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An audiometric analysis of hearing acuity in Montana school band directors

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AN AUDIOMETRIC ANALYSIS OF HEARING ACUITY IN MONTANA SCHOOL BAND DIRECTORS

by

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CHAPTER I

INTRODUCTION

History of the Problem

An association between noise exposure and a decrease in hearing sensitivity has been recognized as a problem since the beginning of industrialization. As early as 1880[1], otolaryngologists began referring to occupational deafness. "Boilermakers' deafness", as the injury was once termed, represented a "hearing loss that develops gradually over months and years"[2], predominately in the higher frequencies.

Numerous authors have contributed papers relating noise with hearing loss.[3,4,5] In fact, over 250 contributions are listed in a 1950 monograph supplement to the

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[1]Rudmose, Wayne, "Hearing Loss Resulting from Noise Exposure", Handbook of Noise Control, McGraw-Hill Book Company, Inc., New York, 1957, Cyril M. Harris, Editor, p. 7-1.

[2]Davis, Hallowell and Silverman, S. R., Hearing and Deafness, Holt, Rinehart and Winston, Inc., New York, 1960, p. 106.

[3]Snow, William B., "Sound-Level Surveys for Hearing Conservation", Noise Control, March, 1959, p. 13.

[4]Kryter, K. D., "The Effects of Noise on Men", Journal of Speech and Hearing Disorders, 1950, Supplement 1, p. 28.

[5]Rosenblith, Walter A., "Industrial Noises and Industrial Deafness", Journal of the Acoustical Society of America, 1942, pp. 220-225.

Journal of Speech and Hearing Disorders.[6]

Intense levels of "unwanted sound" within the armed forces have spearheaded extensive recent studies in this area of research. In an audiometric survey among Air Force personnel, Kopra[7] found significantly greater hearing losses at 3000, 4000 and 6000 cps in a job-noise-exposed group than in a group of non-noise-exposed individuals. Ward[8], reporting audiometric research among Naval personnel, asserted that large and small caliber gunfire may have been a major cause of hearing loss. A similar study comprising over 3000 armor personnel demonstrated that "severely" exposed men in a 30 to 39 year age group had hearing losses that were 20 db greater in some high frequencies than an identical age group of "negligibly" exposed men.[9] A current Air Force regulation[10] makes the wearing of ear protection mandatory for men working under noise conditions when octave analysis of the noise indicates a sound pressure level of 95 db for octaves within a

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[6]Kryter, op. cit.

[7]Kopra, Lennart L., "Hearing Levels and Types of Hearing Loss Among Selected Air Force Personnel", Journal of Speech and Hearing Research, Vol. 3, December, 1960, p. 327.

[8]Ward, W. Dixon, "Hearing of Naval Aircraft Maintenance Personnel", Journal of the Acoustical Society of America, December, 1957, p. 1289.

[9]Soloman, Lawrence N. and Fletcher, John L., "Survey of Hearing Losses Among Armor Personnel", Journal of Speech and Hearing Research, December, 1958, p. 350.

[10]Air Force Regulation 160-3, Dept. Air Force, Washington, D. C., October, 1956, p. 5.

frequency range of 300 to 4800 cycles per second.

The recognition that intense sounds are associated with hearing losses has been empirically verified in other employment areas. Lierle and Reger[11] noted that "tractor noise is sufficiently high in intensity to produce high frequency losses in tractor operators with noise susceptible ears if exposed over a period of years." In 1957, results of a survey during a state fair hearing program in Wisconsin[12] disclosed greater high frequency losses among factory and farm workers than among office employees. Quigley[13] reports that hearing losses in Japanese steel mill workers "appeared to be directly related to the intensity of noise exposure and the number of years of exposure." Of more recent consideration is the question posed by Kessler[14] whether the hearing of dentists might be impaired by prolonged use of drills.

Cognizance of the general noise-loss enigma has actuated

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[11]Lierle, D. M. and Reger, Scott N., "The Effect of Tractor Noise on the Auditory Sensitivity of Tractor Operators", Annals of Otology, Rhinology and Laryngology, June, 1958, Vol. 67, No. 2, p. 372.

[12]Glorig, Aram, et. al., 1954 Wisconsin State Fair Hearing Survey, American Academy of Opthalmology and Otolaryngology, Research Center, Subcommittee on Noise in Industry, Los Angeles, 1957.

[13]Quigley, Stephen P., Editor, DSH Abstracts, 1960, p. 15. From a study by Kawata, Tominaga and Abe, Otol. Fukuoka, Fukuoka, 1959, p. 37.

[14]Kessler, Howard E., "Hearing - as related to dentistry.", Dental Radiography and Photography, Vol. 34, No. 1, 1961, p. 2.

progressive steps toward a better understanding of this relationship. In 1952 a subcommittee of the American Standards Association began investigating the relations between hearing losses in industrial workers and exposure to industrial noise. A year later a population distribution survey revealed that about ten million production workers were employed in industries classified as "noisy".[15] Today, subcommittees of the American Speech and Hearing Association[16], the American Laryngological, Rhinological and Otological Society[17] and the American Academy of Opthalmology and Otolaryngology[18] are exploring the relations of hearing acuity to noise. According to a United States Public Health Officer, "The number of workers exposed to noise exceeds any other occupational hazard."[19]

Unfortunately, the relationship between various noise stimuli and their effects upon individuals is complex and not fully understood. The sensory-neural hearing loss that may follow noise exposure varies with the intensity and dur-

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[15]Cox, Jerome R., "Noise in Industry", The Laryngoscope, March, 1958, p. 446.

[16]"Report of Subcommittee on Hearing in Large Groups", Journal of Speech and Hearing Disorders, Monograph Supplement 5, September, 1959, p. 61.

[17]Cox, op. cit., pp. 440-508.

[18]Rosenblith, Walter A., et. al., The Relations of Hearing Loss to Noise Exposure, American Standards Association, New York, 1954, p. 5.

[19]Yaffee, C. D., United States Public Health Service, Science News Letter, May, 1958, p. 277.

ation of the sound and with the distribution of energy within the sound. In addition, there are individual differences in susceptibility to the same noise.[20] Consequently, it is currently not possible to make predictions about the degree of hearing loss that might occur in a measurable noise environment for a specific individual.

The determination of hearing loss that might be attributed to noise is further complicated by two factors: (1) presbycusis, the gradual reduction in hearing acuity through increasing age, and (2) temporary threshold shift, the temporary decrease of hearing sensitivity following an exposure to an intense sound.[21]

At the present time there is no physiological or audiological means of dissociating "old age deafness" from hearing loss that follows noise exposure. "Age, otological disease and noise exposure may all produce inner-ear hearing loss. There is no way of telling from the individual audiogram which of these causes produced a given loss."[22] However, recent researchers have attempted to separate the results of

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[20]Wever, Ernest G. and Lawrence, Merle, Physiological Acoustics, Princeton University Press, Princeton, N. J., 1954, pp. 47-66.

[21]Newby, Hayes A., Audiology, Appleton-Century-Crofts, Inc., New York, 1958, pp. 50-51.

[22]Glorig, Aram, et. al., "Hearing Loss in Industry", The Laryngoscope, March, 1958, p. 457.

noise from those of presbycusis.[23,24] The mean hearing loss of non-noise-exposed individuals within a certain age group is subtracted from the mean hearing loss of noise-exposed subjects within the same age group. The difference is considered to be attributable to noise.

A temporary shift of hearing threshold due to noise will, with sufficient rest, return to its pre-exposure level. Temporary threshold shift is affected by the same parameters as hearing loss, in that it, too, depends upon the frequency composition, intensity and duration of the noise exposure. Unlike a permanent shift of threshold, temporary threshold shift varies inversely with the amount of time that has elapsed since the cessation of the sound. Because this reversable hearing loss decreases as a function of time, various rest interims following noise exposure have been proposed in order to reduce or eliminate its effects on tests for hearing loss. The subcommittee on Noise in Industry has suggested a minimum of 16 hours of rest between noise exposure and audiometric testing.[25] Other studies have assumed that intervals from 12 to 48 hours between the cessation of the noise exposure and the hearing test adequately limit the effect of

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[23]Rudmose, op. cit., p. 74.

[24]Corso, John F., "Age and Sex Differences in Pure-Tone Thresholds", Journal of Acoustical Society of America, April, 1959, p. 498.

[25]Glorig, "Hearing Loss in Industry", op. cit., p. 456.

temporary threshold shift.[26,27]

The Problem Defined

Typically, loss of hearing acuity becomes a problem to the individual when it is communicatively or occupationally handicapping. Thus, two questions of primary importance are raised: whether the noise environment associated with a job or profession will modify hearing, and whether this modification is sufficient to create such a problem for that individual.

Musicians are perhaps unique from many occupations in that their work is closely affiliated with their auditory perception. Hence we might expect a hearing loss to constitute more of an occupational problem among these individuals. Band and orchestra directors are commonly subjected to sounds of relatively high intensity during the performance of their professional duties. However, whether this noise is sufficient to incur a loss of hearing and whether such a loss might prove occupationally handicapping are questions that remain problematical.

It is the intent of this study to determine by audiological testing whether school band and orchestra directors have hearing losses greater than comparable groups who have not been exposed to these occupationally produced sounds.

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[26]Rudmose, op. cit., pp. 7-15.

[27]Rosenblith, et. al., op. cit., pp. 37-38.

CHAPTER II

PROCEDURE

Selection and Qualification of Subjects

School band directors are herein defined as individuals whose livelihood consists primarily of directing bands and orchestral groups in the school systems of Montana.

Approximately 100 male school band directors attended the Montana State University Music Festival on May 4, 5 and 6, 1961. Sixty-five individuals participated as subjects in the hearing tests.

It was not deemed necessary to disqualify any of the subjects because of recent exposure to intense sound. This determination was quite subjective, based primarily on the subjects' answers to Question 4 of the Questionnaire (See Appendix A) and on personal interviews held with the subjects. Although all of the school band directors were exposed to the sounds of small ensembles during the Music Festival, none reported having directed a full band or orchestra or having been exposed to "intense" sounds of extended duration in the 24 hours preceding the hearing test.

Since data resulting from the school band director group was divided into appropriate ten year age categories, it was necessary to eliminate one subject from the total sample. This individual was the only subject represented on the 60 to

69 year age decade; hence both the subject and his age group were eliminated from the study.

Testing Rooms and Equipment

The hearing tests were administered in two acoustically treated rooms[28] in the Montana State University Music Building and one Model 403 Industrial Acoustics Company testing room in the University Speech and Hearing Clinic. Prior to the tests the ambient noise level in the first two music rooms was monitored with a Type 1555-A General Radio Company Sound Level Meter. Despite the proximity of several student practice rooms in use during the monitoring sessions, the highest sound pressure level attained during any single session was less than 45 db, using the C network. This figure adequately satisfies the minimum criteria for audiometric "quiet" suggested by several authors.[29,30,31] Since the third testing room was designed and constructed specifically for audiological testing, this qualification appeared suffi-

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[28]Rooms are double-wall construction with separate foundations and acoustically treated doors. The acoustical consultant for the construction of the building was Verne O. Knudsen, Ph.D., University of California, Los Angeles, Calif.

[29]Guide for Conservation of Hearing in Noise, American Academy of Opthalmology and Otolaryngology, Subcommittee on Noise in Industry, Los Angeles 28, California, 1957, p. 23.

[30]Glorig, Aram, "Audiometric Testing in Industry", Handbook of Noise Control, McGraw-Hill Book Company, Inc., New York, 1957, Cyril M. Harris, Editor, p. 6-6.

[31]Hirsh, Ira J., The Measurement of Hearing, McGraw-Hill Book Company, New York, 1952, p. 160.

cient for the purposes of this study.

Three pure tone audiometers were used in the hearing tests: a Maico F-1, A Beltone 10-A, and a Maico H-1. These instruments had been factory calibrated within 8 months prior to the study. In addition, 10 normal ears were used to confirm the continued calibration of all audiometers immediately prior to and following the school band director tests.[32]

Instructions and Tests

Each subject was seated with his back toward the audiometrist and the test equipment. He was instructed to listen for tones, some of which would be very weak. He was asked to either depress a signal button or hold up a finger for as long as the tone was present, releasing the button or lowering the finger when the tone disappeared.

A discrete frequency pure tone air conduction hearing test was administered to each individual. The right ear or "better" ear was tested first at the following frequencies: 1000, 500, 1000, 1500, 2000, 3000, 4000 and 6000 cycles per second. The presentation of the first 1000 cycle tone was regarded as a conditioning technique and was not registered on the audiogram. A descending-ascending method was used, the threshold being crossed a minimum of two times in each direction. Masking was delivered to the better ear when a threshold difference of more than 35 db existed between the

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[32]Newby, op. cit., p. 86.

two ears.

Three audiometrists were employed in the testing. An estimate of the reliabilities between audiometrists was obtained by a test re-test procedure. Twenty-two students were given pure tone hearing tests in their right ears at two frequencies by each of the three audiometrists. Pearson product moment correlations were determined for each frequency between the author and each of the other two audiometrists. The correlations between the author and the first audiometrist at 500 and 4000 cycles were .87 and .95 respectively. The correlations between the author and the second audiometrist were, at the same respective frequencies, .93 and .86. (See Table I)

The Questionnaire

A two page questionnaire (See Appendix A) was given to each subject prior to the hearing test. The information contained on this form was designed to serve three purposes: (1) Identification of the individual. (2) Classification of the subject in regard to the extent of his occupational noise experience. (3) Further evaluation of the individual on items pertinent to his hearing acuity, such as military experience, ear pathology, etc.

The Wisconsin State Fair Hearing Survey

Three comparative groups were selected from the 1954

TABLE I

Audiometric Results of the Right Ears of Twenty-two Subjects Tested at 500 cps and 4000 cps by the Writer (M) and Two Other Audiometrists Engaged in the Survey.

SUBJECTS	500 cps			4000 cps		
	L	M	D	L	M	D
1	-10	-10	-10	-10	-10	-10
2	0	0	-10	15	- 5	- 5
3	-10	-10	-10	-10	- 5	5
4	-10	-10	-10	-10	-10	-10
5	-10	-10	-10	-10	- 5	- 5
6	-10	-10	-10	0	-10	0
7	-10	-10	-10	-10	-10	-10
8	-10	-10	-10	-10	0	- 5
9	-10	-10	-10	-10	-10	-10
10	-10	-10	-10	- 5	- 5	- 5
11	0	- 5	5	20	5	5
12	-10	-10	-10	5	10	15
13	- 5	- 5	- 5	-10	- 5	- 5
14	- 5	-10	- 5	15	5	5
15	-10	-10	-10	- 5	-10	-10
16	5	5	10	10	5	0
17	0	- 5	0	20	20	20
18	-10	-10	-10	5	-10	- 5
19	-10	-10	- 5	-10	- 5	0
20	-10	-10	- 5	5	0	0
21	0	- 5	- 5	0	0	5
22	- 5	- 5	- 5	50	45	45

Wisconsin State Fair Hearing Survey[33] to serve as bases for comparison with the audiometric results of the school band directors. This survey was chosen because it constitutes a recent, rather large population survey employing modern audiometric methods and testing conditions comparable to those used in this investigation. The first group is composed of 330 male factory workers. Glorig, et. al. report that with the exception of the 20 to 29 year age group, this factory worker sample evidenced significantly more hearing loss than a group of office workers tested during the Wisconsin Hearing Survey. Two hundred and seventeen male office workers comprise the second comparative group. This sample appears to be the least exposed to noise of the occupational groups tested during this survey. The third group is composed of 712 males who had at least a ninth grade education. The authors of the Wisconsin State Fair Hearing Survey Monograph found that the majority of inter-decade differences between the educated group and a sample of males with less than ninth grade education were statistically significant[34]; the educated having less hearing loss than the "uneducated".

Glorig and his co-workers suggest that "because of probable differences in noise exposure",[35] there are differences

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[33]Glorig, et. al., 1954 Wisconsin State Fair Hearing Survey, op. cit.

[34]The authors state that the majority of differences were found to be significant at the 5% level.

[35]Glorig, et. al., 1954 Wisconsin State Fair Hearing Survey, op. cit., p. 75.

in hearing loss between the three comparative groups.

It was evident that prior to any comparison of data between the school band directors and the Wisconsin Hearing survey subgroups, similar procedures in obtaining the data were necessary. These similarities between the two studies included a common choice of test frequencies, the selection of certain items on the questionnaire, similar audiometric procedures used during the testing, and the grouping of results in appropriate 10 year age categories.

Subjects with Military Service

Glorig[36], Kopra[37] and others have related the degree of hearing loss to previous military service and to noise levels associated with service occupations. Although no attempt was made to separate the results of the present study on the basis of amount of noise within service connected jobs, a general comparison was made between school band directors who had military service and those who did not.

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[36]Glorig, et. al., 1954 Wisconsin State Fair Hearing Survey, op. cit., p. 103.

[37]Kopra, Lennart L., "Hearing Levels and Types of Hearing Loss Among Selected Air Force Personnel", Journal of Speech and Hearing Research, Vol. 3, No. 4, December, 1960, p. 333.

CHAPTER III

RESULTS

Sixty-four male school band directors were given individual pure tone hearing tests in both ears. The results were grouped into four appropriate age categories (See Appendix B) and mean hearing losses of right and left ears within each age group and for each test frequency were determined. These groups were then compared with the mean hearing losses for men in equivalent subgroups of the 1954 Wisconsin State Fair Hearing Survey.[38] The differences between the means of the three comparative subgroups and the school band directors were tested by the following "t" test:

$$t = \frac{M_1 - M_2}{\sqrt{\frac{N_1 s_1^2 + N_2 s_2^2}{N_1 + N_2 - 2}\left(\frac{1}{N_1} + \frac{1}{N_2}\right)}}$$

The level of significance used in all comparisons was 5%.

With few exceptions, the comparison between factory workers and school band directors, which is presented in Table II, revealed differences that were found to be statistically significant. The factory worker subgroup showed

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[38] Glorig, et. al., 1954 Wisconsin State Fair Hearing Survey, op. cit.

TABLE II

Mean Hearing Losses and "t" Scores of Factory Workers and School Band Directors, According to Age Group, Ear and Test Frequency.

20 to 29 Years						
EAR	WSF	BD	t	WSF	BD	t
	500 cps			1000 cps		
Right	6.03	- .42	1.62	10.07	-2.92	3.17*
Left	6.84	- 2.92	3.03*	10.07	-5.21	4.26*
	1500 cps			2000 cps		
Right	10.29	- 5.00	3.83*	10.22	-3.54	3.44*
Left	9.41	- 7.08	4.83*	9.93	-5.62	4.12*
	3000 cps			4000 cps		
Right	19.63	1.63	3.56*	27.28	6.46	4.01*
Left	20.15	2.92	4.13*	24.19	8.12	3.50*
	6000 cps					
Right	28.90	14.17	2.64*			
Left	29.26	16.25	2.62*			

*A "t" value of 1.99 (df = 90) is required for significance at the 5% level.

TABLE II

Mean Hearing Losses and "t" Scores of Factory Workers and School Band Directors, According to Age Group, Ear and Test Frequency.

30 to 39 Years						
EAR	WSF	BD	t	WSF	BD	t
	500 cps			1000 cps		
Right	9.29	- 2.00	3.25*	13.06	- 3.00	4.40*
Left	11.18	.60	2.79*	15.06	- 1.20	5.91*
	1500 cps			2000 cps		
Right	16.06	- 3.00	4.97*	15.65	- 4.00	4.81*
Left	17.41	- 1.80	4.46*	20.18	- 1.00	5.10*
	3000 cps			4000 cps		
Right	28.18	6.60	4.57*	37.41	11.80	5.04*
Left	34.06	6.80	5.55*	43.65	14.80	5.73*
	6000 cps					
Right	41.06	29.00	2.03*			
Left	47.18	30.60	2.74*			

*A "t" value of 1.98 (df = 108) is required for significance at the 5% level.

TABLE II

Mean Hearing Losses and "t" Scores of Factory Workers and School Band Directors, According to Age Group, Ear and Test Frequency.

40 to 49 Years						
EAR	WSF	BD	t	WSF	BD	t
	500 cps			1000 cps		
Right	15.87	.50	2.26*	22.14	- .50	3.10*
Left	15.88	1.00	2.13*	22.47	2.50	2.72*
	1500 cps			2000 cps		
Right	26.32	.50	3.06*	29.34	14.00	1.66
Left	26.26	2.00	2.83*	28.41	13.00	1.74
	3000 cps			4000 cps		
Right	42.75	24.50	1.95	49.78	29.00	2.50*
Left	44.67	24.00	2.31*	51.10	30.00	2.58*
	6000 cps					
Right	52.60	35.50	1.84			
Left	55.44	37.00	1.98			

*A "t" value of 1.98 (df = 99) is required for significance at the 5% level.

TABLE II

Mean Hearing Losses and "t" Scores of Factory Workers and School Band Directors, According to Age Group, Ear and Test Frequency.

50 to 59 Years						
EAR	WSF	BD	t	WSF	BD	t
	500 cps			1000 cps		
Right	17.79	- 3.00	2.17*	23.49	- 4.00	4.59*
Left	16.57	- 3.00	2.35*	23.20	- 6.00	3.10*
	1500 cps			2000 cps		
Right	28.20	- 4.00	5.67*	31.45	- 1.00	3.25*
Left	28.31	- 3.00	2.99*	32.27	1.00	2.89*
	3000 cps			4000 cps		
Right	47.15	9.00	3.82*	54.88	16.00	4.18*
Left	53.49	19.00	3.51*	60.52	27.00	3.77*
	6000 cps					
Right	60.00	32.00	2.43*			
Left	66.28	37.00	2.54*			

*A "t" value of 1.99 (df = 89) is required for significance at the 5% level.

greater hearing losses than school band directors in all comparisons except the 20 to 29 year age groups at 500 cps for right ears and the 40 to 49 year age groups at 3000 cps for right ears, and at 2000 and 6000 cps for both ears.

Mean threshold differences between office workers and school band directors were tested for statistical significance within three age decades.[39] The information presented in Table III suggests that school band director hearing acuity thresholds are somewhat more similar to those of office workers than any of the other comparative subgroups in this investigation. However, significant differences exist at most frequencies within the 30 to 39 and 50 to 59 year age groups, where school band directors demonstrated less hearing loss than office workers. Most of the similarities between the results of these two samples occur within the 40 to 49 year age group where differences were not statistically significant except at 1000 cps for right ears.

Glorig, et. al., found that the majority of males in the Wisconsin State Fair Hearing Survey who had less than a ninth grade education also had significantly greater hearing losses at 1000 and 4000 cps than males with ninth grade or more education.[40] School Band directors within three age

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[39]Since authors of the Wisconsin Hearing Survey Monograph found no statistically significant differences between office workers and factory workers in the 20 to 29 year decade, this age group was deleted from the statistical treatment of office workers and band directors.

[40]Educational differences in hearing loss were only investigated at these frequencies in this survey.

TABLE III

Mean Hearing Losses and "t" Scores of Office Workers and School Band Directors, According to Age Group, Ear and Test Frequency.

30 to 39 Years						
EAR	WSF	BD	t	WSF	BD	t
	500 cps			1000 cps		
Right	5.75	- 2.00	2.47*	8.91	- 3.00	3.19*
Left	5.57	.60	2.03*	8.33	- 1.20	3.00*
	1500 cps			2000 cps		
Right	8.85	- 3.00	3.85*	10.40	- 4.00	4.04*
Left	10.23	- 1.80	3.36*	10.06	- 1.00	3.57*
	3000 cps			4000 cps		
Right	16.55	6.60	2.20*	22.76	11.80	2.33*
Left	20.92	6.80	3.58*	26.67	14.80	2.55*
	6000 cps					
Right	29.94	29.00	.18			
Left	31.72	30.60	.21			

*A "t" value of 1.98 (df = 110) is required for significance at the 5% level.

TABLE III

Mean Hearing Losses and "t" Scores of Office Workers and School Band Directors, According to Age Group, Ear and Test Frequency.

40 to 49 Years						
EAR	WSF	BD	t	WSF	BD	t
	500 cps			1000 cps		
Right	7.42	.50	1.30	11.36	- .50	2.41*
Left	5.45	1.00	1.15	9.09	2.50	1.58
	1500 cps			2000 cps		
Right	10.23	.50	1.80	13.64	14.00	.05
Left	10.00	2.00	1.68	11.82	13.00	.02
	3000 cps			4000 cps		
Right	23.56	24.50	.13	27.50	29.00	.17
Left	23.33	24.00	.09	27.58	30.00	.04
	6000 cps					
Right	38.86	35.50	.53			
Left	38.71	37.00	.25			

*A "t" value of 1.99 (df = 74) is required for significance at the 5% level.

TABLE III

Mean Hearing Losses and "t" Scores of Office Workers and School Band Directors, According to Age Group, Ear and Test Frequency.

50 to 59 Years						
EAR	WSF	BD	t	WSF	BD	t
	500 cps			1000 cps		
Right	7.34	- 3.00	1.29	12.34	- 4.00	2.09*
Left	10.86	- 3.00	2.52*	14.61	- 6.00	2.26*
	1500 cps			2000 cps		
Right	14.83	- 4.00	3.88*	15.31	1.00	1.78
Left	16.48	- 3.00	2.16*	17.11	1.00	1.83
	3000 cps			4000 cps		
Right	27.81	9.00	5.58*	38.75	16.00	2.33*
Left	35.39	19.00	4.96*	43.75	27.00	5.20*
	6000 cps					
Right	39.30	32.00	.97			
Left	54.53	37.00	4.93*			

*A "t" value of 2.00 (df = 67) is required for significance at the 5% level.

groups were compared to "educated" males of the Wisconsin Hearing Survey. Except for the 40 to 49 year age subgroup at 4000 cps, left and right ears, the "educated" males evidenced significantly more hearing loss than school band directors at the two frequencies tested. (See Table IV)

Mean hearing losses of men with military service and those with no military service are presented for the 20 to 29 year age group in Table V. Such a comparison was feasible only for individuals within this age decade because of the high incidence of subjects with military service in the other age categories. No statistically significant differences in hearing loss were observed between school band directors with military service and those without.

As a measure of central tendency the mean is more sensitive to extreme values and skewness. Despite this limitation means were used because it was desirable to statistically compare this audiological data with that of another study. Medians, however, are generally considered to be more accurate measures of central tendency because of skewness found typically in audiometric data. For this reason a comparison between the median hearing losses in each age group, right and left ears combined, of the Wisconsin State Fair Hearing Survey and the school band directors is presented in Table VI. Only four test frequencies were used in this comparison in order to conform to those presented in the Wisconsin Hearing Survey Monograph. In all instances the median thresholds for school band directors are lower than median threshold values from the Wisconsin data.

TABLE IV

Mean Hearing Losses and "t" Scores of "Educated" Group and School Band Directors, According to Age Group, Ear and Test Frequency.

30 to 39 Years

EAR	WSF	BD	t	WSF	BD	t
	1000 cps			4000 cps		
Right	9.13	-3.00	4.02*	29.86	11.80	3.64*
Left	9.89	-1.20	3.35*	34.12	14.80	3.99*

*A "t" value of 1.97 (df = 334) is required for significance at the 5% level.

40 to 49 Years

EAR	WSF	BD	t	WSF	BD	t
	1000 cps			4000 cps		
Right	14.68	- .50	2.43*	38.19	29.00	1.50
Left	15.11	2.50	2.11*	33.05	30.00	.28

*A "t" value of 1.97 (df = 229) is required for significance at the 5% level.

50 to 59 Years

EAR	WSF	BD	t	WSF	BD	t
	1000 cps			4000 cps		
Right	15.00	-4.00	2.34*	44.80	16.00	2.80*
Left	16.86	-6.00	2.77*	48.92	27.00	2.11*

*A "t" value of 1.97 (df = 183) is required for significance at the 5% level.

TABLE V

Mean Hearing Losses and "t" Scores of School Band Directors 20 to 29 Years of Age Who Had Military Service and No Military Service, According to Ear and Test Frequency.*

EAR	MIL.	NO MIL.	t	MIL.	NO MIL.	t
	500 cps			1000 cps		
Right	- 1.36	.38	.32	-2.27	-3.08	.13
Left	- 3.18	- 2.69	.17	-5.00	-5.38	.12
	1500 cps			2000 cps		
Right	- 4.09	- 5.76	.32	-4.54	-2.69	.35
Left	- 6.36	- 7.30	.36	-5.90	-5.38	.20
	3000 cps			4000 cps		
Right	- .45	2.69	.41	4.09	8.46	.78
Left	1.36	4.23	.83	6.36	9.61	.58
	6000 cps					
Right	11.81	16.15	.73			
Left	17.27	15.38	.31			

*A "t" value of 2.07 (df = 22) is required for significance at the 5% level.

TABLE VI

Median Hearing Losses for Men in Each Age Group of the Wisconsin State Fair Hearing Survey and School Band Directors, Right and Left Ears Combined.*

	AGE							
	20-29		30-39		40-49		50-59	
FREQ.	WSF	BD	WSF	BD	WSF	BD	WSF	BD
500	1.0	- 5.0	2.4	- 5.0	5.4	0	7.3	- 2.5
1000	3.4	-10.0	5.4	- 5.0	9.4	- 5.0	12.2	- 7.5
2000	4.5	- 7.5	7.8	-10.0	12.4	5.0	20.9	- 2.5
4000	13.9	2.5	28.7	7.5	40.8	17.5	52.8	22.5
No. Ears	638	48	694	50	602	20	638	10

*Based on a Table in the 1954 Wisconsin State Fair Hearing Survey Monograph.

CHAPTER IV

DISCUSSION

The results of this study suggest that there is little evidence to support a consistant relationship between occupational noise and hearing loss in this sample of school band directors. Lower thresholds of hearing were demonstrated by school band directors among all age group comparisons with the 1954 Wisconsin State Fair Hearing Survey except the 40 to 49 year old office workers. In addition, median hearing losses were less for band directors at four frequencies than for equivalent subgroups of the Wisconsin Hearing Survey.

The latter difference becomes particularly significant in view of a previous comparison made between the data of the Wisconsin Hearing Survey and results of the 1935-1936 National Health Survey.[41] The authors of the Wisconsin Hearing Survey Monograph state that, with minor exceptions, the two sets of median hearing thresholds are quite similar.[42] The results of the 20 to 29 year National Health Survey were used in the establishment of the American Standard for audiometric zero. As revealed in Table VI, school band directors

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[41] Glorig, et. al., 1954 Wisconsin State Fair Hearing Survey, op. cit., p. 23.

[42] Ibid.

in the 20 to 29 year age group demonstrated thresholds that ranged from 6 db to 13 db lower than the equivalent Wisconsin Hearing Survey subgroup. It appears that the school band director medians for this age group more closely approximate the more stringent British Standard for audiometric zero. Davis and Usher point out that investigations used to establish the British standard indicate results that "came out at levels some 10 db or so below (or more sensitive than) those of the American Standard."[43]

The fact that school band directors evidenced less hearing loss than most of the comparative age groups may be ascribed to a number of factors.

Band directors may be more highly motivated during a hearing test than individuals in the comparative groups. Davis[44], in discussing the differences between the American and British standards for audiometric zero, partially attributes the more rigorous British standard to the use of well motivated subjects. Band directors, by virtue of their profession, may rely more on auditory perception than individuals in dissimilar job categories. It follows, perhaps, that they may be more highly motivated during a test of their hearing acuity. There is some evidence to support a "hyper-

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[43]Davis, Hallowell and Usher, J. Richardson, "What is Zero Hearing Loss", Journal of Speech and Hearing Disorders, Vol. 22, December, 1957, p. 671.

[44]Davis, Hallowell, "For an International Audiometric Zero", ASHA, Vol. 1, October, 1959, p. 47.

concern" for hearing ability among this group of musicians. In the Wisconsin Hearing Survey from 20 to 30 per cent of the members of each age group reported some form of ear pathology. Despite the apparent better hearing of school band directors, the intra-decade percentages of subjects reporting trouble with their ears were higher, from 30 to 48 per cent.

Similarly, it is conceivable that because of their musical training and experience band directors exercise superior ability in discerning tones. The relationship between hearing and listening, the roles of loudness, pitch, discrimination and other factors in auditory experience are cited as research needs by recent investigators in the field of Audiology.[45] Whether the "trained ears" of these musicians constitute an advantage over other occupational groups during hearing tests poses a question that merits investigation.

If the audiometric results of school band directors were evaluated in terms of a more rigorous standard of audiometric zero would the effects of occupational noise be apparent? Some individual results would seem to indicate this possibility. However, only the 40 to 49 year age group reflected hearing losses that appear partially consistant with those of factory workers and there is some evidence that this group of school band directors may have been atypical because of previous noise experience. Seven out of the ten subjects

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[45] Journal of Speech and Hearing Disorders, Monograph Supplement 5, September, 1959, "Report of Subcommittee on Hearing Problems in Adults", p. 57.

within the 40 to 49 year group reported on the Questionnaire that they had worked in "noisy" military and civilian jobs, such as in an aircraft factory, target range duty and as anti-aircraft gunners.

These implications are limited in their conclusiveness by the smallness of the band director age groups. The relationship between occupational noise and hearing loss among these musicians cannot be entirely discounted until more thorough determinations are made utilizing larger samples. Such determinations might include an investigation into the relationship between motivated and unmotivated subjects during a pure tone hearing test, the effect of musical experience on subjects participating in hearing tests and a comparison between hearing losses of band directors and those of a non-noise exposed group.

CHAPTER V

SUMMARY AND CONCLUSIONS

Sixty-four male school band directors were given individual pure tone hearing tests at 500, 1000, 1500, 2000, 3000, 4000 and 6000 cps. The audiometric results were then grouped into the following age categories: 20 to 29, 30 to 39, 40 to 49 and 50 to 59 years. Mean hearing losses of right and left ears within each age group and test frequency were compared to three subgroups of the 1954 Wisconsin State Fair Hearing Survey: A factory worker sample, an office worker sample and a group composed of individuals with at least a ninth grade education. In addition, school band directors with military service and those without military service within the 20 to 29 year age group were evaluated for differences in hearing loss.

The intent of this study was to determine whether the noise to which school band directors are occupationally exposed is associated with loss of hearing acuity.

Within the limits of this study the following conclusions seem warranted: (1) The occupational noise exposure to which school band directors are subjected is not associated with greater hearing loss. (2) Intra-decade comparisons indicate that school band directors have better hearing than factory workers, better hearing than the Wisconsin

Hearing Survey "educated" males, and hearing thresholds that are, in the majority of instances, significantly lower than office workers. (3) No statistically significant differences in hearing loss were found between school band directors who served in the military and those who did not. (4) A noise-loss relationship in school band directors is not indicated by this study. However, certain inconsistancies between the results of these musicians and those of comparative groups, and comparatively high thresholds of certain individual band directors point out the need for a more thorough investigation of the problem, using larger population samples. Additional suggestions for future research include determinations whether these musicians are more motivated during a pure tone hearing test than dissimilar vocational classes and whether school band directors make better use of their hearing acuity for pure tone testing.

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APPENDICES

APPENDIX A

Hearing Survey Questionnaire Which Was Completed by Each School Band Director Participating in the Hearing Tests

HEARING SURVEY QUESTIONNAIRE

1. Name_____
   Last First Initial

2. Address_____
   School City State

3. Age_____ _____
   (Years) (Months)

4. How many hours has it been since you were last exposed to live music or any "intense" sound?_____

5. Estimate the total number of hours per week that you are exposed to live music._____

6. Estimate the total number of weeks per year that you are exposed to live music._____

7. How many years have you been associated with live music in some capacity?_____

8. Have you ever had any trouble with your ears?_____
   If "yes", please check the appropriate space.
   1. Earaches_____
   2. Draining or running ears_____
   3. Injuries_____
   4. Other_____

9. Have you ever had any trouble with your nose or throat? _____. If "yes", please check the appropriate space.
   1. Sore throats_____
   2. Tonsils out_____
   3. Nose operations_____
   4. Frequent colds_____
   5. Other_____

10. Have you ever had any hard blows to your head?_____ If "yes", please check the appropriate space.
    1. Were you unconscious_____
    2. Bleeding from the ears_____
    3. Skull fracture_____
    4. Other_____

11. Does anyone in your family or a close relative have a hearing loss?_____

12. Where have you lived most of your life? On a farm_____. In a town_____.

13. Have you often shot a gun? (Do not include military experience.) Yes_____ No_____
If yes, for what reason?
1. Hunting_____
2. Target Practice_____
3. Contests_____
What weapons? Rifle_____ Shotgun_____ Pistol_____.

14. Do you now drive a:
1. Car_____ Frequently?_____
2. Tractor_____ Frequently?_____
3. Truck_____ Frequently?_____
4. Motorcycle_____ Frequently?_____

15. Have you had Military experience?_____ If so, what branch?_____

16. What noisy occupations have you held within the Military Service, such as Target Range Duty, driving a tank, working in an engine room, etc.

1. _____ (Military job) How long?_____ (Months)
2. _____ (Military job) How long?_____ (Months)
3. _____ (Military job) How long?_____ (Months)

17. Have you ever worked in noisy civilian jobs, such as factories?

1. _____ (Name of job) How long?_____ (Months)
2. _____ (Name of job) How long?_____ (Months)
3. _____ (Name of job) How long?_____ (Months)

18. Have you ever been bothered by head noises? Yes___No___
If yes, do your head noises become apparent after musical practice sessions? Yes_____ No_____

If yes, are these sounds tonal in quality or more like a noise?

Tonal_____ Noise_____

If tonal, can you estimate the frequency?_____

If noise, please describe_____

APPENDIX B

Individual Pure Tone Threshold Results of Sixty-four Montana School Band Directors

20 to 29 Years								
SUBJECT	EAR	500	1000	1500	2000	3000	4000	6000
1	R	25	25	20	30	30	30	30
	L	5	0	- 5	0	0	5	20
2	R	0	- 5	-10	0	5	10	30
	L	- 5	-10	- 5	0	5	20	20
3	R	0	-10	-10	-10	5	0	5
	L	5	- 5	- 5	-10	10	20	30
4	R	-10	-10	-10	-10	- 5	10	15
	L	- 5	-10	-10	-10	0	5	10
5	R	-10	-10	-10	-10	-10	0	10
	L	- 5	-10	-10	-10	-10	- 5	0
6	R	-10	-10	-10	-10	- 5	- 5	15
	L	-10	-10	-10	-10	- 5	- 5	5
7	R	- 5	0	- 5	0	10	10	30
	L	0	10	0	- 5	0	10	55
8	R	0	5	-10	- 5	- 5	0	10
	L	- 5	-10	-10	-10	0	0	10
9	R	- 5	-10	- 5	- 5	15	40	45
	L	10	0	0	- 5	10	20	50
10	R	- 5	- 5	-10	-10	-10	0	20
	L	-10	-10	-10	-10	-10	- 5	35
11	R	-10	-10	- 5	-10	0	0	5
	L	-10	- 5	-10	0	5	10	20

20 to 29 Years								
SUBJECT	EAR	500	1000	1500	2000	3000	4000	6000
12	R	- 5	-10	-10	- 5	0	-10	5
	L	-10	-10	-10	0	15	5	10
13	R	0	0	- 5	- 5	- 5	- 5	10
	L	0	- 5	-10	- 5	5	5	10
14	R	- 5	- 5	-10	-10	-10	- 5	0
	L	-10	-10	-10	-10	0	0	- 5
15	R	-10	0	- 5	0	0	5	10
	L	- 5	5	5	5	0	10	10
16	R	- 5	- 5	- 5	- 5	- 5	0	15
	L	-10	-10	-10	-10	- 5	- 5	5
17	R	0	-10	-10	-10	-10	0	0
	L	0	-10	-10	- 5	5	10	5
18	R	-10	-10	-10	-10	0	0	0
	L	- 5	-10	-10	- 5	0	5	10
19	R	5	-10	-10	-10	- 5	10	5
	L	0	-10	-10	-10	- 5	-10	10
20	R	- 5	-10	- 5	- 5	-10	- 5	-10
	L	-10	-10	-10	- 5	0	10	10
21	R	5	- 5	-10	- 5	20	25	45
	L	5	- 5	-10	-10	30	55	15
22	R	50	55	45	40	40	35	30
	L	15	15	15	10	20	25	25

20 to 29 Years								
SUBJECT	EAR	500	1000	1500	2000	3000	4000	6000
23	R	0	-10	-10	-10	- 5	- 5	0
	L	- 5	-10	-10	-10	- 5	0	10
24	R	0	- 5	-10	-10	0	15	15
	L	- 5	5	-10	-10	5	10	20

30 to 39 Years								
SUBJECT	EAR	500	1000	1500	2000	3000	4000	6000
1	R	- 5	-10	-10	-10	5	0	10
	L	-10	-10	-10	- 5	-10	5	10
2	R	5	0	- 5	-10	15	15	25
	L	10	0	- 5	-10	0	10	30
3	R	- 5	0	5	- 5	-10	0	20
	L	5	- 5	- 5	-10	-10	5	45
4	R	5	0	- 5	-10	- 5	0	5
	L	0	-10	-10	-10	0	5	5
5	R	10	30	45	35	55	60	60
	L	15	25	25	35	50	55	60
6	R	- 5	-10	-10	- 5	40	20	80
	L	- 5	-10	-10	- 5	0	10	20
7	R	10	0	- 5	-10	0	25	25
	L	5	-10	-10	-10	-10	25	- 5
8	R	- 5	5	-10	-10	0	0	20
	L	0	0	0	5	20	20	30
9	R	- 5	-10	-10	-10	0	- 5	15
	L	- 5	- 5	-10	-10	0	0	20
10	R	- 5	-10	-10	-10	- 5	-10	5
	L	- 5	-10	-10	-10	- 5	5	5
11	R	0	-10	-10	-10	- 5	-10	20
	L	0	-10	-10	0	5	- 5	20

30 to 39 Years								
SUBJECT	EAR	500	1000	1500	2000	3000	4000	6000
12	R	0	0	-10	- 5	0	35	95
	L	10	5	-10	- 5	0	15	95
13	R	- 5	-10	0	-10	25	35	30
	L	- 5	-10	-10	-10	20	10	40
14	R	-10	-10	-10	-10	0	10	30
	L	- 5	-10	-10	-10	5	15	40
15	R	5	- 5	- 5	- 5	5	5	60
	L	0	0	0	-10	- 5	30	15
16	R	- 5	-10	0	-10	5	45	50
	L	- 5	- 5	- 5	-10	5	25	15
17	R	- 5	- 5	- 5	0	15	0	20
	L	-10	0	10	10	25	20	25
18	R	0	0	- 5	-10	20	50	40
	L	- 5	0	-10	- 5	0	20	20
19	R	0	- 5	- 5	-10	- 5	10	55
	L	0	- 5	-10	-10	0	5	40
20	R	- 5	- 5	- 5	- 5	0	0	10
	L	- 5	-10	-10	-10	0	5	10
21	R	0	10	5	15	5	15	25
	L	15	25	30	25	45	45	80
22	R	- 5	- 5	- 5	- 5	-10	- 5	10
	L	-10	- 5	-10	- 5	- 5	- 5	25

30 to 39 Years								
SUBJECT	EAR	500	1000	1500	2000	3000	4000	6000
23	R	- 5	-10	-10	5	0	-10	10
	L	0	-10	-10	-10	0	-10	15
24	R	-10	5	15	15	10	5	0
	L	-10	10	15	20	0	0	5
25	R	- 5	-10	-10	-10	5	5	5
	L	35	35	40	45	45	60	100

40 to 49 Years								
SUBJECT	EAR	500	1000	1500	2000	3000	4000	6000
1	R	0	- 5	-10	-10	0	10	15
	L	0	-10	-10	- 5	0	5	30
2	R	- 5	- 5	-10	15	35	45	50
	L	0	5	10	20	50	55	65
3	R	5	0	10	55	65	65	60
	L	0	- 5	- 5	25	55	50	35
4	R	- 5	- 5	-10	- 5	10	5	15
	L	- 5	0	-10	0	10	25	-10
5	R	- 5	0	5	10	20	10	10
	L	- 5	0	0	15	20	20	35
6	R	10	35	40	65	60	75	80
	L	15	35	40	45	50	65	70
7	R	0	- 5	- 5	25	45	55	65
	L	10	5	10	40	60	60	75
8	R	0	-10	0	0	20	10	30
	L	0	5	5	10	5	10	40
9	R	0	- 5	- 5	- 5	0	10	20
	L	- 5	- 5	-10	-10	0	10	20
10	R	5	- 5	-10	-10	-10	5	10
	L	0	- 5	-10	-10	-10	0	10

50 to 59 Years								
SUBJECT	EAR	500	1000	1500	2000	3000	4000	6000
1	R	5	0	- 5	- 5	- 5	5	10
	L	0	-10	0	0	5	5	10
2	R	5	0	5	5	5	15	55
	L	5	5	5	10	35	55	75
3	R	- 5	- 5	0	20	40	15	20
	L	0	- 5	0	5	25	30	15
4	R	-10	- 5	-10	- 5	10	35	45
	L	-10	-10	-10	0	35	35	45
5	R	-10	-10	-10	-10	- 5	10	30
	L	-10	-10	-10	-10	- 5	10	40