AN INVESTIGATION OF AGE AS A FACTOR IN THE TESTING OF ADULTS WITH THE CID AUDITORY TEST W-22

Thesis for the Degree of M. A.

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ABSTRACT

AN INVESTIGATION OF AGE AS A FACTOR IN THE TESTING OF ADULTS WITH THE CID AUDITORY TEST W-22

by Margaret Bramble

The purpose of this study is to analyze the speech discrimination ability of adults within seven age levels as measured by the CID Auditory Test W-22.

The subjects for this study were eighty-four adults between the ages of sixteen and fifty. Each listened to one of the following word lists (1-C, 2-C, 3-C, 4-C, 1-D, 2-D, 3-D, 4-D, 1-F, 2-F, 3-F, 4-F) from the standardized recordings of the CID Auditory Test W-22 presented at 50 decibels (re: 0.002 dyne/cm^2). Tests were administered individually with responses recorded on prepared answer sheets.

An analysis of variance indicates that there is no significant variation among age groups at the five per cent level of confidence. There is no systematic change in means or in deviation from the means as age increases.

Based on these findings, the following conclusion is made. Age is not a factor in testing the speech discrimination ability of adults sixteen to fifty with the CID Auditory Test W-22.

Every group of adults in this study performed better than did any group of children tested by Nielsen[1] or McNamee[2] with the CID Auditory Test W-22. Some possible reasons for the difference in scores are degree of neurological development, amount of listening experience, familiarity with vocabulary, and differences in testing procedure.

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[1]Karen Nielsen, "Speech Sound Discrimination of Pre-School Children as Measured by the CID Auditory Test W-22" (unpublished Master's dissertation, Department of Speech, Michigan State University, 1961).

[2]Joan McNamee, "An Investigation of the Use of the CID Auditory Test W-22 with Children" (unpublished Master's dissertation, Department of Speech, Ohio State University, 1960).

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By

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CHAPTER I

STATEMENT OF THE PROBLEM

Introduction

In the past twenty-five years the use of speech reception tests has greatly increased. They have not replaced pure tone tests but have served as an adjunct to them. As a valid estimate of day-to-day hearing they give a diagnosis and prognosis not given by pure tone tests.[1]

Speech reception tests are of two types: (1) tests determining the threshold of intelligibility and (2) speech discrimination tests. The speech discrimination tests measure the ability of a subject to correctly hear speech sounds presented at sufficient intensity so that intensity itself is not a factor in scoring.[2]

This paper is concerned with speech discrimination testing. Specifically it deals with the CID Auditory Test W-22. Age as a factor affecting test scores will be the focus.

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[1]Oscar Ferrer, "Speech Audiometry: A Discrimination Test for Spanish Language," Laryngoscope, 70 (1960), 1541-1542.

[2]Leland A. Watson and Thomas Tolan, Hearing Tests and Hearing Instruments (Baltimore: The Williams and Wilkins Company, 1949), 439.

Statement of Problem and Purpose of Study

Presbycusis is a term long used to describe the hearing loss associated with aging. This appears to be a rather complicated relationship which at present is not completely understood. Some studies exploring the dimensions of presbycusis have been presented in the past ten years. These have tested several types of population, mainly with pure tone audiometry.

The report of the 1954 Wisconsin State Fair Hearing Survey supports the idea that there is a difference in test results between the various ages of adults with pure tone audiometry.[3] Young adults were shown to yield better thresholds than were a less select group of normal subjects drawn from the population at large.[4]

J. F. Corso recently completed a ten year study on adults eighteen to sixty-five. This group was carefully screened to eliminate those individuals with excessive noise exposure and physical illnesses or defects affecting hearing. Results showed a decrease in hearing sensitivity

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[3]Aram Glorig, "Some Medical Implications of the 1954 Wisconsin State Fair Hearing Survey," American Academy of Ophthamology and Otolaryngology, 61 (1957), 160-171.

[4]James F. Jerger et al., "Some Relations Between Normal Hearing for Pure Tones and for Speech," Journal of Speech and Hearing Research, 2 (1959), 126-140.

with increasing age. The loss was progressive, spreading from the higher to the lower frequencies.[5]

Aram Glorig and Hallowell Davis report similar results after testing a group of men with no noise exposure.[6]

These changes in hearing threshold occur concomitantly with changes in the ability to discriminate speech. However these two changes are not isomorphic. In older individuals the discrimination of speech may be poor and the hearing loss mild.[7]

Little research can be found concerning the effect of aging on speech discrimination.

Age was not considered in the original testing of the CID Auditory Test W-22. Ira J. Hirsh et al. presented the results of testing normal hearing adults. At 80 db the average score was 98%.[8]

In a study by McNamee, school children were given the CID Auditory Test W-22 at 50 db. Average scores ranged

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[5]J. F. Corso, "Age and Sex Difference in Puretone Thresholds," A.M.A. Archives of Otolaryngology, 77 (April, 1963), 385.

[6]Aram Glorig and Hallowell Davis, "Age, Noise and Hearing Loss," Annals of Otology, Rhinology, Laryngology, 70 (June, 1961), 556-571.

[7]G. Pestalozza and I. Shore, "Clinical Evaluation of Presbycusis on the Basis of Different Tests of Auditory Function," Laryngoscope, 65, (1955), 1161.

[8]Ira J. Hirsh et al., "Development of Materials for Speech Audiometry," Journal of Speech and Hearing Disorders, 17 (1952), 332.

from 70.5% in grade one upward to 87.66% in grade ten and 90.08% in young adults.[9]

In 1961 at Michigan State University, Nielsen tested three, four, and five year old children with the CID Auditory Test W-22. Scores were much lower than those presented either by Hirsh or McNamee. Again there was a rise in test scores as age increased.[10]

Briefly, there is a hearing loss associated with aging. Changes in speech discrimination do not differ systematically with changes in hearing threshold. Test results of McNamee, Nielsen, and Hirsh differ. Age was not a factor in the original testing of the CID Auditory Test W-22. These statements would suggest several questions:

(1) Does the mean number of correct responses of adults to the CID Auditory Test W-22 vary from age to age?

(2) On the CID Auditory Test W-22 how do the results of adults of specific ages compare with the results of pre-school and school aged children?

(3) What is the relationship among scores on the CID Auditory Test W-22 as a function of age groups?

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[9]Joan F. McNamee, "An Investigation of the Use of the CID Auditory Test W-22 with Children" (unpublished Master's dissertation, Department of Speech, Ohio State University, 1960), pp. 28-29.

[10]Karen Nielsen, "Speech Sound Discrimination of Pre-School Children as Measured by the CID Auditory Test W-22" (unpublished Master's dissertation, Department of Speech, Michigan State University, 1961), pp. 26-28.

Hypothesis

The following hypothesis is proposed:

There is no significant variation in the mean number of correct responses to the CID Auditory Test W-22 among any of the following age groups: 16-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49.

Importance of Study

Speech hearing tests are an important means of evaluating the use of the hearing function. They determine how satisfactorily one can receive communication rather than just the ability of the ear to hear sounds of varied intensity and pitch.

Many factors can influence the results of speech hearing tests; DiCarlo suggests synthesis, analysis, discrimination, concentration, cluster, memory, effort fatigue, and language ability.[11] In using a test where so many variables may be present, it seems imperative to learn as much about the variables as possible in order to control or eliminate them when necessary.

In the original testing of the CID Auditory Test W-22 the effect of age was not considered. The importance of this study is the investigation of age as a factor in speech discrimination testing. Knowledge of the effect of age or the lack of effect of age on test scores on the

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[11] Watson, op. cit., p. 438.

adult level will increase the information relative to the usefulness of the CID Auditory Test W-22.

Since the CID Auditory Test W-22 is the basis for compensation purposes, additional knowledge about the test would be important.

Combining these findings with those of Nielsen and McNamee should result in a more complete evaluation of the effects of age on the CID Auditory Test W-22.

Definition of Terms

The following are definitions of terms employed in this study.

Presbycusis--The effects of age on hearing.

Speech Reception Tests--Audiometric tests which utilize speech samples--syllables, words, phrases, or sentences as stimuli. These include both speech threshold and speech discrimination tests.

Speech Discrimination Tests--Those speech reception tests which measure a person's ability to distinguish between similar sounds or words.

CID Auditory Test W-22--A speech discrimination test developed at the Central Institute of the Deaf, made up of four lists each containing fifty different phonetically balanced monosyllabic words.

Normal Hearing--If a person passes a pure tone sweep check hearing test in each ear at frequencies of 250 cps,

500 cps, 1000 cps, 2000 cps, 4000 cps, and 8000 cps at an intensity of 15 db this person is viewed as having normal hearing.

Organization of the Thesis

Chapter I has discussed the statement of the problem with which this study is concerned. This has included an introduction and a discussion of the purpose of the study. The hypothesis has been stated. Terms used in the study have been defined, and the organization of the thesis has been given.

Chapter II presents a review of the literature concerning speech reception tests. The development of the CID Auditory Test W-22 is discussed. A review of studies dealing with presbycusis is also presented.

Chapter III describes the testing including subjects, equipment, and procedure.

Chapter IV presents the results, the statistical analysis and discussion.

Chapter V includes the summary and conclusions of the study.

CHAPTER II

REVIEW OF THE LITERATURE

The Development of Speech Reception Tests

Although many of the speech reception tests currently used are of recent origin, such testing began with the invention of the Edison phonograph in the 1870's. Some twenty years later the first speech audiometer was invented by Sohier-Bryant.[1] Bryant reports one of the early tests in the A.M.A. Archives of Otolaryngology published in 1904.[2]

The telephone industry has played a major part in the development of speech reception tests. Dr. G.A. Campbell was one of the first to propose the use of sounds for testing speech intelligibility over the telephone. In early testing, words and sentences were chosen haphazardly. Campbell used initial consonants combined with the ee sound.[3]

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[1]Douglas MacFarlan, "Speech Hearing Tests," Laryngoscope, 55 (1945), 72.

[2]C.V. Hudgins et al., "The Development of Recorded Auditory Tests for Measuring Hearing Loss for Speech," Laryngoscope, 57 (1947), 60.

[3]H. Fletcher and J.C. Steinberg, "Articulation Testing Methods," Bell System Technical Journal (1929), 808.

In 1917 I.B. Crandall prepared word lists with both simple and compound consonant forms. All common vowels were used in the combinations and with the frequency of written speech.[4] This was one of the early attempts to construct phonetically balanced word lists.

William A. Bristol used the electric phonograph with a pickup that activated a telephonic circuit to test (and instruct) deaf children. He presented a testing list in 1926 composed of sixty-three words. These words were often monosyllabic, usually common to children such as ball, one, two, or Monday.[5]

Also in the 1920's the Western Electric 4-A Audiometer was employed to test children. Test items were recorded digits. This was a group screening procedure.[6]

Two of the pioneers in the development of articulation tests were H. Fletcher and J.C. Steinberg. The tests they developed were tools in the development of the telephone and related communication systems.[7] They prepared a test that was published in 1929. This was comprised of consonant-vowel-consonant syllables with the

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[4] Ibid., pp. 808-811.

[5] MacFarlan, op. cit., p. 72.

[6] Hudgins, op. cit., p. 60.

[7] Watson, op. cit., p. 452.

consonants and vowels and their positions in proportions found in spoken language. This test was based on the revised scientific alphabet.[8]

Although the background for the measuring of intelligibility lay in these tests of Fletcher some thirty years ago they were not followed up by those in the field of speech. Fletcher was primarily concerned with the phonetic element of speech and with the evaluating of telephonic equipment.[9]

Shortly before and during World War II much was accomplished at the Harvard Psycho Acoustic Lab in the development of articulation tests. Stressed in these tests of words and sentences were equivilance among test forms and phonetic equation.

The urgent need for good communication via airplane inter-communication equipment, despite noises, motivated researchers. But problems were multiple, including varied speaking intelligibility of students and the lack of availability of constant listening groups. Since there was need for short tests, workers

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[8]Fletcher, op. cit., p. 808.

[9]Hess Haagen, "Intelligibility Measurement," Speech Monographs, 13 (1946), 4.

looked hopefully at new approaches to intelligibility testing. These pressures led to a concentration of work on word intelligibility.[10]

To J.P. Egan goes credit for the original PB word lists. The variables to which he gave primary concern were phonetic content and word familiarity.[11] The PB lists contain monosyllabic words. Each list has the phonetic elements in frequencies of occurences corresponding to their frequencies in spoken English.[12]

Currently, there are four types of materials used in testing articulation. They are syllable lists, monosyllabic words, spondaic words, and sentences.[13]

In articulation intelligibility tests short monosyllabic words are generally preferred. These tests are of sufficient intensity so that loudness itself is not a factor.[14]

Criterion for these tests in studies done in the languages of England, Germany, Denmark, Sweden, Hebrew,

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[10] Ibid., pp. 4-7.

[11] Charles Hutton and John Weaver, "PB Intelligibility and Word Familiarity," Laryngoscope, 69 (1959), 1443-1450.

[12] Ira Hirsh, The Measurement of Hearing (New York: McGraw-Hill Book Company Inc., 1952), p. 130.

[13] James P. Egan, "Articulation Testing Methods," Laryngoscope, 58 (1948), 962.

[14] Watson, op. cit., p. 439.

Italy, France, Finland, and Portugal are: (1) monosyllabic structure, (2) equal phonetic composition, (3) a representative distribution of sounds, (4) equal range and average difficulty, and (5) words of common usage.[15] The United States now has an additional criterion. It is the intelligibility of the speaker.[16]

Development of the CID Auditory Test W-22

The twenty PB lists developed by Egan were modified by Ira Hirsh and others at the Central Institute for the Deaf. The resulting test is the CID Auditory Test W-22. It consists of 200 monosyllabic words divided into four 50 word lists. Each list is phonetically balanced. There are six scramblings of each list. The use of the test is to determine the subject's discrimination loss for speech. Hirsh defines discrimination loss as the difference between 100% and the percentage of given speech material the listener repeats correctly at a level sufficiently high so that further increase in intensity will not increase the number of correct answers.[17]

Criteria for the vocabulary used in this test were: (1) one syllable words and no repetitions of

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[15]Ferrer, op. cit., pp. 1541-1542.

[16]Ibid.

[17]Hirsh, op. cit., p. 328.

words, (2) familiarity, and (3) phonetic composition corresponding to that of English as a whole as much as possible.[18]

The CID Auditory Test W-22 seems to have been very carefully constructed. The authors of that test have tested it extensively. Further testing, using untrained listeners, has been carried out by John Corso. His test results are in close agreement with those of the trained listeners in the original testing.[19] The CID Auditory Test W-22 appears to be a test with real value.

Presbycusis

The old man with the loud voice and ear trumpet of past years has been modernized to the elderly gentleman with the concealed hearing aid. The awareness of poorer hearing in the aged has long been present. Understanding of this loss is still incomplete.

Credit for first describing the clinical manifestations of high tone deafness associated with aging is given to a German Named Zwaardemaker, 1899.[20]

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[18] Ibid.

[19] John F. Corso, "Confirmation of Normal Discrimination Loss for Speech on the CID Auditory Test W-22," Laryngoscope, 67 (1957), 365-370.

[20] Harold F. Schuknecht, "Presbycusis," Larynogoscope, 65 (1955), 404.

The first major study of the effects of age on threshold of hearing was by C. C. Bunch. In 1929 he reported pure tone test results of a group of hospital patients. Above 512 cps there was a loss in average of thresholds, in each successive decade. Averages for thresholds of lower frequencies were fairly constant regardless of age.[21]

Bunch did further research with his patients suffering from arteriosclerosis, hypertension, cardiac conditions and syphilis. He concluded that although this loss in acuity in the high frequencies associated with advanced age was a constant factor in these patients, these diseases were not responsible for the loss.[22]

With each study more characteristics of this hearing loss, presbycusis, were discovered. Different causes were suggested; different phases studied. In 1939 Noble H. Kelley reported his findings concerning auditory acuity and age, presbycusis and the perception of music, and presbycusis and the reception of speech. Concerning speech he stated that in recognition of consonants, persons over sixty were inferior at all intensities. In recognition

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[21]C. C. Bunch, "Age Variation in Auditory Acuity," A.M.A. Archives of Otolaryngology, 9 (1929), 625-636.

[22]C. C. Bunch, "Further Observations of Age Variations in Auditory Acuity," A.M.A. Archives of Otolaryngology, 13 (1931), 179.

of vowels, persons over sixty were not handicapped above 10 db above their threshold.[23]

During and after World War II the period of great advance for speech reception tests, very little was accomplished in the study of presbycusis.

In the middle 1950's Pestalozza and Shore reported that discrimination for speech was poor in the older individual, even in those with a mild hearing loss.[24] Joseph Sataloff and H. Menduke, testing a group of individuals sixty-four to ninety-three, found a low correlation between age and hearing loss. There was little additional hearing loss for pure tone after sixty-five.[25]

John Corso considered both age and sex differences in pure-tone thresholds. He found, in agreement with earlier research, a hearing loss in the aged, more marked in the higher frequencies. He also reported a sex difference in hearing threshold, independent of age.[26]

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[23]Noble H. Kelley, "A Study in Presbycusis," A.M.A. Archives of Otolaryngology, 29 (1939), 513.

[24]G. Pestalozza and I. Shore, "Clinical Evaluation of Presbycusis on the Basis of Different Tests of Auditory Function," Laryngoscope, 65 (1955), 1161.

[25]Joseph Sataloff and H Menduke, "Presbycusis," A.M.A. Archives of Otolaryngology, 66 (1957), 274.

[26]John F. Corso, "Age and Sex Differences in Pure-Tone Thresholds," The Journal of the Acoustical Society of America, 31 (April, 1959), 507.

With an increase in the life span of man, the total field of geriatrics has become more important. Many phases of the aging process are being studied extensively. The study of one phase, presbycusis, is found with increasing frequency in the literature.

In the 1960's, despite increasing knowledge, Glorig claims that more needs to be known about this type of hearing loss.[27] C. P. Goetzinger et al. report that in so far as is known there is no tentative normative data for auditory discrimination at advanced ages. They explore the effects of both age and sex on auditory sensitivity and discrimination.[28]

The research of Robert Klotz and Marjorie Kilbane again points to the limits of current knowledge. They report a decline with age in the ability to hear and understand speech with a discrimination loss greater than expected.[29]

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[27]Aram Glorig and James Nixon, "Distribution of Hearing Loss in Various Populations," Annals of Otology, Rhinology and Laryngology, 69 (1960), 497.

[28]C. P. Goetzinger et al., "A Study of Hearing in Advanced Age," A.M.A. Archives of Otolaryngology, 73 (June, 1961) 662.

[29]Robert E. Klotz and Marjorie Kilbane, "Hearing in an Aging Population," The New England Medical Journal, 266 (February 8, 1962), 277-280.

I. Kirikae et al. report impairment in speech discrimination above the threshold in adults fifty to seventy with normal thresholds.[30]

Aram Glorig and James Nixon completed a study in 1962 with individuals above seventy. They have derived a mathematical formula describing the progress of presbycusis.[31]

Works by Corso, Glorig and Nixon, and Glorig and Davis have considered noise exposure as a factor in hearing loss.[32,33,34] Glorig and Davis feel that those unexposed to noise must be isolated in order to study the effects of age. They conclude that the average age effect, of itself, does not produce hearing impairment at 500 cps, 1000 cps, or 2000 cps by age seventy. They feel the threshold shift for speech should be only 10 db.[35]

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[30] I. Kirikae et al., "A Study of Hearing in Advanced Age," International Audiology, 2 (Dec., 1963), 173-175.

[31] Aram Glorig and James Nixon, "Hearing Loss as a Function of Age," Laryngoscope, 72 (1962), 1596-1610.

[32] John Corso, "Age and Sex Difference in Puretone Thresholds," A.M.A. Archives of Otolaryngology, 77 (April, 1963), 385.

[33] Aram Glorig and J. Nixon, "Distribution of Hearing Loss in Various Populations," Annals of Otology Rhinology and Laryngology, 69 (1960), 497-516.

[34] Aram Glorig and H. Davis, "Age, Noise and Hearing Loss," Transactions of the American Otological Society, Inc., XLIX (1961), 262-277.

[35] Ibid.

Currently there is disagreement both in the degree of shift and in the anatomical causes of it. Ronald Hinchcliffe states that speech discrimination loss must be due to retro-neural lesions, degenerative changes of the brain.[36] Glorig and Davis claim the age effect on hearing is chiefly conductive, that it is the noise induced hearing loss which is sensory-neural.[37]

Progress is being made; more is being learned; and there is much yet to be learned about presbycusis.

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[36]Ronald Hinchcliffe, "The Anatomical Locus of Presbycusis," Journal of Speech and Hearing Disorders, 27 (November, 1962), 307-309.

[37]Glorig and Davis, op. cit., p. 276.

CHAPTER III

SUBJECTS, EQUIPMENT, AND TESTING PROCEDURE

Subjects

Eighty-four subjects participated in this study. Six males and six females comprised each of the following age groups: 16-19, 20-24, 25-29, 30-34, 35-39, 40-44, and 45-49. Each subject had passed a pure tone sweep check hearing test in each ear at frequencies of 250 cps, 500 cps, 1000 cps, 2000 cps, 4000 cps, and 8000 cps at an intensity of 15 db. None were familiar with the CID Auditory Test W-22 and all were untrained listeners.

Equipment

All pre-test screening and all testing were done on the Allison Audiometer, Model 20-A, manufactured by Allison Labs, Puente, California. This audiometer is in the Hearing Clinic, Michigan State University.

Materials

The records employed in testing the CID Auditory Test W-22 were from Technisonic Studios, 1201 Brentwood Blvd., St. Louis 17, Missouri. Word lists were 1-C, 2-C, 3-C, 4-C, 1-D, 2-D, 3-D, 4-D, 1-F, 2-F, 3-F, and 4-F.

Prepared answer sheets were utilized by the subjects for the recording of responses (See Appendix I, page 45).

Procedure

All testing was executed between 7:00 and 9:00 p.m. in the acoustically treated room in the hearing clinic which is coupled to the control room. Subjects were tested individually with no one other than the subject and the tester present. Testing for each subject was completed in one session. A pure tone sweep check was given at 250 cps, 500 cps, 1000 cps, 2000 cps, 4000 cps, and 8000 cps for each ear at an intensity of 15 db. If the sweep check was passed at each and every frequency for each ear the CID Auditory Test W-22 was given.

An identical explanation was given orally to each subject directing him as to his part in the test:

> This is a record of a man saying a list of words which I want you to write down. He introduces each word with the phrase, 'You will say.' I want you to write down the word he says to say. For example, if he said 'You will say Dick,' you would write Dick. All are one syllable words.

The CID Auditory Test W-22 was presented at 50 db binaurally, using each of the twelve scramblings once in each group. Output was measured and adjusted by the voltage unit meter of the Allison Audiometer each time a record was changed. Subjects recorded their responses

on prepared answer sheets which were checked and rechecked using as a key the CID Auditory Test W-22 lists from Measurement of Hearing[1] with corrections (see Appendix II, page 46).

[1]Ira J. Hirsh, The Measurement of Hearing (New York: McGraw-Hill Book Company, Inc., 1952).

CHAPTER IV

RESULTS AND DISCUSSION

Results

Test scores were tabulated with the results shown in Appendix III, page 45. Several statistical treatments were used to determine variations between age groups and between the different word lists.

The mean--most stable measure of central tendency--was determined for each age group and for each word list by the formula $M = \frac{\Sigma X}{N}$

where

M = the arithmetic mean

X = test score

N = number of scores

and Σ denotes "sum of."[1] Means by age group are shown in Figure 1. Means by word list are in Figure 2.

Because of an extreme score in the 30-34 age group, word list 2-D, medians were also determined by the formula

$$Mdn = \ell + i\left(\frac{\frac{N}{2} - \text{cum } f_i}{f_m}\right)$$

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[1]Henry E. Garrett, Elementary Statistics (New York: Longmans, Green and Company, 1956) p. 29.

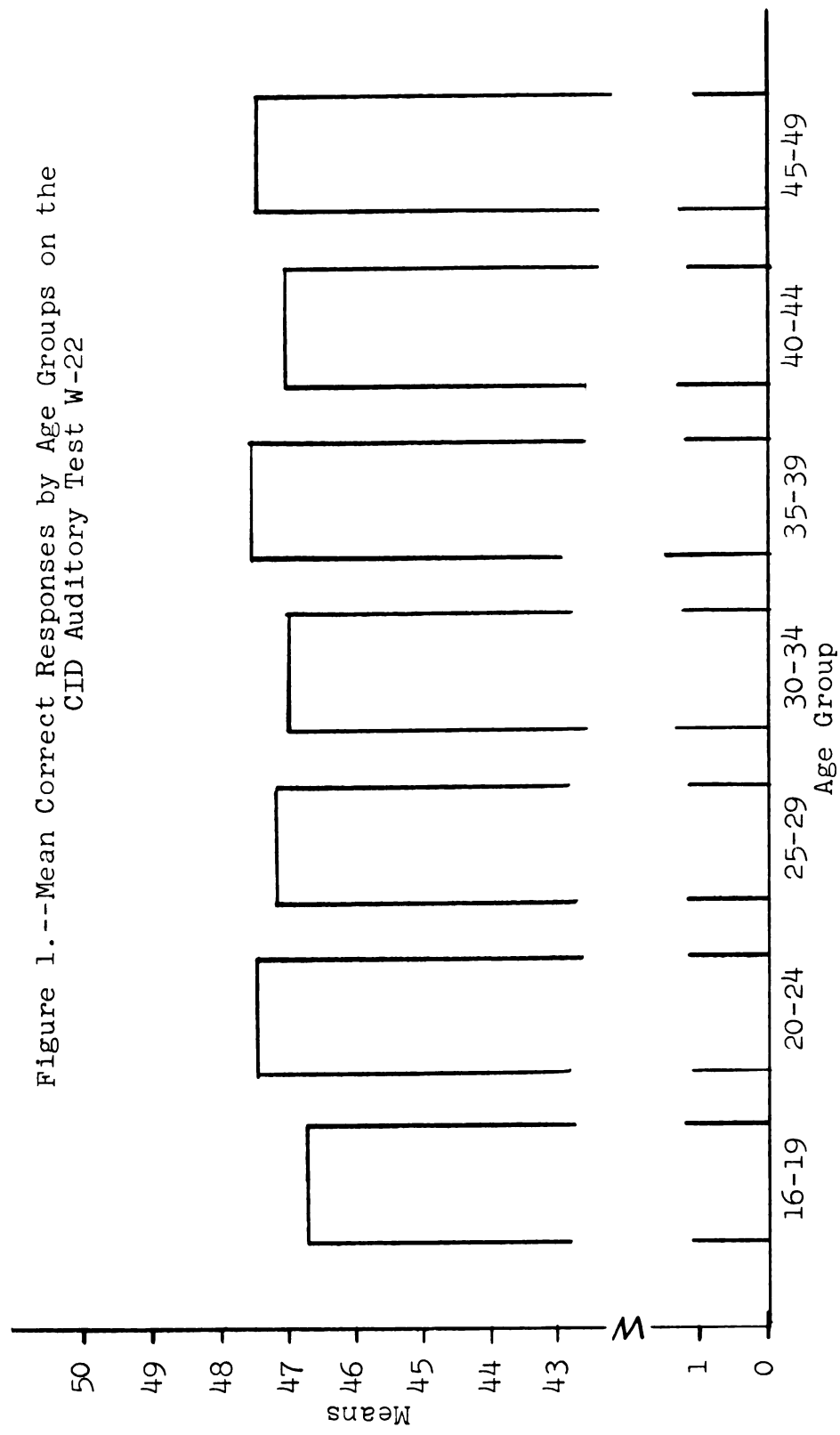
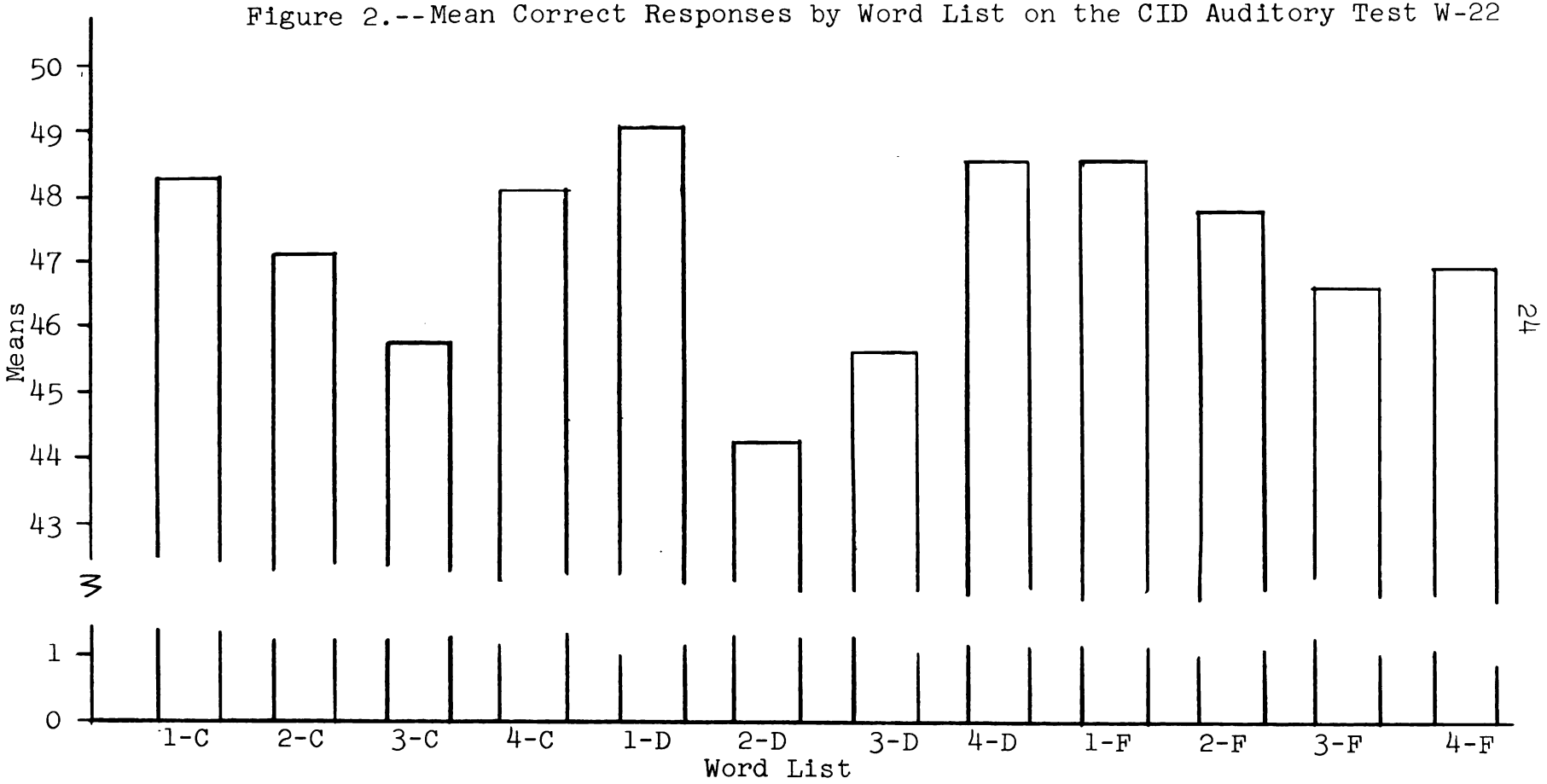


Figure 1.--Mean Correct Responses by Age Groups on the CID Auditory Test W-22

Figure 2.--Mean Correct Responses by Word List on the CID Auditory Test W-22



where

l = lower limit of i upon which Mdn lies

$N/2$ = 1/2 of the total number of scores (N)

cum f_i = sum of scores on i's below l

f_m = frequency on the i containing the Mdn

i = length of interval.[2] Medians by age group are illustrated in Figure 3; medians by word list in Figure 4.

Standard Deviation from the Mean for Each Age Group

When there is a variation, the mean is not descriptive of the entire population. A measure of variability is necessary. The standard deviation, most important measure of variability, is calculated around the mean. Because the standard deviation is determined by extracting the square root of the variance its values are expressed in units of the original scoring scale. It has the additional advantage of being mathematically manageable and is often the basis of additional statistical treatment.[3]

The standard deviation from the mean for each age group was found by utilizing the formula

$$\sigma = \sqrt{\frac{\Sigma x^2}{N}}$$

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[2]Ibid., p. 37.

[3]Paul Blommers and E. F. Lindquist, Elementary Statistical Methods (Boston: Houghton Mifflin Company, 1960), pp. 139-141.

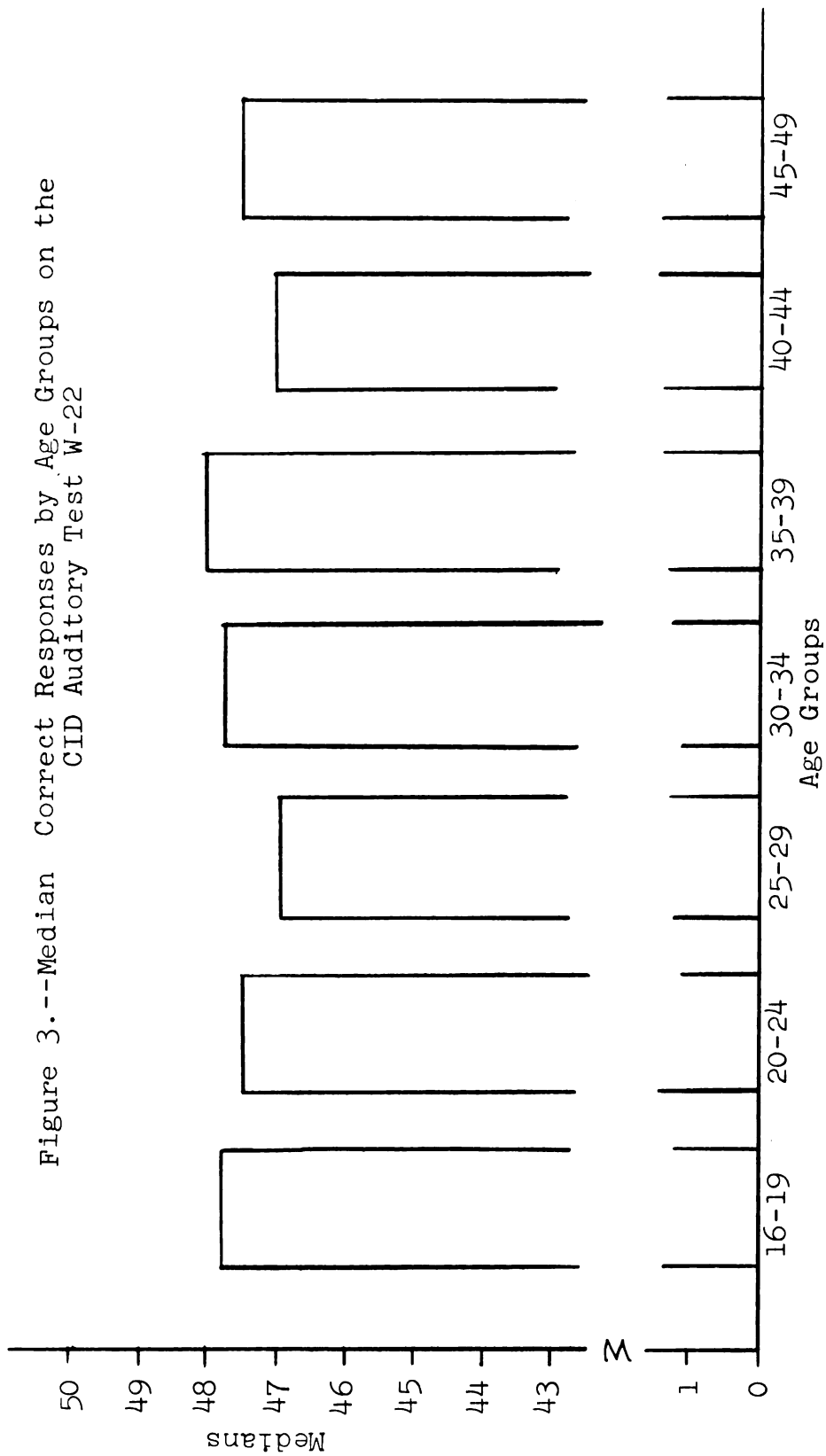
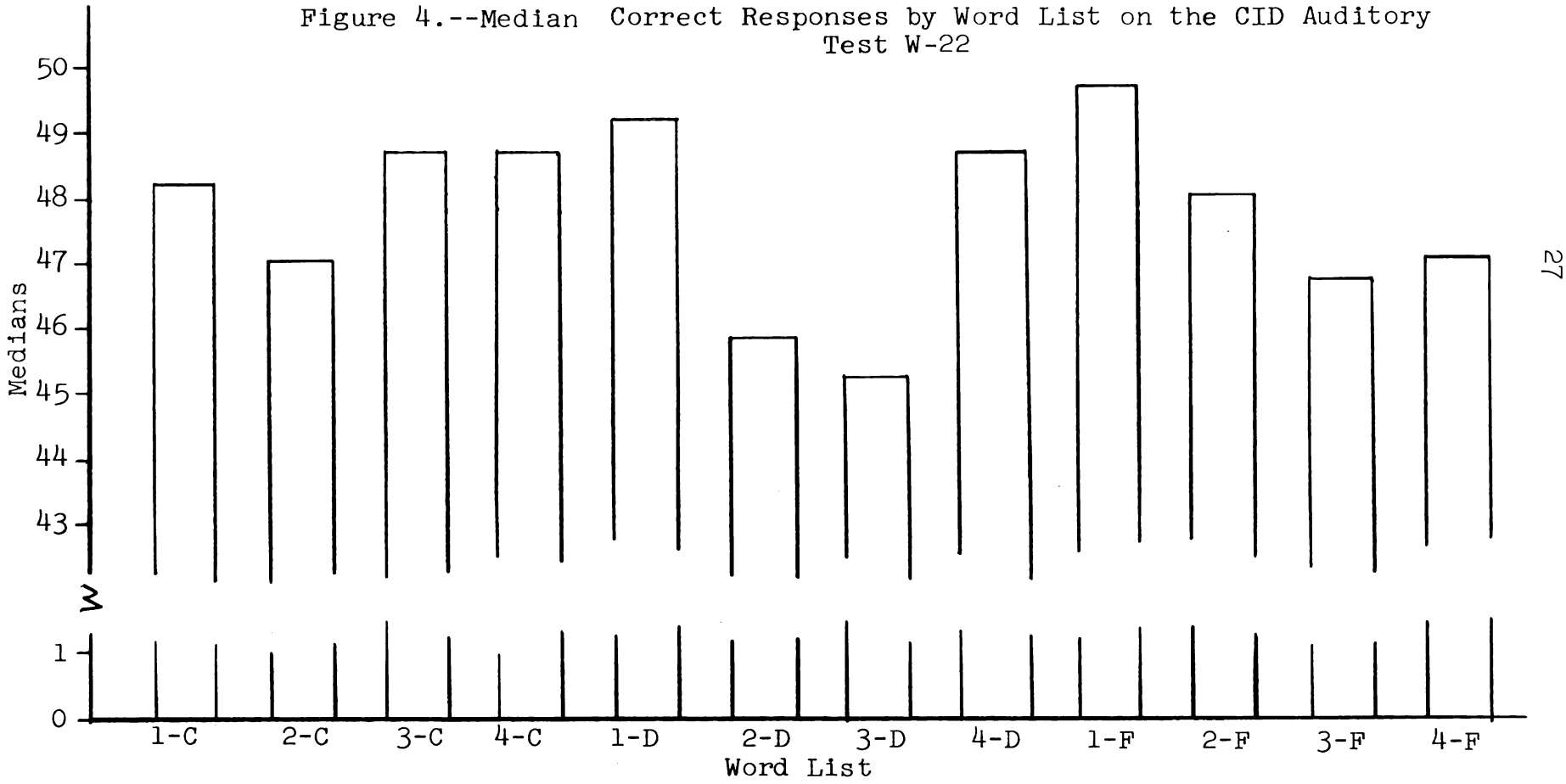


Figure 3.--Median Correct Responses by Age Groups on the CID Auditory Test W-22

Figure 4.--Median Correct Responses by Word List on the CID Auditory Test W-22



where

σ = standard deviation

Σ denotes "sums of"

x = deviation from the mean

N = number of scores.[4] Results are presented in Table I.

TABLE I

STANDARD DEVIATION FOR AGE GROUPS

Age	Mean	Standard Deviation
16-19	46.75	2.314
20-24	47.50	1.849
25-29	47.25	1.534
30-34	47.00	3.240
35-39	47.67	1.748
40-44	47.08	1.706
45-59	47.50	1.607

Standard Deviation from the Mean for Each Word List

The standard deviation from the mean for each word list was also found by utilizing the same formula. Results are presented in Table II.

[4]Garrett, op. cit., p. 52.

TABLE II

STANDARD DEVIATIONS FOR WORD LISTS

Word List	Mean	Standard Deviation
1-C	48.29	1.749
2-C	47.14	.833
3-C	45.86	1.356
4-C	48.14	1.549
1-D	49.14	.640
2-D	44.29	2.910
3-D	45.57	1.676
4-D	48.57	.903
1-F	48.57	2.381
2-F	47.86	1.125
3-F	46.57	1.170
4-F	47.00	.756

Analysis of Variance

An analysis of variance, employing the method developed by Fisher, was done to determine significant variations among age groups.[5] While this analysis does not show where the variation may be, it does ascertain if there is

[5] J. P. Guilford, Fundamental Statistics in Psychology and Education (New York: McGraw-Hill Book Company, Inc., 1942), pp. 145-151.

significant variance to warrant further inspection and statistical treatment. The results are given in Table III.

The formulas are

$$\text{between variance} = \frac{n\Sigma d^2}{k-1}$$

and

$$\text{within variance} = \frac{\Sigma x_s^2}{k(n-1)}$$

when n = number of measurements in each set

d = deviation of set means from grand mean

k = number of sets

x = deviation within sets.

TABLE III

TOTAL VARIANCE SUBDIVIDED INTO TWO COMPONENTS

Components	Degrees of Freedom	Sums of Squares	Variance
Between	6	7.7136	1.2856
Within	77	362.0836	4.7024
Totals	83	369.7972	

$$F = \frac{1.2856}{4.7024} = .265$$

According to Snedecor's table of points for the distribution of F, and F score of .265 with 6 and 77

degrees of freedom does not show significant variations among age groups at the five per cent level of confidence.[6]

Comparison of Means with McNamee and Nielsen

Means of the age groups were compared with means reported by McNamee[7] and Nielsen.[8] Results are shown in Figure 5.

Discussion

Age Groups

There is little variation between means of scores of the seven age groups. Difference between the highest and lowest mean is .92. Age groups ranked from low to high by means are 16-19, 30-34, 40-44, 25-29, 20-24 and 45-49, and 35-39. Although the lowest mean represents the youngest age group, no further signs of continuity appear.

Age groups ranked from low to high by medians are 25-29, 40-44, 45-49, and 20-24, 16-19, 30-34 and 35-39 with 1.1 between the highest and lowest.

The greatest standard deviation, which is 3.240 in the 30-34 age group is 2.1 times as large as the smallest which is 1.534 for ages 25-29. Standard deviations ranked from smallest to largest are 25-29, 45-49

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[6] Ibid.

[7] McNamee, op. cit., p. 29.

[8] Nielsen, op. cit., p. 26.

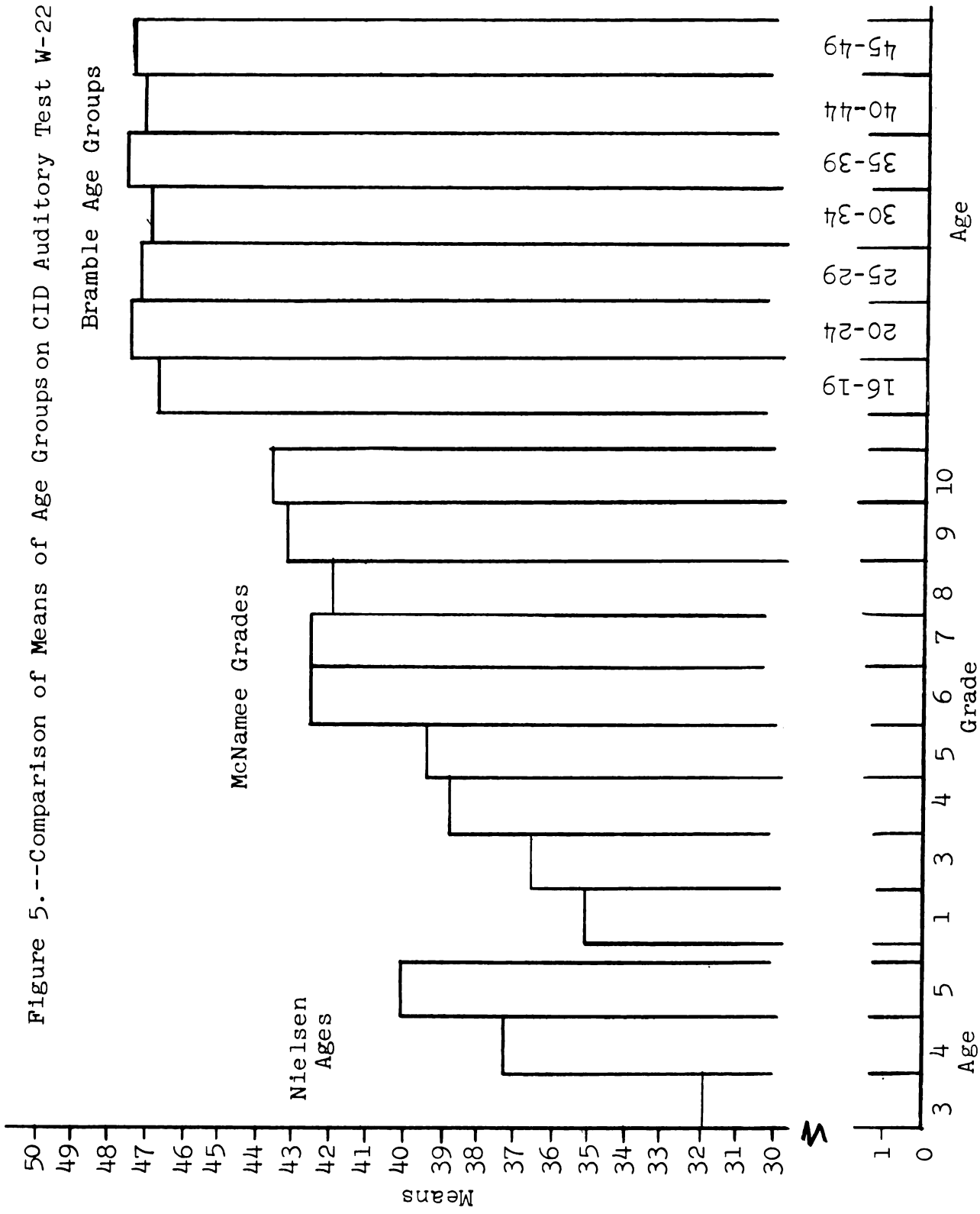

Figure 5.--Comparison of Means of Age Groups on CID Auditory Test W-22

40-44, 35-39, 20-24, 16-19, and 30-34. No relationship between the amount of variation from means and age is apparent.

Word Lists

There is greater variation between means of scores on the twelve word lists, with 4.85 between the lowest and highest. Three of the four word lists with the smallest means are different scramblings of the number three list (3-C, 3-D, and 3-F). Three of the four word lists with the largest means are scramblings of the number one list (1-C, 1-D, and 1-F). The greatest difference between medians of scores is 4.38. There is less indication of any pattern than with the means. Standard deviations for word lists range from .6395 to 2.910.

Analysis

The analysis of variance computed according to the Fisher formulas shows none of these variations to be significant at the five per cent level of confidence. On the basis of this, the hypothesis, which states that there are no significant variations in the mean number of correct responses to the CID Auditory Test W-22 among any of the following age groups: 16-19, 20-24, 25-29, 30-34, 35-39, 40-44, or 45-49, cannot be rejected. Nor can any part of the hypothesis be rejected.

Since there is no significant variation among age groups it would appear that age is not a factor in speech discrimination testing between the ages of sixteen and fifty. These findings would support the opinion of Glorig and Davis, that no allowance need be made for the age effect when judging the hearing impairment for which compensation is to be paid.[9]

Comparison with Studies by McNamee[10] and Nielsen[11]

When test results are compared with those of McNamee and Nielsen an upward curve is indicated with the mean number of correct responses of all adult groups greater than those of any of the groups of children. In both the pre-school and school age children scores increased with age. This trend is not present in the adult groups. Both McNamee and Nielsen report significant variations between some of the ages tested. No significant variations are found between any of the age groups from 16-19 to 45-49.

On the basis of these three studies, several statements can be made: Adults score higher on the CID

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[9]Aram Glorig and Hallowell Davis, "Age, Noise and Hearing Loss," Transactions of the American Otological Society, Inc., XLIX (1961), 262-277.

[10]McNamee, op. cit.

[11]Nielsen, op. cit.

Auditory Test W-22 than do children. Children's scores on the CID Auditory Test W-22 tend to increase as a function of age.

These statements raise many questions. Primarily, what does the CID Auditory Test W-22 measure besides the ability to descriminate speech? Vocabulary? The ability to concentrate? Listening ability? Perhaps young children do not have the neurological development necessary to discriminate speech as well as do adults. It would be interesting to compare the results obtained by children and adults on a test using words more familiar to children.

Children may simply lack in listening experience. John Corso has reported that adults who are not trained listeners, score as well on the CID Auditory Test W-22 as do adults who are experienced listeners.[12] It seems doubtful that the same would be true of children. Nielsen's training session prior to testing might account for her obtaining higher scores at the four and five year level than those reported by McNamee in the first and third grades. Adults may be trained listeners by years of living experiences. It would be interesting to test children after giving them formal listening experiences.

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[12]John F. Corso, "Confirmation of Normal Discrimination Loss for Speech on CID Auditory Test W-22," Laryngoscrope, 67 (1957), 369-370.

Both McNamee and Nielsen were given responses orally. In the adult study responses were written. This might influence scores.

More needs to be known about the incorrect responses of both children and adults. It has not been reported whether subjects of all ages make the same errors or the same kind of errors, whether certain words are missed more frequently than others, or whether there is a pattern to the position of errors. In the study of adults, certain words were missed every time while others were never missed. This may or may not be true with children.

It seems that additional studies concerned with these possible differences in adults and children would be of value in understanding their varied abilities as measured by the CID Auditory Test W-22.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

Speech audiometry is often employed for the assessment of hearing in conjunction with pure tone testing. This results in a more valid estimate of an individual's hearing than can be obtained by pure tone audiometry alone. In this research, the CID Auditory Test W-22 is utilized to study the effect of age on the speech discrimination ability of adults.

The process of aging appears to affect hearing. As an adult ages, thresholds for pure tone in the higher frequencies increase. Concurrent with the pure tone loss is a loss in the ability to discriminate speech sounds. The changes in hearing threshold do not differ systematically with changes in speech discrimination. There is not complete understanding of these changes in hearing nor is there agreement as to causes.

A review of the literature reveals little research concerned with the relationship between aging and speech discrimination. The majority of studies have been published in the past seven years. Most of these have been research on the elderly. Little is presented

on adults below fifty. In the original testing of the CID Auditory Test W-22 with adults, age was not considered.

The subjects for this study were 84 adults, twelve in each of the following age groups: 16-19, 20-24, 25-29, 30-34, 35-39, 40-44, and 45-49. All had passed a pure tone screening at 15 decibels. Each subject listened to one list of the CID Auditory Test W-22 (1-C, 2-C, 3-C, 4-C, 1-D, 2-D, 3-D, 4-D, 1-F, 2-F, 3-F, or 4-F) presented at 50 decibels and recorded responses on a prepared answer sheet. Tests were administered individually.

An analysis of variance indicates that there are no significant variations among age groups at the five per cent level of confidence. There is no systematic change in means as age increases. Standard deviations do not differ greatly as a function of age. Means for scores by age groups are higher than all means presented by both McNamee[1] and Nielsen[2] in their testing of children.

Conclusions

On the basis of the findings of this study the following conclusions are made:

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[1]McNamee, op. cit., p. 29.

[2]Nielsen, op. cit., p. 26.

1. Within the ages of sixteen years to fifty years, scores on the CID Auditory Test W-22 do not vary significantly as a function of age.

2. Every group of adults ages sixteen years to fifty years performed better on the CID Auditory Test W-22 than did any of the pre-school or school age children tested by either McNamee[3] or Nielsen.[4]

Implications for Further Research

In answering the questions set forth in this study, many additional questions have arisen. The following are some which might warrant further investigation.

1. Will children with formal listening training have higher scores on the CID Auditory Test W-22 than children without training?

2. Will children with formal listening training perform as well as adults on the CID Auditory Test W-22?

3. How do scores of adults above fifty years compare with those of adults ages sixteen years to fifty years on the CID Auditory Test W-22?

4. Are there variations between scores of children and adults on a speech test comprised of words common to a child's vocabulary?

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[3]McNamee, op. cit.

[4]Nielsen, op. cit.

5. Do children make the same errors, or the same kind of errors on the CID Auditory Test W-22 as do adults?

6. On the CID Auditory Test W-22 are certain words missed significantly more often than other words?

7. What is the relationship between adults' scores on the CID Auditory Test W-22 and their scores on other measures of sound discrimination?

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APPENDICES

APPENDIX I

SAMPLE OF ANSWER SHEET

Name _____ Sex _____ Age _____

Test No. _____ Date _____

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____
21. _____
22. _____
23. _____
24. _____
25. _____
26. _____
27. _____
28. _____
29. _____
30. _____
31. _____
32. _____
33. _____
34. _____
35. _____
36. _____
37. _____
38. _____
39. _____
40. _____
41. _____
42. _____
43. _____
44. _____
45. _____
46. _____
47. _____
48. _____
49. _____
50. _____

APPENDIX II

CID AUDITORY TEST W-22

List 1-C

1. felt
2. bells
3. owl
4. jam
5. what
6. them
7. isle (aisle)
8. bathe
9. none (nun)
10. it
11. up
12. stove
13. an
14. not (knot)
15. skin
16. us
17. earn (urn)
18. deaf
19. wet
20. as
21. or (oar)
22. there (their)
23. east
24. knees
25. carve
26. yard
27. thing
28. ran
29. law
30. high
31. chew
32. me
33. ace
34. see (sea)
35. mew
36. him
37. day
38. ache
39. hunt
40. you (ewe)
41. she
42. dad
43. true
44. could
45. give
46. low
47. poor
48. twins
49. wire
50. toe

List 2-C

1. smart
2. well
3. jaw
4. off
5. cap
6. does
7. that
8. with
9. live (verb)
10. one (won)
11. die (dye)
12. gave
13. chest
14. yore (your)
15. knee
16. ham
17. tare (tear)
18. new (knew)
19. cars
20. young
21. key
22. else
23. star
24. odd
25. way (weigh)
26. bin (been)
27. eat
28. ice
29. oak
30. send
31. tree
32. and
33. flat
34. hurt
35. move
36. rooms
37. then
38. ail (ale)
39. thin
40. pew
41. own
42. hit
43. dumb
44. air (heir)
45. too (two,to)
46. show
47. now
48. ill
49. ease
50. by (buy)

APPENDIX II--Continued

List 3-C

1. though
2. bill
3. may
4. nest
5. do
6. use (yews)
7. tie
8. done (dun)
9. oil
10. no (know)
11. ears
12. dull
13. ate (eight)
14. if
15. start
16. add (ad)
17. shove
18. are
19. he
20. raw
21. smooth
22. year
23. aim
24. have
25. say
26. three
27. hand
28. glove
29. pie
30. owes
31. wool
32. end
33. jar
34. farm
35. is
36. out
37. we
38. west
39. tan
40. on
41. king
42. when
43. camp
44. book
45. ten
46. knit
47. this
48. lie (lye)
49. chair
50. cute

List 4-C

1. wood (would)
2. bee (be)
3. they
4. dust
5. ought (aught)
6. jump
7. leave
8. in (inn)
9. ear
10. than
11. bread (bred)
12. will
13. darn
14. of
15. toy
16. cook
17. shoe
18. hang
19. near
20. go
21. aid
22. net
23. clothes
24. where
25. am
26. chin
27. all (awl)
28. who
29. few
30. stiff
31. my
32. nuts
33. save
34. his
35. tin
36. so (sew)
37. yet
38. art
39. can
40. why
41. eyes (ayes)
42. tea (tee)
43. men
44. arm
45. pale (pail)
46. our (hour)
47. through (thru)
48. dolls
49. yes
50. at

APPENDIX II--Continued

List 1-D

1. owl
2. wire
3. isle (aisle)
4. give
5. up
6. she
7. wet
8. ace
9. skin
10. day
11. east
12. law
13. thing
14. carve
15. mew
16. earn (urn)
17. chew
18. or (oar)
19. hunt
20. an
21. true
22. none (nun)
23. poor
24. what
25. felt
26. toe
27. jam
28. low
29. bathe
30. dad
31. stove
32. ache
33. us
34. see (sea)
35. as
36. high
37. knees
38. yard
39. ran
40. there (their)
41. you (ewe)
42. deaf
43. him
44. not (knot)
45. me
46. it
47. twins
48. bells
49. could
50. them

List 2-D

1. jaw
2. ease
3. that
4. die (dye)
5. new (knew)
6. with
7. knee
8. then
9. cars
10. does
11. star
12. oak
13. eat
14. way (weigh)
15. tree
16. and
17. move
18. tare (tear)
19. dumb
20. live (verb)
21. now
22. cap
23. smart
24. by (buy)
25. thin
26. chest
27. off
28. show
29. too (two,to)
30. hit
31. well
32. ail (ale)
33. ham
34. young
35. send
36. hurt
37. odd
38. bin (been)
39. ice
40. else
41. key
42. own
43. rooms
44. yore (your)
45. pew
46. one (won)
47. air (heir)
48. flat
49. ill
50. gave

APPENDIX II--Continued

List 3-D

1. may
2. chair
3. tie
4. ears
5. king
6. ten
7. start
8. we
9. add (ad)
10. when
11. aim
12. pie
13. hand
14. say
15. wool
16. smooth
17. is
18. shove
19. tan
20. ate (eight)
21. camp
22. oil
23. this
24. do
25. though
26. cute
27. nest
28. knit
29. done (dun)
30. jar
31. dull
32. west
33. he
34. farm
35. raw
36. owes
37. have
38. three
39. glove
40. year
41. end
42. are
43. out
44. if
45. on
46. no (know)
47. book
48. use (yews)
49. lie (lye)
50. bill

List 4-D

1. they
2. yes
3. leave
4. pale (pail)
5. bread (bred)
6. eyes (ayes)
7. toy
8. yet
9. near
10. save
11. clothes
12. few
13. all (awl)
14. my
15. so (sew)
16. am
17. tin
18. shoe
19. can
20. darn
21. men
22. ear
23. through (thru)
24. ought (aught)
25. wood (would)
26. at
27. dust
28. our (hour)
29. in (inn)
30. tea (tee)
31. will
32. are
33. cook
34. his
35. go
36. stiff
37. where
38. chin
39. who
40. net
41. hang
42. aid
43 nuts
44. arm
45. why
46. than
47. of
48. jump
49. dolls
50. bee (be)

APPENDIX II--Continued

List 1-F

1. isle (aisle
2. ace
3. east
4. hunt
5. earn (urn)
6. what
7. jam
8. ache
9. him
10. bells
11. owl
12. twins
13. as
14. there (their)
15. not (knot)
16. ran
17. high
18. stove
19. low
20. poor
21. an
22. mew
23. law
24. wet
25. give
26. it
27. could
28. yard
29. dad
30. us
31. you (ewe)
32. none (nun)
33. felt
34. carve
35. up
36. wire
37. she
38. chew
39. thing
40. day
41. skin
42. true
43. or (oar)
44. bathe
45. toe
46. knees
47. see (sea)
48. me
49. deaf
50. them

List 2-F

1. knee
2. flat
3. tree
4. else
5. smart
6. ail (ale)
7. gave
8. by (buy)
9. ice
10. oak
11. air (heir)
12. then
13. die (dye)
14. jaw
15. bin (been)
16. rooms
17. live (verb)
18. send
19. thin
20. off
21. hurt
22. dumb
23. yore (your)
24. star
25. that
26. ease
27. pew
28. does
29. odd
30. tare (tear)
31. with
32. chest
33. now
34. young
35. eat
36. own
37. new (knew)
38. well
39. one (won)
40. cars
41. key
42. move
43. hit
44. show
45. cap
46. ham
47. way (weigh)
48. and
49. too (two,to)
50. ill

APPENDIX II--Continued

List 3-F

1. west
2. start
3. farm
4. out
5. book
6. when
7. this
8. oil
9. lie (lye)
10. owes
11. glove
12. cute
13. three
14. chair
15. hand
16. knit
17. pie
18. ten
19. wool
20. camp
21. end
22. king
23. on
24. tan
25. we
26. ears
27. ate (eight)
28. jar
29. if
30. use (yews)
31. shove
32. do
33. are
34. may
35. he
36. though
37. say
38. bill
39. year
40. nest
41. raw
42. done (dun)
43. have
44. tie
45. aim
46. no (know)
47. can
48. will
49. through (thru)
50. dust

List 4-F

1. our (hour)
2. art
3. darn
4. ought (aught)
5. stiff
6. am
7. go
8. few
9. arm
10. yet
11. jump
12. pale (pail)
13. yes
14. bee (be)
15. eyes (ayes)
16. than
17. save
18. toy
19. my
20. chin
21. shoe
22. his
23. ear
24. tea (tee)
25. at
26. wood (would)
27. in (inn)
28. men
29. cook
30. tin
31. where
32. all (awl)
33. hang
34. near
35. why
36. bread (bred)
37. dolls
38. they
39. leave
40. of
41. aid
42. nuts
43. clothes
44. who
45. so (sew)
46. net
47. can
48. will
49. through (thru)
50. dust

APPENDIX III

TEST SCORES

Age \ Test	1-C	2-C	3-C	4-C	1-D	2-D	3-D	4-D	1-F	2-F	3-F	4-F
16-19	45	47	45	49	49	42	48	49	43	48	48	48
20-24	50	46	45	49	49	46	44	49	49	49	47	47
25-29	47	47	45	49	50	46	47	47	50	47	46	46
30-34	50	47	48	47	49	38	43	48	50	49	48	47
35-39	50	49	45	48	49	46	45	49	50	46	47	48
40-44	48	47	45	50	48	46	45	50	48	47	45	46
45-49	48	47	48	45	50	46	47	48	50	49	45	47

ROOM USE ONLY