

AD-779 144

TEST-RETEST AUDIOMETRIC RELIABILITY  
IN UNSELECTED SAMPLES OF ARMY  
PERSONNEL

George A. Luz, et al

Army Medical Research Laboratory

Prepared for:

Army Medical Research and Development  
Command

13 December 1973

DISTRIBUTED BY:

**NTIS**

National Technical Information Service  
U. S. DEPARTMENT OF COMMERCE  
5285 Port Royal Road, Springfield Va. 22151

DISPOSITION

Destroy this report when no longer needed.  
Do not return it to the originator.

---

Citation of specific commercial equipment, materials, or trade names in this report does not constitute an official endorsement or approval of the use of such commercial products.



UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 1,075	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER <b>AD-779 144</b>
4. TITLE (and Subtitle) <b>TEST-RETEST AUDIOMETRIC RELIABILITY IN UNSELECTED SAMPLES OF ARMY PERSONNEL</b>		5. TYPE OF REPORT & PERIOD COVERED <b>Final</b>
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) <b>CPT George A. Luz, MS (Ph.D.) and Michel Loeb, Ph.D.*</b>		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS <b>SGRD-UK US Army Medical Research Laboratory Fort Knox, Kentucky 40121</b>		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS <b>61102A 3A161102B71P 08 089**</b>
11. CONTROLLING OFFICE NAME AND ADDRESS <b>SGRD US Army Medical Research and Development Command Washington, D. C. 20314</b>		12. REPORT DATE <b>13 December 1973</b>
		13. NUMBER OF PAGES <b>11</b>
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) <b>UNCLASSIFIED</b>
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) <b>Approved for public release; distribution unlimited.</b>		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES <b>*University of Louisville, Louisville, Kentucky 40208. **work unit terminated 30 June 1973.</b>		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) <b>Hearing Loss Noise Audiology Audiometry Ear</b> <p style="text-align: center;">Reproduced by NATIONAL TECHNICAL INFORMATION SERVICE U S Department of Commerce Springfield VA 22151</p>		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) <p>The objective of this study was to determine audiometric reliability in two unselected samples of Army personnel. A mobile audiometric laboratory was used to test and retest the hearing of protected basic combat trainees before and after firing a machine gun and of tank mechanics before and after a weekend of rest. Air conduction audiograms were used. Audiometric reliability was high in both groups, leading to the conclusion that a previous report of low audiometric reliability in individuals tested before and after basic combat</p> <p style="text-align: right;">(cont)</p>		

DD FORM 1 JAN 73 1473

EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

Block Number 20 (cont)

training-advanced individual training should probably be interpreted as resulting from permanent, noise-induced changes in auditory sensitivity.

AD \_\_\_\_\_

REPORT NO. 1,075

TEST-RETEST AUDIOMETRIC RELIABILITY IN  
UNSELECTED SAMPLES OF ARMY PERSONNEL

(Final Report)

by

CPT George A. Luz, MSC (Ph.D.)<sup>†</sup>  
and  
Michel Loeb, Ph.D.\*

US ARMY MEDICAL RESEARCH LABORATORY  
Fort Knox, Kentucky 40121

\*UNIVERSITY OF LOUISVILLE  
Louisville, Kentucky 40208

13 December 1973

Military Performance:  
Auditory Perception and Psychophysics  
Work Unit No. 089<sup>††</sup>  
Physiology  
Task No. 08  
Basic Research in Support of Military Medicine  
DA Project No. 3A161102B71P

<sup>†</sup>Present address:

Officer Student Battalion, Academy of Health Sciences, USA,  
Fort Sam Houston, Texas 78234

<sup>††</sup>Work Unit terminated 30 June 1973.

Approved for public release; distribution unlimited.

USAMRL REPORT NO. 1,075  
DA PROJECT NO. 3A161102B71P

ABSTRACT

TEST-RETEST AUDIOMETRIC RELIABILITY IN  
UNSELECTED SAMPLES OF ARMY PERSONNEL

OBJECTIVE

To determine audiometric reliability in two unselected samples of Army personnel.

METHOD

A mobile audiometric laboratory was used to test and retest the hearing of protected basic combat trainees before and after firing a machine gun and of tank mechanics before and after a weekend of rest. Air conduction audiograms were used.

CONCLUSION

Audiometric reliability was high in both groups, leading to the conclusion that a previous report of low audiometric reliability in individuals tested before and after basic combat training-advanced individual training should probably be interpreted as resulting from permanent, noise-induced changes in auditory sensitivity.

## TEST-RETEST AUDIOMETRIC RELIABILITY IN UNSELECTED SAMPLES OF ARMY PERSONNEL

### INTRODUCTION

Evidence from cross-sectional audiometric studies of Army personnel has indicated an increase in the incidence of premature hearing loss over the past 15 years (1,2). In order to isolate some of the factors underlying this increase, a series of studies was initiated on the hearing of new trainees. The present study is part of this series. Other reports in the series are Loeb, Luz, Sheidler, and Vanderhei (3), Luz and Loeb (4), Loeb, Cameron, G. Luz, S. Luz, and Vanderhei (5), and Luz, Decatur, and Thompson (6).

The current study--a report on audiometric reliability--was conducted to answer questions raised by Luz and Loeb (4). In that report, the audiograms of trainees measured at the end of advanced individual training were compared with ones that had been measured for the same individuals prior to the beginning of basic combat training. Two different samples were studied: (1) individuals retested at their original post with the same equipment being used for both audiograms and (2) individuals retested at other posts with different equipment used for the two audiograms. The results--indicating that audiometric reliability was uniformly higher for the latter group--were unexpected and contrary to common sense. Thus, these results were interpreted as due to some uncontrolled variable.

The source of the uncontrolled variable seemed to be the sampling procedure. For the sample tested and retested at the original post, nearly all of the individuals were recovered. Efforts were made to seek out reluctant testees and bring them to the test site. In contrast, the sample tested at two different posts represented only a third of the individuals known to be available. The group of individuals was comprised of men who obeyed a written letter-request urging them to report to the post audiologist for testing.

The observation of the differences in test-retest reliability between these two samples led to the formulation of two explanatory hypotheses: (1) Individuals who heeded the letter-request tended to be the more intelligent individuals and more adept at taking audiometric examinations. For this reason, they showed higher audiometric reliability than did the more complete sample. (2) Individuals who heeded the letter-request tended to be the more likely to observe safety regulations. As a result, these individuals suffered less hearing loss during training and, consequently, showed higher audiometric reliability. Although there was no clear way to decide between these hypotheses, there was some slight evidence in favor of the second; the more select sample showed generally smaller (and less significant) decrements in the group mean audiogram than did the more complete sample.

The issue raised by the first hypothesis--that unselected samples of Army personnel may lead to lower reliability of audiometric examinations--seemed worth pursuing. If this is the case, then the recommended programs in audiometric screening for noise-exposed Army personnel (7) would be of little value (8). For this reason, audiometric reliability was studied in two unselected samples of Army personnel exposed to noise. The spacing between test and retest was shorter than that reported in the 16 week study of trainees conducted by Luz and Loeb (4) and little change in auditory acuity was expected to occur during the period.

#### SAMPLE I: BASIC TRAINEES PROTECTED BY EARPLUGS

Methods and Material. The 42 men comprising the first sample were drawn from three different companies of basic trainees. Only their right ears were tested. The first audiograms were taken in the morning prior to any noise exposure. The second audiograms were taken in the late afternoon about an hour after their last exposure. Subjects (Ss) were warned that they would be retested and were advised to wear earplugs during the day.

Exposures during the day consisted of one firing of a shoulder-held missile, practice firing of a machine gun and, finally, a rapid-fire course involving sporadic firing of the M-16 rifle. Since this exposure came near the end of the training cycle, the Ss' ears had been exposed to many other impulsive noises in the weeks before this exposure.

Testing was conducted with one of three audiometers: a Maico manual (H1), an ARJ-4, or an ARJ-5 automatic audiometer from which thresholds at 1000, 2000, 3000, 4000, and 6000 Hz were obtained and converted to the standard of ISO (1964). These audiometers were housed in a trailer van insulated with sound-absorbing materials. Measurements of sound levels inside the van indicated that noise levels were acceptable at all test frequencies except 1000 Hz where the provisions of TB Med 251 (7) were exceeded by 9 dB. Testing was carried out by a registered nurse and a college-educated technician. Both had received on-the-job training in audiometry.

Results. Although mean threshold shifts of 1 to 3 dB were observed for the various test frequencies (Fig. 1), none of these differences reached statistical significance when tested with a paired comparison test. Product-moment correlation coefficients calculated for each frequency ranged from a high of .92 for thresholds at 4 kHz to a low of .75 for 1 kHz. The other reliability coefficients were .87 at 2 kHz, .85 at 3 kHz, and .86 at 6 kHz.

Discussion. The reliability coefficients calculated on this unselected sample of 42 trainees were much higher than those calculated for the two samples of basic trainees reported by Luz and Loeb (4). Of these three samples, reliability was lowest for the sample of 96 trainees who had been tested prior to basic training and retested with the

same equipment after advanced individual training. Reliability coefficients for threshold measurements on this group ranged between .15 and .44 over the 1 to 6 kHz region. Since the equipment and method of sampling were the same for both the current group of 42 Ss and the former group of 96 Ss, the lowered reliability could appear to be due to the greater amount of time intervening between the test and retest for the former group of 96 Ss. During this time, significant changes in hearing acuity were undoubtedly occurring, thus, changing audiometric reliability.

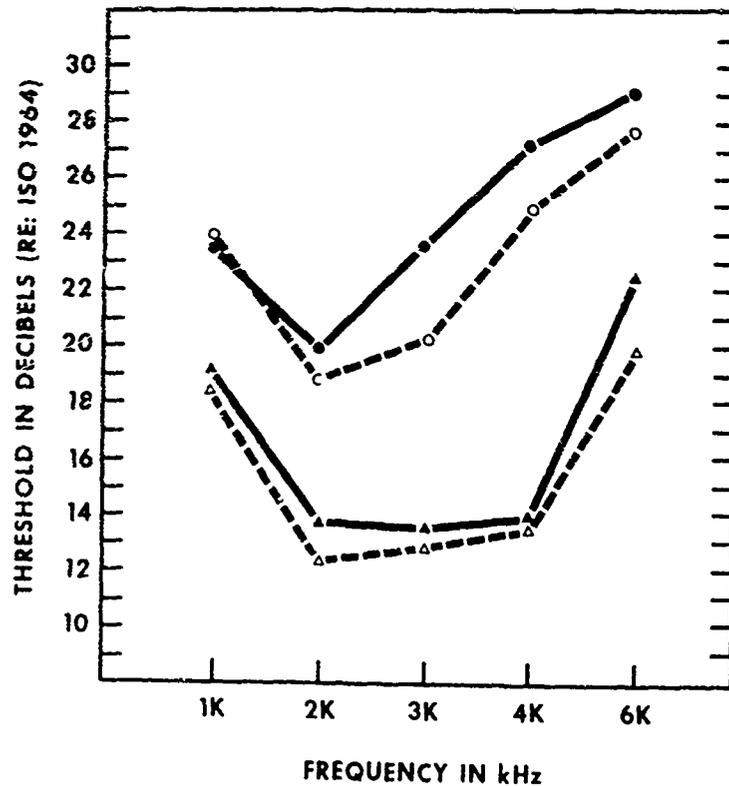


Fig. 1. Average thresholds for 42 Army trainees before a day of firing (open triangles) and after a day of firing (closed triangles) and for 29 tank mechanics before a week of work (open circles) and at the close of a week of work (closed circles).

#### SAMPLE II: TRAINED TANK MECHANICS

Methods and Material. The 29 men comprising the second sample were working as tank mechanics. Their ages ranged between 18 and 41 years with a median age of 22. Only two men were older than 30 years. The sample comprised the entire work force of a high-status tank repair shop.

Testing was conducted in the same van as for the previous samples. Only the Maico manual audiometer was used. Thresholds for the right ear were obtained at 1, 2, 3, 4, and 6 kHz by a registered nurse with on-the-job training in audiometry.

Because there was reason to believe that some of the men were failing to utilize available ear protection during the testing of diesel engines, audiograms were taken both before and after the weekend. The first audiograms were taken before the weekend, the second after, the third before, and the fourth after the weekend.

Results. Six product-moment correlation coefficients were calculated for each frequency tested (Table 1). As in Sample I, the highest coefficient--.90--was observed for 4 kHz (range of .79 to .90) with the other two high frequencies falling close behind (range of .77 to .88 for 6 kHz and .80 to .86 for 3 kHz). The coefficients for the lower frequencies tended to be smaller (range of .51 to .73 for 2 kHz and .54 to .76 for 1 kHz).

TABLE 1

Test-Retest Reliability of Mechanics on Four Consecutive Audiograms

Frequency	Comparison Being Made					
	1 vs 2	1 vs 3	1 vs 4	2 vs 3	2 vs 4	3 vs 4
1000 Hz	.54	.75	.69	.72	.70	.76
2000 Hz	.55	.64	.51	.62	.73	.64
3000 Hz	.80	.84	.82	.83	.86	.81
4000 Hz	.79	.84	.89	.87	.90	.86
6000 Hz	.80	.82	.79	.88	.77	.83

The mean thresholds before the weekend were somewhat higher than those after the weekend. The largest increase in sensitivity was 3.5 dB at 3 kHz. However, none of these threshold shifts were significant when individually analyzed by paired comparison tests.

Discussion. The range of coefficients for Sample II (.54 to .90) was somewhat lower than the range for Sample I (.76 to .92) but still much above the range for the complete sample of basic trainees (.15 to .44) reported by Luz and Loeb (4). For four of the frequencies--2, 3, 4, and 6 kHz--the range of coefficients for Sample II also exceeded the coefficients from the more reliable sample of Luz and Loeb (4). In view of the high audiometric reliability for these two unselected groups of personnel, it may be concluded that Army personnel have the necessary skills to take audiometric examinations. Thus, the low test-retest reliability seen after exposure to the noise of basic and advanced individual training would appear to be symptomatic of permanent changes in hearing acuity.

## LITERATURE CITED

1. Fletcher, J. L. and L. N. Solomon. A survey of hearing losses among Armor personnel. USAMRL Report No. 282, 1956 (DDC AD No. 119674).
2. Walden, B. E., D. W. Worthington, and H. W. McCurdy. The extent of hearing loss in the Army: A survey report. Walter Reed General Hospital, 1971.
3. Loeb, M., G. Luz, D. Sheidler, and S. Vanderhei. Assessment of auditory acuity, ear protection, and prediction of hearing loss in military personnel. Technical Report No. 73-1, Psychology Department and Performance Research Laboratory, University of Louisville, 1973.
4. Luz, G. and M. Loeb. Longitudinal studies of the hearing of trainees: A feasibility study. USAMRL Report No. 1,046, 1973 (DDC AD No. 766403).
5. Loeb, M., P. D. Cameron, G. Luz, S. Luz, and S. Vanderhei. Assessment of hazard posed by training to military personnel wearing ear protection and its relationship to questionnaire responses. Technical Report No. 73-2, Psychology Department and Performance Research Laboratory, University of Louisville, 1973.
6. Luz, G., R. Decatur, and R. Thompson. Psychological factors related to the voluntary use of hearing protection in hazardous noise environments. USAMRL Report No. 1,066, 1973.
7. TB Med 251. Noise and conservation of hearing. Headquarters, Department of the Army, 7 March 1972.
8. Botsford, J. H. The medical monitoring myth. Sound and Vibration, 4: 11, 1970.