	22.42	22.98	22.85	23.25	26.34	28.28	30.60	25.49
"	Drag Racers	N=25	5.89	4.91	7.30	13.26	15.45	17.48	27.36	28.15	27.95	30.17	33.24	27.19	28.01	35.08	31.71	22.76	7.37	4.91	9.42	12.72	15.36	19.06	23.49	23.90	23.17	26.29	27.41	24.78	25.69	30.51	27.99	28.18
"	Rock Band Mem.	N=25	3.85	1.54	3.19	5.93	6.45	8.58	19.50	17.45	20.97	22.05	23.80	22.88	20.86	21.44	22.27	11.49	5.45	3.23	4.34	6.68	5.88	9.61	17.77	19.34	23.94	25.79	25.79	23.79	21.53	25.66	22.78	23.95
"	Male Rock Spect.	N=25	6.15	4.67	4.90	4.11	5.94	6.47	18.27	15.82	18.23	19.33	25.26	19.17	18.97	15.87	21.65	16.87	5.80	11.08	10.58	14.10	13.78	13.16	20.08	20.23	21.52	26.54	26.13	23.21	27.89	24.31	29.66	25.59
"	Female Rock "	N=25	4.29	3.41	6.13	4.55	6.50	9.32	19.49	19.78	17.38	20.00	21.80	21.20	24.81	27.66	27.00	32.10	7.82	5.77	7.60	5.18	8.86	9.79	22.04	19.79	19.56	19.08	23.64	23.50	33.42	32.64	28.73	21.45

APPENDIX I

DEFINITIONS OF CATEGORIES OF NOISE
EXPOSURE GIVEN TO PROSPECTIVE SUBJECTS

Normal-those who have not held a job in a noisy environment for prolonged periods of time (a place where you have to shout to converse with fellow workers, or get close and talk into their ear), who have no past history of ear infections, drainage, or other adverse diseases of the ear, nor severe blows to the head and who are not aware of problems with their hearing.

Rock Musicians-those who have been playing in a group for a year or more, or played in a group for a year or more in the past.

Rock Spectators-those who have for a year or more, or for a year or more in the past attended 3-5 rock concerts per month and listened to rock music on the radio or stereo for one or more hours per day.

Sport Shooters-those who now, or in the past, shot rifles, pistols, or shotguns habitually for a year or more as members of teams, as a hobby, target shooting, or hunting.

Auto or Drag racers-those who now, or in the past, for one year or more raced cars or drag raced on either the streets or at drag strips.

Motorcycle or Motorbike riders-those who now or in the past rode motorcycles or motorbikes daily, or for prolonged times frequently (such as weekend trail biking) for one year or longer.

APPENDIX II

O.M.B. NO. 68-571054
APPROVAL EXPIRES: 6/30/72

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DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
National Institute for Occupational Safety and Health
Cincinnati, Ohio 45202

HEARING SURVEY OF YOUNG ADULTS

ASSURANCE OF CONFIDENTIALITY

The U.S. Public Health Service hereby gives its assurance that your identity and your relationship to any information obtained by reason of your participation in the Hearing Survey of Young Adults will be kept confidential in accordance with PHS regulations (42 CFR 1.103(a)) and will not otherwise be disclosed except as specifically authorized below. A copy of this regulation will be made available to you upon request.

Marcus M. Key, M.D.
Assistant Surgeon General
Director
National Institute for Occupational Safety and Health

CONSENT

I hereby voluntarily agree to participate in the Occupational Noise and Hearing Study which will be conducted by the U.S. Public Health Service. It has been explained to me that in addition to my answering a questionnaire, there will be a routine medical examination of my ears and a standard hearing test. I have been advised that I may withdraw from this study at any time if I so desire.

Signature Date

AUTHORIZATION TO RELEASE MEDICAL INFORMATION

I hereby request the U.S. Public Health Service to inform my personal physician should there be any evidence from this study of an active ear disorder.

Dr. _____

Street

City State Zip Code

Telephone

Signature Date

Hobby _____
Participant Number _____

(Note: Questions 1-8 below are to be completed by staff interviewer anytime before hearing exam).

(1) Name: _____

(2) Address: _____

(3) Age: _____ (4) Sex: _____

(5) Part or Full Time Job History:

a. Have you worked in jobs, either part time or full time, in which the noise levels were such that you had to raise your voice to be understood? Yes _____ No _____
b. If yes to (a), we should like to list those jobs and the number of months in which you were employed on them. We shall start with the most recent one.

	Type of Job (Describe)	Place of Work (plant, hospital, school)	Source of Noise	Months of Employment	Did you use Ear Protection
i					
ii					
iii					
iv					
v					

(6) Military Service:
a. How many years were you in military service? 1 - 2 - 3
b. What Branch? Army Navy Marines Air Force Coast Guard
c. How many months were you in combat? _____
d. What specific assignments did you have? (Circle)

_____ Ear Protection: Yes No Sometimes

_____ Ear Protection: Yes No Sometimes

_____ Ear Protection: Yes No Sometimes

e. Did you fire weapons for more than 100 days? Yes _____ No _____
f. Circle the kinds of weapons you fired: Individual Crew Both

Hobby _____
Participant Number _____

(7) Specific Non-Occupational Interests:

a. In which one of the following activities do you participate regularly?
   1. Member of a Rock-and-Roll Band _____
   2. Sport Shooting _____
   3. Auto or Drag Racing _____
   4. Motorcycling _____
   5. None of the Above _____

b. How many years have you participated in this activity? (Circle)
   1 - 2 - 3 - 4 - 5 - more

c. How many days per week do you typically spend in this activity? (Circle)
   1 - 2 - 3 - 4 - 5 - 6 - 7

d. On the days in which you are a participant what is the average number of hours spent in this activity? _____

e. Do you routinely wear ear protectors when involved in this activity? Yes _____ No _____ Sometimes _____

(8) Other Non-Occupational Noise Exposure:

a. Do you participate in any other hobbies or other off-job activities that are typically noisy or have loud sounds (e.g., sport flying, machine work, mechanized farming, etc.)?

   Yes _____ No _____ Specify _____

b. For how many years have you taken part in this hobby or activity?

   _____

c. How frequently? (daily, weekly, monthly) _____

d. What types of vehicles or forms of transportation have you used at least three days a week? (Check as many as apply and record other required information)

Vehicle		For how many years at this frequency	Average time per day in vehicle	Actual frequency of use per week
Automobile	___			
Bus	___			
Motorcycle	___			
Streetcar	___			
Subway	___			
Airplane	___			
Motorboat	___			

Other (Specify) _____

Hobby_____
Participant_____

(Note: Questions 9 and 10 will be completed by the resident otologist prior to the hearing examination.)

(9) Relevant Medical History:

Have you had any of the following:	(Circle)		Comments
(a) Severe blow to head	yes	no	
(b) Head noises	yes	no	
(c) Medical treatment for ears	yes	no	
(d) Running ears	yes	no	
(e) Earaches	yes	no	
(f) Hearing aid	yes	no	
(g) Medication	yes	no	
(h) Deafness in Family	yes	no	
(i) Do you think you have normal hearing?	yes	no	

(10) Otologic Check: (Circle) Normal ( ) Abnormal ( )

			Elaborative Comments:
(a) Perforation of drum head	R(ight)	L(eft)	
(b) Drainage from ear	R	L	
(c) Malformation or growth in ear	R	L	
(d) Ear occlusion	R	L	
(e) Ear disease	R	L	
(f) Other (specify)	R	L	

Hobby _____
Participant _____

(Note: Question 11 below will be completed by audiometrist just before subject takes hearing exam.)

(11) Time and Duration of Last Notable Exposure:

(a) What was your most recent exposure to loud noise (specify, e.g., hobby, horn, airplane, workplace, gunshot, etc.)?

_____

(b) How long ago did this exposure take place? (In days)

_____

(c) How long did the exposure last? (Minutes or hours)

_____

(12) Hearing Level Data:

Pure Tone I

Date:	Tester:	
Time:	Station:	
Freq	R	L
500		
1000		
2000		
3000		
4000		
6000		
8000		
9000		
10000		
12000		
14000		
16000		
18000		

Pure Tone II (Optional)

Date:	Tester:	
Time:	Station:	
Freq	R	L
500		
1000		
2000		
3000		
4000		
6000		
8000		
9000		
10000		
12000		
14000		
16000		
18000		