NAVAL SUBMARINE MEDICAL CENTER
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

MEMORANDUM REPORT 70-2

TENTATIVE AUDIOMETRIC HEARING THRESHOLD LEVEL STANDARDS FROM 8 THROUGH 18 KILOHERTZ

MF12.524.004-9010D09

11 February 1970

Investigator
J. Donald Harris
and
Cecil K. Myers

Submitted by:

J. Donald Harris
Head, Auditory Research Branch

Reviewed and Approved by:

Charles F. Gell, M.D., D.Sci. (Med)
Scientific Director
SubMedResLab

Reviewed and Approved by:

J. D. Bloom, CDR MC USN
Director
SubMedResLab

Approved and Released by:

J. E. Stark
Captain, MC U.S. Navy
COMMANDING OFFICER, SUBMEDCEN

SUMMARY PAGE

THE PROBLEM

To standardize an audiometric test in the octave 10-20 kiloHertz to relate to U.S. Navy selection procedures.

FINDINGS

Suggested standards are presented for the frequencies 8, 9, 10, 11, 12, 13, 14, 15, 16, 18 kiloHertz for a sample of 100 young healthy men in the U.S. Naval Submarine Service.

APPLICATION

For the use of otologists, audiologists, and personnel selection groups interested in the use of high-frequency audiometry as an index of early damage to the ear due to noise, disease, etc.; and those groups interested in selecting individuals in the Navy who are especially acute in the highest audible octave.

ADMINISTRATIVE INFORMATION

This investigation was conducted as a part of Bureau of Medicine and Surgery Research Work Unit MF12.524.004-9010D - Optimization of Auditory Performance in Submarines. The manuscript for the present report was approved for publication on 11 February 1970, and designated as Memorandum Report No. 70-2. The present report is No. 9 on this Work Unit.

PUBLISHED BY THE NAVAL SUBMARINE MEDICAL CENTER

ABSTRACT

Both ears of 100 young healthy candidates for Submarine Service, aged 17-23 years, normal by otoscopy but otherwise unselected, were given Bekesy-type audiometry through 18 kiloHertz. Minimum audible pressures were obtained comparable to those from a published study on adolescent males; there is also correspondence with the British Standard for young adults up to 15 kiloHertz. It is suggested that the time is approaching for standardizing audiometry in the octave 10-20 kiloHertz using all available data.

TENTATIVE AUDIOMETRIC HEARING THRESHOLD LEVEL STANDARDS FROM 8 THROUGH 18 KILOHERTZ

I. INTRODUCTION

In a recent comparison[1] of seven systems for determining absolute hearing thresholds, either minimum audible fields (MAF) using loudspeakers, or minimum audible pressures (MAP) using earphones, it was found that any of several systems could yield acceptably reliable and valid data, though preference could be given to some systems over others.

Of the MAP systems used, the preferable was the TRACOR, Inc., unit developed by Dr. Wayne Rudmose, a Bekesy-type fixed-frequency audiometer with the additional restriction applied here that the earphone should not be held in the hand by S but should be more rigidly coupled to the ear with a headband and a universal-joint mounting.

The subjects for these comparisons were trained laboratory observers, with some mild hearing losses represented, and could not for either of these reasons serve in any way as a standardizing group for a population of young, healthy and audiometrically-naive men. This study reports initial data on the Rudmose audiometer for a group of 100 otoscopically normal young sailors.

II. METHOD

Subjects. Of the first 111 generally healthy sailors referred to this facility for hearing testing in connection with a long-range study of the effects of submarine duty on hearing and other bodily variables, eleven were not otoscopically normal or were in need of ear wax removal. Results for the remaining subjects (200 ears) are summarized here. Tbe model age was 21 years, range 17-23 years.

Workspace and Apparatus. S sat in an anechoic chamber of 13,392 cu. ft. with the earphone fitted to the ear, and held the audiometer's microswitch in his hand. The audiometer provides tones of 4 - 18 kHz in 1-kHz steps, omitting 17 kHz. An interrupted tone is on for 30 sec while S traces his threshold, then it automatically steps to the next higher frequency. The transducer is actually a high quality microphone, with a small cylindrical horn fitted with an olive for coupling to the ear canal. We constructed locally a light headband with two small universal joints allowing E and S together to position the olive in the canal.

In calibration, the audiometer is set to maximum output and the tip of the cylindrical horn attached to the earphone is made to look directly into the faceplate of a Bruel and Kjaer 1/4-inch microphone, the two spaced 1/32 inch apart. Table 1 gives the SPL at "0" on the audiometer card for this particular unit by this calibration procedure.

Procedure. Ss had previously had a group audiometer examination by the tone-burst technique covering the range 0.5 - 8 kHz, but had had no experience with high-frequency audiometry. Some had had experience with tracking audiometry at Armed Forced Examination Stations. They were taken one by one into the anechoic room and given verbal instructions as to the use of the handswitch and as to the criterion of audibility for the pulsed tones. Both men cooperated in fixing the olive firmly and yet comfortably in the meatus, where it remained untouched while that ear was being tested. Right and Left ears were counterbalanced across Ss. Each S was given a practice of 2 min (4-9 kHz) and the traced thresholds watched carefully by E. In case S needed more practice he would have been given it.

III. RESULTS AND DISCUSSION

Average thresholds are in Table 1 and are plotted in Figure 1. Variability is also entered in Table 1 and in Figures 2-3.

The distributions of acuity in Figures 2-3 leave no doubt that such thresholds are essentially normally distributed, with a few cases of real hearing loss represented. A check of the median thresholds in Table 1 shows good correspondence within a few dB with the mean thresholds; however, because of the slight skew of the distributions of Figures 2-3 on the hearing loss side, the median is the preferable measure.

The first frequency upwards from 8 kHz of which the mean is different on a statistically significant basis from that of 8 kHz is 13 kHz, at which frequency the thresholds rapidly deteriorate.

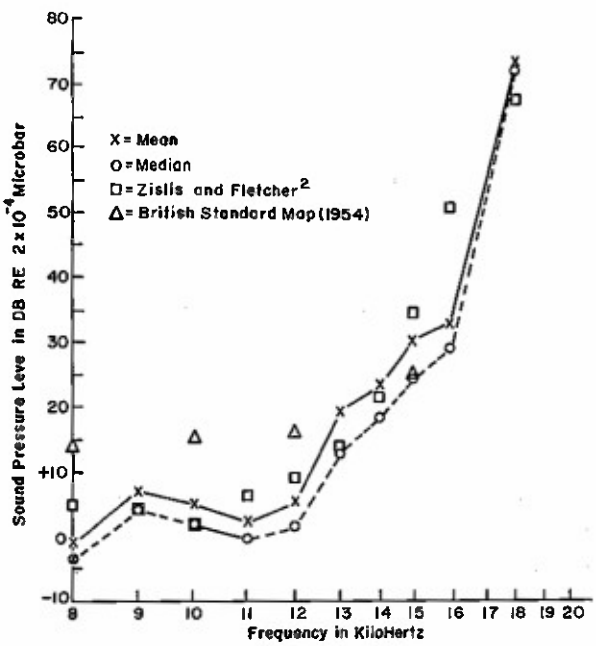

Fig. 1: Average thresholds in SPL compared with two previous studies.

TABLE 1: SOUND PRESSURE LEVEL AT "0" ON THE TRACOR, Inc. BEKESY HIGH-FREQUENCY AUDIOMETER, TOGETHER WITH THRESHOLDS FOR 100 YOUNG MEN

	Frequency in KiloHertz									
	8	9	10	11	12	13	14	15	16	18
SPL at "0"	-5.5	7.0	-0.3	-4.5	-5.0	2.6	1.4	5.0	5.3	26.5
Mean Threshold in SPL	-0.28	7.42	5.45	2.73	6.30	19.25	23.92	30.65	33.55	74.15
Standard $Error_{Mn}$	0.94	0.96	0.90	0.99	1.11	1.47	1.53	1.71	1.76	1.55
Median Threshold in SPL	-3.0	4.7	2.2	0.0	2.0	13.1	18.1	24.5	29.0	72.5

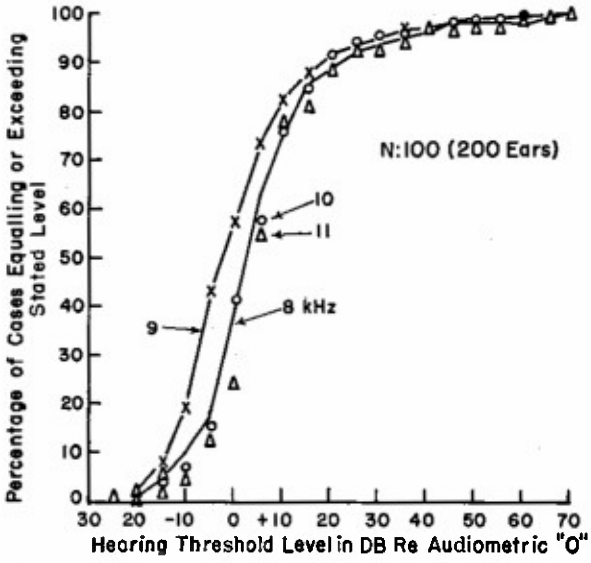

Fig. 2: Cumulative distributions of thresholds for the frequencies 8-11 kiloHertz

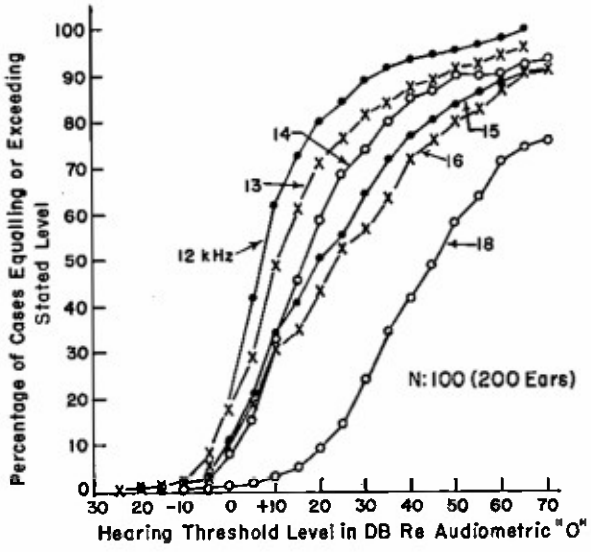

Fig. 3: Cumulative distributions of thresholds for the frequencies 12-18 kiloHertz

These data can best be compared with those from a group of 30 males (60 ears) aged 11-18 years, given tests with the same type of audiometer[2]. Figure 1 compares the two sets of medians. The correspondence is rather close as to the form of the curve, with an unexplained discrepancy of about 20 dB at 16 kHz. These data are also not greatly different from the British 1954 Standard Monaural Minimal Audible Pressure (MAP) based largely on the work of Dadson and King[3] through 15 kHz. It would seem that some standardization may be nearer than would have been deemed possible a few years ago. The present data are offered as another step in that direction.

IV. SUMMARY

Both ears of 100 young healthy candidates for Submarine Service, aged 17-23 years, normal by otoscopy but otherwise unselected, were given Bekesy-type audiometry through 18 kHz. Minimum audible pressures were obtained comparable to those from a published study on adolescent males; there is also correspondence with the British Standard for young adults up to 15 kHz. It is suggested that the time is approaching for standardizing audiometry in the octave 10-20 kHz using all available data.

REFERENCES

1. Myers, C.K., and Harris, J.D. Comparison of seven systems for air conduction audiometry from 8 - 20 kc/s. USN SubMedCen Report No. 567, 18 Feb 1969.

2. Zislis, T., and Fletcher, J.L. Relation of high frequency threshold to age and sex. J. Audit. Res., Vol. 6, 189-198, 1966.

3. Dadson, R.S., and King, J.H. A determination of the normal threshold of hearing and its relation to the standardization of audiometers. J. Laryngol. Otol., 66, 366-378, 1952.

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)
NAVAL SUBMARINE MEDICAL CENTER, Submarine Medical Research Laboratory

2a. REPORT SECURITY CLASSIFICATION
UNCLASSIFIED

2b. GROUP

3. REPORT TITLE
TENTATIVE AUDIOMETRIC HEARING THRESHOLD LEVEL STANDARDS FROM 8 THROUGH 18 KILOHERTZ

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Interim Report

5. AUTHOR(S) (First name, middle initial, last name)
J. Donald HARRIS and Cecil K. MYERS

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
11 February 1970	2	3

8a. CONTRACT OR GRANT NO.

b. PROJECT NO.
MF12.524.004-9010D.09

c.

d.

9a. ORIGINATOR'S REPORT NUMBER(S)
SMRL Memo Report No. 70-2

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. DISTRIBUTION STATEMENT
This document has been approved for public release and sale; its distribution is unlimited.

11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY
Naval Submarine Medical Center
Box 600 Naval Submarine Base New London
Groton, Connecticut 06340

13. ABSTRACT

Both ears of 100 young healthy candidates for Submarine Service, aged 17-23 years, normal by otoscopy but otherwise unselected, were given Bekesy-type audiometry through 18 kiloHertz. Minimum audible pressures in the ear canal were obtained comparable to those from a published study on adolescent males; there is also correspondence with the British 1954 Standard for young adults up to 15 kiloHertz. It is suggested that the time is approaching for International Standardizing of audiometry in the octave 10-20 kiloHertz using all available data.

DD FORM 1 NOV 65 1473 (PAGE 1)

S/N 0101-807-6801

UNCLASSIFIED

Security Classification

3ND PPSO 13152

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Audiometry						
Audiometric hearing threshold						
Hearing testing						
Submarine duty, effects on hearing						