SPEECH SOUND DISCRIMINATION OF PRE-SCHOOL CHILDREN AS MEASURED BY THE CID AUDITORY TEST W-22

Thesis for the Degree of M. A.
MICHIGAN STATE UNIVERSITY
Karen Nielsen

1961

SPEECH SOUND DISCRIMINATION OF PRE-SCHOOL CHILDREN AS MEASURED BY THE CID AUDITORY TEST W-22

by

Karen Nielsen

AN ABSTRACT

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

College of Communication Arts, Department of Speech

1961

Approved:

ABSTRACT

SPEECH SOUND DISCRIMINATION OF PRE-SCHOOL CHILDREN AS MEASURED BY THE CID AUDITORY TEST W-22

by Karen Nielsen

The purpose of this study is to analyze the results obtained from pre-school children as they responded to the CID Auditory Test W-22 in order to gain insight into their discrimination ability.

The subjects for this study were 82 three, four, and five-year old normal hearing nursery school children. The standardized recordings of the CID Auditory Test W-22 (Lists 1A, 2A, 3A, and 4A) were transcribed onto magnetic tape and played to the children at a level of 55 decibels in a room with an ambient noise level of 45 decibels. The children were familiarized with the test procedures, but not the test items, prior to the actual testing. The children were tested individually, and the responses were recorded in written form by the examiner.

The findings of this study indicate that discrimination ability of pre-school children appears to increase as a function of age. The deviation of scores from the mean appears to decrease as the age level increases. The children at all ages appear to respond similarly to the two halves of the test. There is a small positive correlation between age and score within each of the age groups. This correlation tends to decrease as age increases.

The conclusions which were drawn from this study suggest that one should not use the CID Auditory Test W-22 for the testing of discrimination in children as he would with adults until further analysis is made of error responses. The discrimination task is apparently not too long for preschool children as evidenced by the fact that there was a good correlation between scores on the first and second halves of the test. There is a systematic difference in the performance of three, four, and five-year olds on the test, the range of deviation becoming smaller as age increases. There is less correlation between age and score as age increases among three, four, and five-year olds. The results of this study follow the trend discovered in the study of school age children, by McNamee, who showed that discrimination performance among these children increases as a function of age.

SPEECH SOUND DISCRIMINATION OF PRE-SCHOOL CHILDREN AS MEASURED BY THE CID AUDITORY TEST W-22

by

Karen Nielsen

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

College of Communication Arts, Department of Speech

1961

Approved:

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

STATEMENT OF THE PROBLEM

Introduction

In the assessment of a hearing level, two questions are of vital importance: (1) What is the level of hearing? and (2) How seriously is the patient handicapped by this level?[1] Davis suggests that the emphasis in audiology must necessarily be upon the understanding of the social functions of hearing and upon increasing the ability of the handicapped individuals to cope with the communicational demands of everyday life.[2] He further suggests that one of the primary reasons for testing hearing is to make a diagnosis. On this diagnosis rests the decision as to treatment and also the forecast as to the improvement or deterioration of hearing.[3] The presence of a hearing loss,

---

[1]Hayes A. Newby, Audiology (New York: Appleton-Century-Crofts, Inc., 1958), p. 57.

[2]Hallowell Davis, Hearing and Deafness (New York: Holt, Rinehart, and Winston, Inc., 1960) p. 6.

[3]Ibid., p. 218.

and in part the severity of that loss, can be determined by pure-tone testing. This type of testing, however, does not necessarily indicate the degree of handicap created by the loss. The handicap of a hearing loss is for the most part social in nature. Because an individual relates socially to his environment chiefly through oral communication, the effect which the hearing loss has upon his reception of speech stimulation is an important aspect of the evaluation.

The evaluation of the social aspects of a hearing loss is carried out through speech audiometry. Individual speech-hearing tests, to be discussed in Chapter II, have been standardized for adults, and are employed in planning for the rehabilitation of the hearing handicapped individual. The administration of these tests is usually a fairly uncomplicated matter, for adults are generally able to understand and follow instructions, and have a long background in the use of speech and speech sounds.

It is as important for the audiologist to discover the degree of social handicap in children as it is in adults, but much further study is necessary to find the most satisfactory methods of carrying out such evaluations. Many advancements have been made in recent years in the area of pure tone audiometry with young children, and Speech Reception tests have been devised which have proven to be quite successful. However, little has been discovered as to the development of discrimination of young children, or methods

of testing for it. Knowledge in this area is important for complete evaluation of hearing loss, for the successful auditory training of young children, and subsequent assessment of success of such training.

Statement of Problem and Purpose of Study

The problem from which this study arose is that of determining the speech discrimination ability of young children. The purpose of this study is to analyze the results obtained from pre-school children as they responded to the CID Auditory Test W-22 (Lists 1A, 2A, 3A and 4A) that has been standardized for adults. From this analysis it is hoped that answers to the following questions can in part be obtained: (1) How well can three, four, and five-year old children respond to the CID Auditory Test W-22? (2) Is there a difference in the over-all responses at the three different age levels? (3) Is there correlation among the responses of children of the same age level to make generalizations regarding expected responses? (4) Is the length of the test a factor in the errors present? and (5) Can the development of discrimination ability be traced through the third, fourth, and/or fifth years of life through analysis of response errors made by these children?

Hypotheses

To answer the above questions the following null hypotheses have been proposed:

1. There is no significant variation among the responses of three, four, and five-year old children to the CID Auditory Test W-22.
2. There is no correlation between responses to the first and second halves of the CID Auditory Test W-22.
3. There is no correlation between age levels within each of the three groups and performance on the discrimination task.

Importance of Study

The most important function of hearing is to allow an individual to communicate, and understand communication, through speech.[1] In the evaluation of hearing of children, as well as of adults, it is desirable in fact quite necessary, to obtain results which indicate how well the individual can discriminate between speech sounds as they occur in everyday speaking situations. The CID Auditory Test W-22, a test of sound discrimination, has been standardized on adults, but little has been discovered as to the success of this test in use with children. In 1960, a study by Joanne McNamee related the results of CID Auditory Test W-22 testing with school age children. There is still, however, no available research on the use of this test with children

---

[1]Douglas McFarlan, "Speech Hearing Testing," Laryngoscope, 55 (February, 1945), p. 71.

under six years of age. The necessity of early diagnosis of hearing loss has long been recognized, and procedures have been developed for such diagnosis. For the planning of a training program for the hard-of-hearing child, more information than the knowledge of the presence of a loss and its severity in terms of decibels is necessary. It is hoped that through this study some information as to the responses of normal hearing pre-school children to the CID Auditory Test W-22 may be discovered. Because it has been found that normal hearing adults average a score of between 90 and 100 per cent on the Auditory Test W-22, discrimination errors in hard-of-hearing adults can be evaluated accordingly.[1] If response norms can be significantly established for children of these age levels, it may become possible to judge from these norms the discrimination handicaps of hard-of-hearing children. It is also hoped that some insight into the development of discrimination ability may be gained through statistical analysis of the scores of these children ranked according to age.

Definition of Terms

For the purpose of this study, the terms used are defined in the following manner:

---

[1]Joanne McNamee, "An Investigation of the Use of the CID Auditory Test W-22 with Children" (unpublished Master's thesis, Ohio State University, 1960).

Speech-hearing tests.--Tests which lead to the evaluation of hearing acuity for speech stimuli.

Speech reception threshold.--The sensational level at which the patient can repeat 50 per cent of the stimulus words correctly.

Speech discrimination, or articulation test.--A Test which allows for examination of a patient's ability to discriminate among acoustically similar sounds or among words that contain acoustically similar sounds.

CID Auditory Test W-22.--A discrimination test consisting of four lists of 50 phonetically balanced one-syllable words. These words are presented to the patient at a level above his Speech Reception Threshold. These lists are available in recorded form.[1]

Phonetically balanced.--Samples of speech sounds in the same proportion with which they occur in running speech.

Normal hearing subjects.--Persons who are able to hear pure tone stimuli at 15 decibels, 500 through 2000 cycles per second.

---

[1]Ira J. Hirsch, et al., "Development of Materials for Speech Audiometry," Journal of Speech and Hearing Disorders, 17 (September, 1952), pp. 322-323.

Organization of the Thesis

Chapter I has contained the statement of the problem which led to this study. It has included an introduction to the topic, an outline of the purpose of the study. It has put forth the hypotheses to be considered in this study, discussed the importance of the study, and defined the terms which will be used throughout the study.

Chapter II will contain a review of the literature available on this topic.

Chapter III will consist of a discussion of the subjects, equipment, and testing procedures utilized in the study.

Chapter IV will consist of a discussion of the results of the study.

Chapter V will contain a summary and the conclusions of the study.

CHAPTER II

REVIEW OF THE LITERATURE

The Need for Speech-Hearing Tests

It is desirable that a person's hearing level be measured in such a way that his hearing ability in every day auditory experiences can be analyzed. Speech-hearing tests have been found to approximate these listening experiences, and thus add validity to pure-tone audiometry. They also appear to have diagnostic and prognostic value.[1]

There are two areas of importance to be considered in speech-hearing testing: (1) the level at which one is able to understand 50 per cent of what is said to him, and (2) one's ability to discriminate fine speech sound differences with the noise level at a minimum.[2] The first of these areas, when subjected to evaluation, yields a quantitative picture of a person's ability to hear speech. The second yields a qualitative type of result. There are many situations in which communication is ineffective because the listener

---

[1]Davis, op. cit.

[2]Adam J. Sortini and Carlyle G. Flake, "Speech Audiometry Testing for Preschool Children," Laryngoscope, 66 (October, 1953), p. 996.

confuses certain sounds with others, or because he does not hear them at all, even though the intensity level of the speech is within the range of hearing of the listener. For this reason, discrimination testing is of vital importance for persons of all ages.

These two areas are evaluated through Speech Reception Threshold Tests and PB, or phonatically balanced, monosyllabic word lists, respectively. After scores on these two tests have been derived there is a need for a qualitative measure of the social adequacy of hearing which can be met through use of the Social Adequacy Index. This index is a scale which evaluates the relationship between the percentage of words correctly understood (discrimination score), and the intensity level at which the words reach the ear of the listener (Speech Reception Threshold).[1] Values of handicap have been assigned to certain points along the Social Adequacy Index scale, and thus the handicap can be designated in terms of numbers.[2] When a Social Adequacy Index is reduced by the Speech Reception Threshold, medical treatment, and/or amplification, can help to raise the score and thus the individual's social adequacy. Davis feels, however, that

---

[1]Hallowell Davis, "The Articulation Area and the SAI for Hearing," Laryngoscope, 58 (1948), p. 762.

[2]Newby, op. cit., p. 117.

neither medical treatment nor amplification can restore a Social Adequacy Index score that is reduced by a discrimination loss, and therapeutic procedures must be undertaken.[1] This points out the necessity of discrimination evaluation for thorough hearing testing and ensuing recommendations.

Factors Important in the Hearing of Speech

The Bell Telephone Laboratories have made several discoveries regarding speech sounds that have shed light upon speech-hearing testing: Vowel sounds are heard twice as easily as consonant sounds; individual vowels and consonants vary greatly in their acoustic characteristics, thus causing some words to be more easily heard than others; education, familiarity, mental acuity or agility, word memory, and word associations are only a few of the factors of importance in good hearing; noises, interruptions, distractions, and cross-talk greatly interfere with hearing and with hearing testing.[2] Because these factors are important to the hearing of speech, they must be taken into consideration when speech-hearing tests are devised and used for evaluative purposes.

Factors Necessary in Devising a Good Speech-Hearing Test

Certain basic criteria are deemed essential as a guide in the selection of any speech-hearing test: (1) familiarity

---

[1]Davis, "The Articulation Area and the SAI for Hearing," op. cit., p. 768.

[2]MacFarlen, op. cit., p. 77.

of the words, (2) phonetic dissimilarity of the words, (3) normal sampling of English speech sounds, and (4) homogeneity with respect to basic audibility.[1] The selection of familiar words is most necessary in reducing to a minimum the factors of education and intelligence.[2]

In addition to this general criteria, certain aspects must be taken into consideration in the development of a test of sound discrimination: (1) monosyllabic structure, (2) equal average difficulty, (3) equal range of difficulty, (4) equal phonetic composition, (5) composition representative of the English language, and (6) words in common usage.[3]

Speech-Hearing Tests

Certain standardized speech-hearing tests are in wide usage today. Many revisions of the earliest such tests have been made until at present it is felt that the speech-hearing test materials and procedures give accurate accounts of the specific hearing problems of hard of hearing individuals.

Hudgins indicates that probably the first speech-hearing test to be developed and recorded was done so by Bryant in 1904. This test did not receive wide usage because of the

---

[1]Clarence Hudgins, et al., "The Development of Recorded Auditory Tests for Measuring Hearing Loss for Speech," Laryngoscope, 57 (1947), p. 58.

[2]MacFarlan, op. cit., p. 82.

[3]James P. Egan, "Articulation Testing Methods," Laryngoscope, 58 (September, 1948) p. 963.

crudeness of phonographic equipment of that day. This test was composed of monosyllables.[1]

The first widely used recorded auditory test for determining hearing loss for speech was developed by Bell Telephone Laboratories in 1926. It was devised for use with the Western Electric 4A Audiometer. The test items were two and three digit numbers spoken by both male and female voices. Attenuation was set into the record by three decibel steps from 30 decibels to minus three decibels, and the subjects wrote the numbers they heard. This test measured the Speech Reception Threshold, and was used for group testing procedures.[2] Numbers were used as stimuli, as it was felt that they were the most familiar and most easily comprehended words in the English language.[3]

In the initial speech-hearing study of the Bell Telephone Laboratories, a large series of sounds of Consonant-Vowel-Consonant, Consonant-Vowel, and Vowel-Consonant combinations were used. This group of sound combinations was called the Standard Articulation Lists and was used for testing the efficiency of telephone circuits. Difficulty in writing down meaningless sounds caused these lists to be unsatisfactory for hearing testing, but they formed the basis for many further speech-hearing tests.[4]

---

[1]Hudgins, op. cit., p. 60. [2]Ibid., pp. 60-61.

[3]MacFarlan, op.cit.,p. 80. [4]Ibid.,pp. 78-79.

The Wengel Audioselective Hearing Test was devised to be administered in conjunction with pure tone hearing tests. The patient was given an earphone, connected to the testing equipment, and a copy of a word sheet. One of each pair of words of like sound was spoken into the microphone, and the patient marked on his sheet the word he thought he heard. This was a test of sound discrimination.[1]

In 1938, Robert West developed a word list which is used in discrimination testing. The examiner pronounces one of a pair of words and the listener checks on an answer sheet the word he thinks he hears. In this test, groups of words have been listed which lie in various frequency zones, and thus the test is one of "selective amplification." It is helpful in discovering the frequency area of the hearing loss.[2]

A similar test of sound discrimination was devised by Alfred Thea in 1941. The record sheets present blocks of three words which sound alike. The person being tested draws a line through the word he believes he hears.[3]

Watson and Knudsen developed a list of 69 words, 20 vowel words, and 49 consonant words. These are used first to find the threshold of speech, and then repeated at various

---

[1] Ibid., pp. 90-91.

[2] Ibid., pp. 91-92.

[3] Ibid., pp. 99-101.

levels above threshold. The grading of the test results gives the percentage syllable articulation score.[1]

In the late 1940's a program of audiometric test development was undertaken at the Harvard University Psycho-Acoustic Laboratory (PAL) with three aims in view: (1) to explore further the problems involved in the construction of audiometric tests for measuring directly the hearing loss for speech, (2) to produce a test suitable for precise laboratory measurements of all degrees of hearing loss, and (3) to explore by means of verbal tests the possibility of differentiating between high-frequency deafness and that which is uniform throughout the audible frequency range.[2] This program led to standardized tests for both Speech Reception Threshold and Auditory Discrimination.

The PAL Auditory Tests numbers 9 and 12 measure the threshold of intelligibility for spondaic (two-syllable, equally accented)[3] words and for sentences, respectively.[4]

The PAL PB-50 Lists were developed by Egan. He was most interested in the development of these lists because he felt that the loss for speech could be predicted quite

---

[1] Ibid, pp. 93-95.

[2] Ibid.

[3] Morris F. Heller, Functional Otology (New York: Springer Publishing Company, Inc., 1955), p. 120.

[4] Hirsh, et al., op. cit., p. 321.

reliably from an audiogram and thus the measure of discrimination loss gave the most useful information regarding the hearing of speech.[1] Twenty lists were devised, each containing 50 monosyllabic words and satisfying the discrimination criteria mentioned earlier.[2]

There were certain deficiencies in the PAL Speech-Hearing test lists: (1) certain Speech Reception Threshold recordings yielded slightly different thresholds from other of the recordings, (2) the vocabulary utilized in the PB lists was too large for many clinical patients, and (3) the recorded versions of the PB lists were not available in suitably standard form. Improvements were made in the PB lists in the areas of familiarity and of phonetic balancing.

The Central Institute of the Deaf further refined these tests, and the results are presently the most generally accepted lists for speech hearing-testing.

CID Auditory Test W-1--There are six scramblings of a single list of 36 spondaic words. These lists permit the measurement of the threshold of intelligibility of speech. The most familiar spondees from PAL numbers 9 and 12 were obtained from ratings of judges on a three-point scale, and the most simple and most difficult words were omitted from the final list.

---

[1] Ibid., p. 322.

[2] Egan, op. cit., p. 963.

CID Auditory Test W-2--The same words and word orders are utilized as those on the CID W-1 test. The intensity of the recording is attenuated three decibels every three words for use in rapid estimations of the threshold of intelligibility.

CID Auditory Test W-22--A vocabulary of 200 monosyllabic words is divided into four lists of 50 words each. Each list is phonetically balanced, that is, the speech sounds within the list occur with the same relative frequency as they do in representative samples of the English language. There are six scramblings of each list. The words are spoken with the carrier phrase "you will say" and a 1000 cycles per second calibration tone is set at the average level of the carrier phrase. This test is used to determine a person's discrimination loss for speech. The level at which a person is tested is sufficiently high so that a further increase in intensity is not accompanied by a further increase in amount of speech material repeated correctly. Large discrimination losses have been found to yield important diagnostic distinctions.[1]

The Testing of Children

Guilford and Haug contend that the ultimate success of speech and language development in the hard-of-hearing child is dependent on appropriate early training procedures following the accurate diagnosis of the impairment.[2] In testing the

---

[1]Hirsh, op. cit., pp. 322-333.

[2]Frederick R. Guilford and C. Olaf Haug, "Diagnosis of Deafness in the Very Young Child," Archives of Otolaryngology, 55 (February, 1952), p. 101.

hearing of children, one must appreciate the importance of relatively short attention spans, longer reaction times, and must take into consideration variations of mental abilities and the backgrounds of environmental experiences. Morley has observed that in spontaneous play the pre-school child usually gives only a short time to any one particular activity. This relative brevity of attention will influence the child's reaction to any particular activity. He found the attention span to be 2.5 minutes at two years of age, 4.7 minutes at three years of age, and 5.6 minutes at four years of age. He also found that in a competitive situation the attention span is longer than in either the unmotivated or praised effort situation. A child's reaction time was found to increase with age.[1]

A child's speech ability must also be taken into consideration. Travis found that at all age levels from five to adult, individuals with functional speech disorders made significantly more errors on a discrimination test than individuals with normal speech. The test used in this study consisted of each sound in the English language paired with every other sound and with itself to comprise a test of 366 pairs of speech sounds. A high percentage of the sounds

---

[1] D. E. Morley, "Rationalism in Testing Hearing of Children," Volta Review, 50 (1948), p. 470.

missed in the test were those with which these cases were having speech difficulty.[1]

Hutton and Weaver found that at Kindergarten and lower elementary grade levels there are substantial differences between the two word familiarity extremes. This study made use of the Thorndike-Lorge general count and the total occurrence in Rinsland's elementary school list of words. It was the opinion of these men that the size of the differences is great enough to cause serious concern about the use of the PB W-22 lists and recordings in hearing testing at lower grade levels.[2]

Many methods have been devised for the testing of hearing in children. Of these tests, those which are concerned with the hearing of speech are generally of the type that denote the level of intelligibility for speech, and do not tell the examiner much about the discrimination ability of the child.

The "Western Electric 4-A Audiometer" has been used for group testing of children, utilizing spoken numbers.[3]

---

[1]Lee E. Travis and Bessie Rasmus,"The Speech Sound Discrimination Ability of Cases with Functional Disorders of Articulation," Quarterly Journal of Speech, 17 (April, 1931), pp. 217-226.

[2]Charles Hutton and John Weaver, "PB Intelligibility and Word Familiarity," Laryngoscope, 69 (November, 1947), pp. 159-160.

[3]MacFarlan, op. cit., p. 74.

The Crowden method of testing children from ages two to four, developed at the University of London, utilizes a phonograph record on which words are recorded. This record is accompanied by a card illustrating the words on the record. The child responds by pointing to the picture of the word heard.[1]

In 1943, Laila Larsen, at Indiana University, developed a very practical speech-hearing test for young children which closely resembles the Crowden test.[2]

The Ewings, T. Littler, and P. Kerridge developed a list of words and sentences representing a selection of a large variety of speech sounds, and found that children under seven years of age would have difficulty with them because of lack of familiarity.[3]

The Maico Company has devised a test with numbers and selective words. A picture sheet with four columns for each ear offers a choice in each column of three objects which sound alike in pronunciation except for the constant elements. The child being tested merely checks which one of the three objects he believes he heard named. The test words are chosen to detect cases of high tone hearing loss from 1000 to 4000 cps.[4]

Marian Quick found that a multiple choice test could provide a method of response that would measure speech perception regardless of the subject's lack of capacity in

---

[1] Ibid., p. 82.
[2] Ibid., p. 83.
[3] Ibid., p. 95.
[4] Ibid., p. 114.

other areas, specifically speech. With this test the child could underline the word rather than write it, and she found 25 words to be the optimum length for the test. She devised this test specifically for small deaf children.[1]

A recording developed by Edna K. Monsees in 1952 serves the same purpose in testing hearing of children as is served by the CID Auditory Test W-1 in adults. Side one of the test record is used with toys, and the child points to toys as requested by the recorded voice. Side two contains numbers which the child must repeat as long as he can hear them.[2]

Sortini and Flake have tested both the Speech Reception Threshold and Discrimination ability with the use of toys. They found toys to be helpful for evaluating the pre-school child's ability to hear and understand speech from a communicative standpoint.[3]

Siegenthaler feels that an examiner must use speech signals of known acoustic values which children recognize or can be taught to recognize, and he must obtain voluntary responses which can be judged as evidence of hearing in order to do adequate subjective testing. With these qualifications in mind, he devised a "Picture Identification Test" which

---

[1]Marian A. Quick, "A Test for Measuring Achievement in Speech Perception Among Young Deaf Children," Volta Review, 55 (January, 1953), pp. 28-31.

[2]"Children's Auditory Test," Volta Review, 55 (November, 1953), p. 446.

[3]Sortini, op. cit., pp. 994-995.

required the child to point to simple pictures. The test items were selected to be familiar, phonetically dissimilar, representative of speech sounds, and homogeneous in basic audibility. Both monosyllabic and disyllabic nouns for which pictures could be found were used, and by far the greatest number of pictures were found for the two syllable words. It is felt that this test meets the criteria of an acceptable threshold test, meets the special needs of a test for children, has a close relationship with spondee threshold for a group of adults, and a high correlation with pure tone average hearing loss for a group of children.[1]

Keaster developed a speech-hearing test for children using pictures for 25 nouns particularly familiar to children under six years of age. The child is asked to do certain things with the pictures, such as "put the baby on the floor." The lowest level at which the child is able to follow at least three directions is considered his speech threshold.[2]

Pronovost developed a picture type sound discrimination test as a revision of the Mansur Speech Sound Discrimination Test. Word pairs representing objects which could be pictured easily were selected, and the pairs were so structured that

---

[1]Bruce M. Siegenthaler, Jack Pearson, and Raymond Lezak, "A Speech Reception Threshold Test for Children," Journal of Speech and Hearing Disorders, 23 (May, 1958), pp. 153-159.

[2]Jacqueline Keaster, "A Quantitative Method of Testing the Hearing of Young Children," Journal of Speech and Hearing Disorders, 12 (June, 1947), pp. 159-160.

only one phoneme in the pair differed. There were three pairs of pictures per item, two pairs of same pictures, and one pair of different pictures. This test was found to be reliable and valid, but has limitations. In order to respond to an unlike pair the child need only make a "like-different" judgment, while in response to a like pair, he must make a "like-different" judgment and identification. It is felt that this test does not measure on a high enough level of speech sound discrimination to be used in a definitive study of the abilities of the normal hearing population. The inability to find usable word pairs which can be pictured easily makes it impossible to test each difficult sound in various combinations.[1]

A recent study by McNamee, Ohio State University, has shown that the ability of normal hearing children to respond correctly to the CID Auditory Test W-22 decreases with age. She found adults to average 90 per cent correct responses, and scores decreased to 70.5 per cent by children at the first grade level. No children under six years of age were tested.[2]

---

[1]Wilbert Pronovost and Charles Dumbleton, "A Picture-type Sound Discrimination Test," Journal of Speech and Hearing Disorders, 18 (September, 1953), pp. 258-266.

[2]McNamee, op. cit.

CHAPTER III

SUBJECTS, EQUIPMENT, AND TESTING PROCEDURES

Subjects

Pre-school children ranging in age from three years, zero months, to five years, eight months were subjects in this study. There were 21 three year olds, seven males and 14 females; 39 four year olds, 22 males and 17 females; and 22 five year olds, 10 males and 12 females.

All of the children tested were enrolled in the Spartan Nursery School at Michigan State University, and were the children of students at the University. These children attend the nursery school either two or three half days per week. The nursery is run on a cooperative basis, the permanent staff being aided by each of the parents two times during each school term.

Equipment

Hearing testing for the elimination of subjects whose hearing did not fall within the defined normal limits was done with a Maico audiometer, D9, Serial number 4781, earphone number MX41/AR.

The standardized CID Auditory Test W-22 recordings were transcribed onto magnetic tape at the AudioVisual Center at Michigan State University, the 1000 cycle per second calibration tone included at the beginning of the tape. Lists 1A, 2A, 3A, and 4A were used. Forms for each list were devised by the examiner for transcribing the responses of each child.

The tape was played to each child on an Ampex 620 dual channel tape recorder, (Ampex 601 with 620 Speaker). Only one channel was used for this test.

Procedure

1. Orientation to the test situation.--In order to familiarize the children to the test situation the examiner conducted a practice session with each nursery school group of approximately fifteen children. This session consisted of a discussion of the pure tone test in terms of earphones which air plane pilots wear. The children were allowed to practice responding to sounds by raising their hands. A tape recording was made of one syllable words utilizing a male voice for practice on the discrimination test. These words were chosen in such a way that they did not appear on any of the CID Auditory Test W-22 lists. The presentation of these words on tape approximated the actual testing recording, but more time was allowed between words for practice responses. The children listened to the tape recording and responded to it, first in a group and then

individually as they were pointed out. This orientation session was held in the nursery school room with all groups but one. The youngest children were taken to the testing room for the orientation session for purposes of familiarizing them with the test environment.

2. Hearing screening.--Each child was given a pure tone sweep check hearing test in both ears at 15 decibels, at 500, 1000, and 2000 cycles per second. This testing was done in the testing room and preceded immediately the discrimination test. Any child not responding to all stimuli at 15 decibels was not included in the discrimination testing.

3. CID Auditory Test W-22 Discrimination Testing.--This testing was carried out in a small room away from the nursery school environment. The background noise as tested by a sound pressure level meter (General Radio) was 45 decibels. The calibration tone of the tape recording was set at 55 decibels, 40 decibels above the 15 decibel pure tone threshold and 10 decibels above the background noise, at the ear of the listener. No specific instructions were given the children, as they had all taken part in the practice sessions, but each child was allowed two trial responses to stimuli given by the examiner, as for many of them several days elapsed between the practice session and the actual testing situation. The examiner sat in the room with the child and recorded response errors on the test forms. The recording was played, and no rest period was given. Only one child was in the room with the examiner at one time.

CHAPTER IV

RESULTS AND DISCUSSION

Results

The test results were tabulated and subjected to several statistical treatments. It was the desire of the examiner to find any deviations and correlations that existed among the scores of the children in the three age groups. Only two out of 82 children tested failed to respond verbally to the test, and these results were omitted from the analysis.

Standard deviations from the mean of each age group.-- The standard deviation for each age group was found utilizing the formula $\sqrt{\frac{\Sigma(X-\bar{X})^2}{N-1}}$ The results are presented in Table 1.

TABLE 1

STANDARD DEVIATION FOR EACH AGE GROUP

Age	Number of Subjects	Mean	Standard Deviation
3	19	32.00	4.74
4	39	37.47	4.21
5	22	40.32	3.24

Correlation between the two halves of the test.--A split half correlation was employed to determine whether the number of correct responses to the two halves of the CID Auditory Test W-22 were similar. The Pearson Product-Moment Correlation Coefficient was used:[1]

$$r_{xy} = \frac{\Sigma xy}{N\sigma_x\sigma_y}$$

The results of this analysis are presented in Table 2.

TABLE 2

CORRELATION BETWEEN THE TWO HALVES OF THE CID AUDITORY TEST W-22 FOR EACH AGE GROUP

Age	Correlation between Halves of the Test
3	.53
4	.50
5	.58

Variation among age levels.--The Kruskal-Wallis One Way Analysis of Variance by Ranks was employed to determine if there were a significant variance among the three age groups tested. The formula, as given by Siegel, was:[2]

$$H = \frac{\frac{12}{N(N+1)} \sum_{j=1}^{k} \frac{R_j^2}{n_j} - 3(N+1)}{1 - \frac{\Sigma T}{N^3 - N}}$$

[1]Anna Anastasi, Psychological Testing (New York: The MacMillan Company, 1961), p. 115.

[2]Sidney Siegel, Nonparametric Statistics for the Behavioral Sciences (New York: McGraw-Hill Book Co., Inc., 1956), p. 185.

In the data analyzed, there were many tied scores; therefore, a correction for ties was made. The correction factor is identified in the formula as:

$$1 - \frac{\Sigma T}{N^3 - N}$$

The results of this analysis were:

$$H = \frac{46.55}{.995} = 46.78$$

When referred to a table of Critical Values of Chi Square, with df = 3-1 = 2, the probability associated with the observed value of H was less than .001.

Correlation between age and score within age groups.--A test of correlation was employed to determine the relationship between ages and scores within each of the age groups.

The formula Rho = $1 - \frac{6\Sigma d^2}{N(N^2-1)}$ was used.[1]

The results are presented in Table 3.

TABLE 3

CORRELATION BETWEEN AGE AND SCORE WITHIN EACH AGE GROUP

Age	Rho Correlation
3	.31
4	.30
5	.13

[1]Quinn McNemar, Psychological Statistics (New York: John Wiley and Sons, Inc., 1949), p. 97.

Discussion

The standard deviation does not differ greatly among the three age levels; however, it does appear to decrease as a function of age, thus indicating a tendency for the range of scores to lessen as age increases.

A positive correlation exists between the two halves of the CID Auditory Test W-22 for all three age levels. This correlation does not differ greatly among the three groups. There appears to be a tendency for all of the children within this population to respond somewhat similarly to both halves of the test. Therefore, it is not possible to reject the null hypothesis number two, which states there is no correlation between responses to the first and second halves of the CID Auditory Test W-22. Even though the correlations are not high, there are positive relationships shown.

The Kruskal-Wallis One-Way Analysis of Variance by Ranks was employed to determine the variation among age levels. This technique is extremely useful for determining whether a group of samples are from different populations. Siegel feels that this test "is more efficient than the extension of the median test because it utilizes more of the information in the observations, converting the scores into ranks rather than simply dichotomizing them as above or below the median."[1]

The significance level, calculated by this method, was less than .001, indicating an extremely high probability

---

[1]Siegel, op. cit.

that the three groups of samples did not come from the same parent population. This leads to rejection of the null hypothesis number 1, which states that there is no significant variation among the responses of three, four, and five-year old children to the CID Auditory Test W-22.

The Rho Correlation values found between age and score within each age group indicate a positive but rather low correlation between age and test score. There appears to be a tendency for this correlation to lessen as age increases. The null hypothesis number 3, which states that there is no correlation between age levels within each of the three age groups and performance on the discrimination task, may be rejected only with some reservations. Within the five year level the correlation is low.

In Figure 1 the frequency distribution of the raw scores achieved by each age level is presented. It will be noted that the distributions overlap, while the peaks, or means, appear to increase as a function of age. The range for age three is 21; for age four is 18; and for age five is 11.

In Figure 2 is presented a graphic display of the cumulative distributions of the scores achieved by each age level on the CID Auditory Test W-22. It is of interest to note that at no point do the distributions overlap.

One must remember in studying the above data, that the children tested in this study probably were not a representative

Figure 1. FREQUENCY DISTRIBUTION OF RAW SCORES

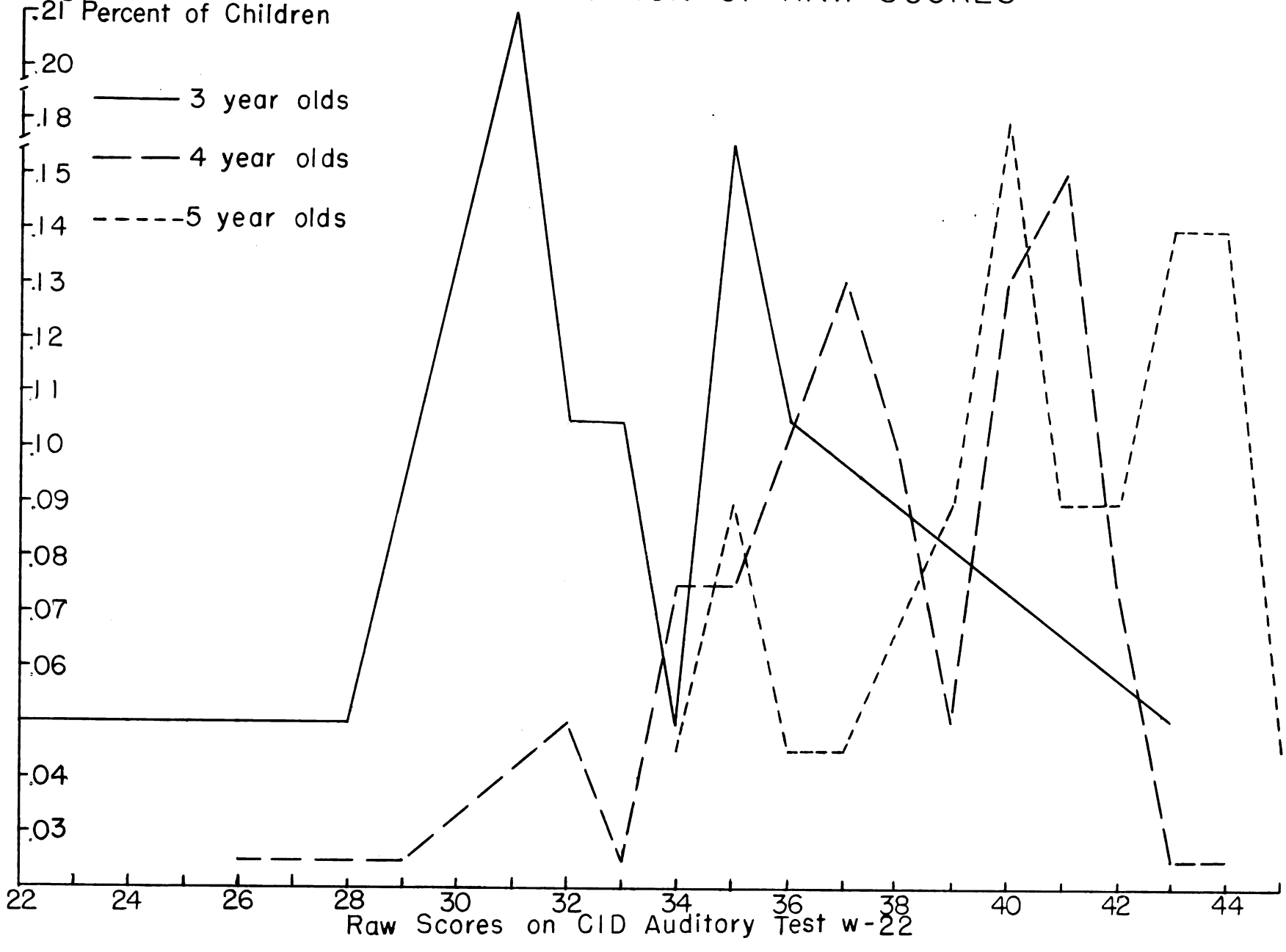
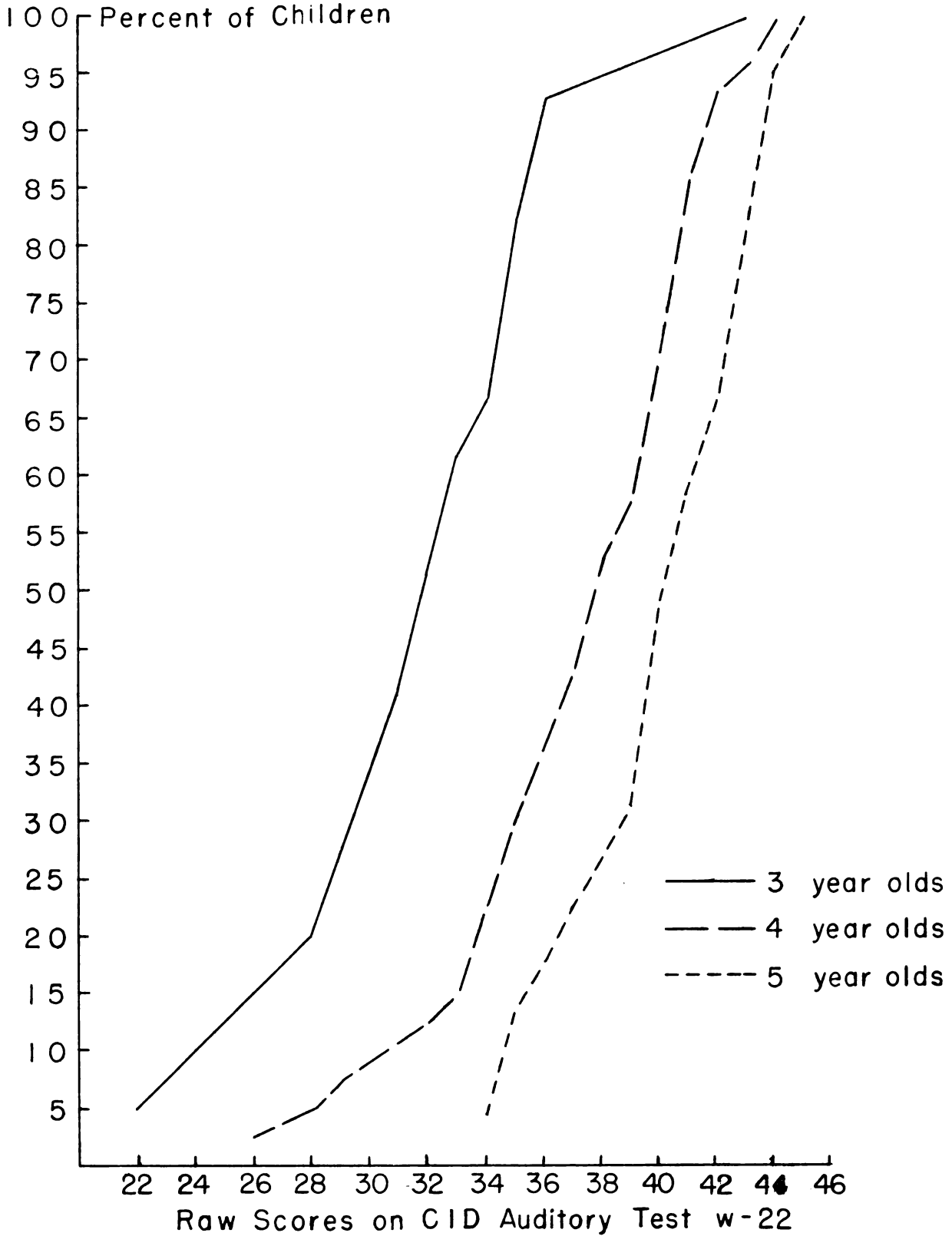


Figure 2. COMULATIVE DISTRIBUTION OF RAW SCORES



sample of the entire population of pre-school children. They were all children of University students and were enrolled in a nursery school, a situation which allowed them to interact socially with a great many other children and adults. This may well account for the excellent cooperation obtained. It is interesting to note that of the 82 children originally tested, only two failed to respond to the test situation in any way.

The results of this study indicate that there is some question as to whether or not the CID Auditory Test W-22 can be used with pre-school children as it is with adults, in determining speech discrimination. There are several indications that discrimination ability increases with age at the pre-school age level. The fact that the range of scores appears to decrease as age increases is consistent with the knowledge that the scores of normal hearing adults will vary only a few points. McNamee has shown that there is a relatively consistent increase in discrimination scores as a function of age. As age levels increase, scores become higher.

Questions concerning reasons for these results can at this time be answered only hypothetically. The attention span of pre-school children is recognized as being somewhat shorter than that of adults, and this can well be a factor in test responses. Word familiarity can also be a causal factor for incorrect responses. Some of the children actually

stopped to ask "What does that mean?" when a stimulus word unfamiliar to them occurred.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The emphasis in audiology, in children as well as in adults, must be upon the understanding of the social functions of hearing. The evaluation of the social aspects of a hearing loss is carried out through speech audiometry. One of the most important areas of speech audiometry, that of discrimination testing, has not yet successfully been utilized with small children.

The purpose of this study has been to analyze the results obtained from pre-school children as they responded to the CID Auditory Test W-22 in an effort to determine the plausibility of administering this test to children of so young an age.

For the planning of a training program for the hard-of-hearing child, knowledge regarding his ability to hear and understand speech is desirable. The importance of this study centers around the possibilities of gaining insight into a child's discrimination ability through use of the CID Auditory Test W-22.

A review of the literature concerning speech-hearing testing of children indicates that, while several Speech

Reception Threshold tests have been devised and successfully utilized with children, no similar procedures have been established for the testing of sound discrimination. Those discrimination tests in existence have been standardized on adults, and have apparently not been, to date, utilized with young children.

The subjects for this study were 82 three, four, and five-year old children enrolled in a University nursery school. A pure tone screening test at 15 decibels eliminated from the study all children whose hearing acuity was not within the defined normal limits. The standardized recordings of the CID Auditory Test W-22 (Lists 1A, 2A, 3A, and 4A), were transcribed onto magnetic tape and played to the children at a level of 55 decibels in a room with an ambient noise level of 45 decibels. An orientation program familiarized the children with the test procedures, while not acquainting them with the actual test items. The children were tested individually, their responses being recorded by the examiner.

The findings of this study indicate that while the standard deviation does not differ greatly among the three age levels tested, it appears to decrease as a function of age. The number of correct responses of all of these children appear to be similar on the two halves of the test. An analysis of variance indicated a significant variation in scores among the three age levels. There appears to be a small positive correlation between age and score within each

of the three age groups, this correlation tending to decrease as age increases.

Conclusions

1. One should not use the CID Auditory Test W-22 for the testing of discrimination in children as he would with adults until further analysis is made of error responses.

2. A 50 word discrimination test is apparently not too long for pre-school children as evidenced by the fact that there was a good correlation between scores on first and second halves of the test.

3. There is a systematic difference in the performance of three, four, and five-year olds on the CID Auditory Test W-22, the range of deviation becoming smaller as age increases.

4. There is less correlation between age and score as age increases among three, four, and five-year olds.

5. The results of this study follow the trend discovered in the study of school age children by McNamee, who showed that discrimination performance increases as a function of age.

Implications for Future Research

This study has reported several tendencies relating to the responses of pre-school children to the CID Auditory Test W-22. It has been limited to analysis of the number of correct responses, and there is a wealth of information yet to be obtained regarding the nature of the incorrect responses.

The following questions might well be set forth for future study:

1. Are some sounds more difficult for pre-school children to discriminate than others?
2. Are there any words which are responded to incorrectly by the majority of pre-school children?
3. Are there any words which are responded to correctly by all pre-school children?
4. Are responses by pre-school children to the CID Auditory Test W-22 words related in any way to familiarity values that have been assigned to the words by Thorndike and Lorge?[1]

With information gained from answers to the above questions, a new, revised list of PB words might well be established which could be utilized successfully with pre-school children.

---

[1]E. L. Thorndike and Irving Lorge, The Teacher's Word Book of 30,000 Words (New York: Bureau of Publications, Teachers College, Columbia University, 1944).

BIBLIOGRAPHY

Books

Anastasi, Anne. Psychological Testing. New York: The MacMillan Company, 1961.

Davis, Hallowell and Silverman, S. Richard. Hearing and Deafness. New York: Holt, Rinehart, and Winston, Inc., 1960.

Dixon, Wilfrid J. and Massey, Frank J., Jr. Introduction to Statistical Analysis. New York: McGraw-Hill Book Company, Inc., 1957.

Heller, Morris F. Functional Otology. New York: Springer Publishing Company, Inc., 1955.

Lindquist, E. F. Design and Analysis of Experiments in Psychology and Education. Boston: Houghton Mifflin Company, 1956.

McNemar, Quinn. Psychological Statistics. New York: John Wiley and Sons, Inc., 1949.

Newby, Hayes A. Audiology. New York: Appleton-Century-Crofts, Inc., 1958.

Siegel, Sidney. Nonparametric Statistics for the Behavioral Sciences. New York: McGraw-Hill Book Company, Inc., 1956.

Thorndike, E. L. and Lorge, Irving. The Teacher's Word Book of 30,000 Words. (New York: Bureau of Publications, Teachers College, Columbia University, 1944.

Periodicals

"Children's Auditory Test," Volta Review, 55 (November, 1953), p. 446.

Davis, Hallowell. "The Articulation Area and the SAI for Hearing," Laryngoscope, 58 (1948), pp. 761-778.

Egan, James P. "Articulation Testing Methods," Laryngoscope, 58 (September, 1948), pp. 955-991.

Guilford, Frederick R. and Haug, C. Olaf. "Diagnosis of Deafness in the Very Young Child," Archives of Otolaryngology, 55 (February, 1952) pp. 101-106.

Hirsh, Ira J., Davis, Hallowell, Silverman, S. Richard, Reynolds, Elizabeth G., Eldert, Elizabeth, and Benson, Robert W. "Development of Materials for Speech Aduiometry," Journal of Speech and Hearing Disorders, 17 (September, 1952), pp. 321-337.

Hudgins, Clarence, et al. "The Development of Recorded Auditory Tests for Measuring Hearing Loss for Speech," Laryngoscope, 57 (1947), pp. 57-89.

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

Keaster, Jacqueline. "A Quantitative Method of Testing the Hearing of Young Children," Journal of Speech and Hearing Disorders, 12 (June, 1947), pp. 159-160.

MacFarlan, Douglas. "Speech Hearing Testing," Laryngoscope, 55 (February, 1945), pp. 71-115.

Morley, D. E. "Rationalism in Testing Hearing of Children," Volta Review, 50 (1948), pp. 468-478.

Pronovost, Wilbert and Dumbleton, Charles. "A Picture-type Sound Discrimination Test," Journal of Speech and Hearing Disorders, 18 (September, 1953), pp. 258-266.

Quick, Marian A. "A Test for Measuring Achievement in Speech Perception Among Young Deaf Children," Volta Review, 55 (January, 1953), pp. 28-31.

Siegenthaler, Bruce M., Pearson, Jack, and Lezak, Raymond. "A Speech Reception Threshold Test for Children," Journal of Speech and Hearing Disorders, 19 (September, 1954), pp. 360-366.

Sortini, Adam J. and Flake, Carlyle G. "Speech Audiometry Testing for Preschool Children," Laryngoscope, 63 (October, 1953), pp. 991-997.

Travis, Lee E. and Rasmus, Bessie. "The Speech Sound Discrimination Ability of Cases with Functional Disorders of Articulation," Quarterly Journal of Speech, 17 (April, 1931), pp. 217-226.

Unpublished Material

McNamee, JoAnne. "An Investigation of the Use of the CID Auditory Test W-22 with Children." Unpublished Master's thesis, Ohio State University, 1960.

APPENDICES

APPENDIX A

Scores Age Three

Subject Number	Age	Raw Score	First Half Score	Second Half Score
1	3-0-15	31	14	17
2	3-2-14	24	13	11
3	3-2-17	26	12	14
4	3-3-15	35	19	16
5	3-3-17	35	17	18
6	3-3-30	22	10	12
7	3-5-9	36	20	16
8	3-5-10	31	15	16
9	3-5-18	36	19	17
10	3-6-17	28	15	13
11	3-6-28	31	15	16
12	3-7-1	43	21	22
13	3-7-27	31	13	18
14	3-8-4	33	17	16
15	3-8-15	32	16	16
16	3-8-19	35	17	18
17	3-9-5	32	15	17
18	3-9-27	34	19	15
19	3-11-26	33	14	19

Scores Age Four

1	4-0-9	38	18	20
2	4-0-14	34	17	17
3	4-1-0	33	18	15
4	4-1-2	37	19	18
5	4-1-3	39	19	20
6	4-1-4	32	19	13
7	4-1-7	42	22	20
8	4-1-7	38	20	18
9	4-1-25	28	14	14
10	4-2-12	32	16	16
11	4-2-13	29	12	17
12	4-3-8	37	20	17
13	4-4-5	41	21	20
14	4-5-2	34	17	17
15	4-5-17	39	20	19
16	4-5-28	42	22	20
17	4-5-29	41	21	20
18	4-6-8	26	12	14
19	4-6-10	37	18	19

APPENDIX A--Continued

Subject Number	Age	Raw Score	First Half Score	Second Half Score
20	4-6-27	40	18	22
21	4-6-28	41	21	20
22	4-7-1	41	20	21
23	4-7-22	40	18	22
24	4-8-0	41	21	20
25	4-8-12	40	21	19
26	4-8-13	42	20	22
27	4-8-14	35	19	16
28	4-8-16	38	20	18
29	4-9-19	34	19	15
30	4-10-0	38	17	21
31	4-10-6	40	20	20
32	4-10-9	43	24	19
33	4-10-10	40	21	19
34	4-10-15	35	16	19
35	4-10-17	37	18	19
36	4-11-4	41	21	20
37	4-11-8	37	17	20
38	4-11-9	44	22	22
39	4-11-15	35	17	18
		Scores Age Five		
1	5-0-16	36	18	18
2	5-0-20	43	22	21
3	5-0-29	41	19	22
4	5-1-22	37	20	17
5	5-2-20	42	22	20
6	5-2-21	44	22	22
7	5-2-29	41	21	20
8	5-2-29	42	21	21
9	5-3-1	39	18	21
10	5-3-1	39	20	19
11	5-3-7	45	23	22
12	5-3-7	34	17	17
13	5-3-9	35	18	17
14	5-3-28	40	21	19
15	5-3-28	40	19	21
16	5-4-11	43	22	21
17	5-4-13	43	22	21
18	5-4-24	35	18	17
19	5-5-2	40	21	19
20	5-5-26	40	21	19
21	5-5-26	44	23	21
22	5-8-15	44	23	21

APPENDIX B

WORD LIST FOR PRE-TEST ORIENTATION

please
great
sled
rat
bad
pinch
such
bus
need
five
mouth
rag
put
fed
fold
box
teach
slice
smile
bath
slip
ride
pink
thank
dish

APPENDIX C

CID AUDITORY TEST W-22

List 1A

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

APPENDIX C--Continued

List 2A

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

APPENDIX C--Continued

List 3A

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

APPENDIX C--Continued

List 4A

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