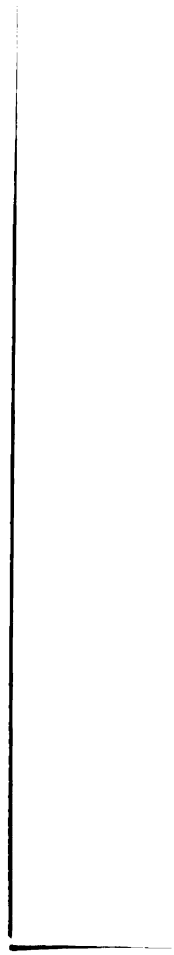
AN INVESTIGATION OF THE USE OF QUANTIFICATION IN ARTICULATION TESTING OF FUNCTIONAL ARTICULATORY DISORDERS

Thesis for the Degree of M. A.

MICHIGAN STATE UNIVERSITY

Norma J. Smith

1965



ABSTRACT

AN INVESTIGATION OF THE USE OF QUANTIFICATION IN ARTICULATION TESTING OF FUNCTIONAL ARTICULATORY DISORDERS

by Norma J. Smith

Testing for articulatory disorders constitutes an important part of the work of the public school speech correctionist. Effective instruments in carrying out such testing are imperative as children with articulatory disorders can compose up to 85 per cent of the case load in a public school.

The main purposes of this study were to construct a short descriptive articulation test which would also be more comprehensive and to devise a method of obtaining the percentage of an individual's improvement.

An articulation test which yielded three indicies was constructed. These were an Articulation Score, a Stimulability Score and an Improvement Index. The test was administered to a sample of 25 school children. A 30-second sample of their conversational speech was recorded. This tape was judged by 12 graduate students in Speech and Hearing Science. The judges used two types of rating scales; an ungrouped rating scale and a grouped rating scale. The hypotheses tested concerned the relationship between the number of consonant sounds misarticulated and the judgement of the severity of that articulatory disorder along an

ungrouped rating scale and along a grouped rating scale.

From the data obtained it was concluded that a positive significant relationship at the .05 level of confidence did exist between the number of test sounds misarticulated and the judgement of severity of the articulatory disorder using both rating scales.

Further research regarding the indices obtained from the test, particularly the Improvement Index, may yield more information as to the possibility of their serving as an estimate of the prognosis for speech therapy.

AN INVESTIGATION OF THE USE OF QUANTIFICATION IN ARTICULATION TESTING OF FUNCTIONAL ARTICULATORY DISORDERS

By

Norma J. Smith

A THESIS

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

MASTER OF ARTS

Department of Speech

1965

TABLE OF CONTENTS

CHAPTER I

STATEMENT OF THE PROBLEM

Introduction

Speech is a very important asset to mankind. Its use among family, friends and at national and international conference tables is almost priceless. Successes or failures in our communication through the medium of speech determines to a great extent the way the world turns.

The effectiveness of speech depends not alone upon mere skill in using words but also upon the mechanics involved in the utterance of these words. The manner in which a verbal communication is articulated may hold a relative degree of importance to what is said. Hence speech may be more effective if it is correctly articulated.

The authors of the book Speech Handicapped School Children maintain that disorders of articulation account for the majority of speech defects found among public school children. The revised edition of the book cites 70 to 85 per cent of the children seen by the public school correctionist as having defects of the articulatory type.[1]

---

[1]Wendell Johnson, Spencer J. Brown, James Curtis, Clarence W. Edney and Jacqueline Keaster, Speech Handicapped School Children, 2nd ed. rev.; (New York: Harper and Row, 1956), p. 9.

The majority of these children have functional articulatory disorders. Anderson gives 75 per cent as the incidence of articulatory disorders found among the speech defectives in the public school population.[1] A questionnaire-type survey of the clinical practices and remedial procedures of a nationwide representative sample of 749 speech therapists revealed that the caseload of the average therapist was 130. This survey also revealed that the average percentage of the articulation cases for the therapists who reported was 81 per cent.[2]

With such a high percentage of the speech therapist's caseload being composed of children with articulatory disorders testing for such disorders becomes important. An effective and comprehensive articulation test particularly for use in describing the articulatory behavior of children would be an aid to the public school speech correctionist.

Purpose of Study

The purpose of this study is two-fold: (1) to devise a short, descriptive and comprehensive articulation test which may be used in describing the articulatory disorders of individuals and (2) to suggest a method whereby an index

---

[1]Virgil A. Anderson, Improving the Child's Speech, (New York: Oxford University Press, 1953), p. 126.

[2]Myfanwy E. Chapman, Ester Herbert, Charlotte Avery, John Selmar, "Clinical Practice: Remedial Procedures," Journal of Speech and Hearing Disorders, Monograph Supplement 8 (1961), p. 59.

of the individual's improvement may be obtained.

Such a test would help to assure the maxium benefit of the speech therapy program to the majority of those who receive its services. The test may be of assistance to the public school therapist in the following ways: (1) selecting a caseload, (2) giving an indication of the child's ability to correct his misarticulated sounds, (3) aiding the therapist in planning therapy, (4) describing the severity of the articulatory problem.

Hypotheses

The clear, intelligible articulation of speech sounds is one aspect of effective communication. When an excessive number of misarticulated sounds appear in one's speech they may be noticed by the listener. If this is true it would suggest that some type of relationship may exist between the number of misarticulated sounds in one's speech and the awareness of these errors by a listener. The present study investigates the following two hypotheses.

Hypotheses.--There is a relationship between the number of consonant sounds misarticulated and the judgement of the severity of that articulatory disorder along an ungrouped rating scale.

There is a relationship between the number of consonant sounds misarticulated and the judgement of the severity of that articulatory disorder along a grouped rating scale.

The terms grouped and ungrouped, as pertaining to rating scales, will be defined subsequently.

Importance of Study

Articulation defects have been recognized as the most prevalent of speech defects among public school children. Studies concerning many aspects of articulatory disorders have been done. In comparison relatively few of these studies have been directly concerned with the quantification of articulatory defects.

The proposed study differs from similar ones in two ways. First, the Descriptive Articulation Test used in this study contains the most frequently misarticulated sounds according to Roe and Milisen.[1] Six sounds from the Wood Articulation Index with a weighted value of more than .90 in two or more positions were also included in the test.[2] Secondly, this study seeks to provide information which will be helpful in devising a method whereby some indication of an individual's ability to improve misarticulated sounds may be obtained.

It is hoped that from this study information may be gained as to the usefulness and practicableness of a

---

[1]Vivian Roe and Robert Milisen, "The Effect of Maturation Upon Defective Articulation In Elementary Grades," Journal of Speech and Hearing Disorders, 7 (1942), p. 43.

[2]Charles Van Riper and John Irwin, Voice and Articulation, (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1958), p. 12.

descriptive articulation test which yields certain numerical indices. It is further hoped that from such a test as the proposed one more comprehensive information may be gained which will aid the therapist in planning and executing more effective therapy. The desire of the writer is that any information which may be gained from this study be of such a nature as to contribute to the development of and greater understanding of articulation testing.

Definition of Terms

For the purposes of this study certain terms employed have been defined in the following manner:

Defective Articulation.--The incorrect production of a speech sound involving either substitutions, omissions, distortions or additions. Substitution is the replacing of one phoneme with another. Omission is leaving out a phoneme where it should occur. Distortion is the modifying of the production of a speech sound so that the acoustic result is inaccurate. Addition is interpolating or adding sounds which are not part of the word.[1]

Using Powers's definition a functional articulatory disorder is "an inability to produce correctly all of the standard speech sounds of the language, an inability for which there is no appreciable structural, physiological

---

[1]Margaret Hall Powers, "Functional Disorders of Articulation: Symptomatology and Etiology," Handbook of Speech Pathology, ed. Lee E. Travis, (New York: Appleton-Century Crofts, Inc., 1957), pp. 713, 714.

or neurological basis in the speech mechanism or its supporting structures."[1]

The Articulation Score yielded by the test is defined as the percentage of test sounds misarticulated by the testee following picture stimulation. This score is obtained by using the following formula in which twenty-one is the total number of sounds contained in the test and P represents the number of sounds which the subject misarticulates by picture stimulation.

$$\text{Articulation Score} = 100 \times \frac{21-P}{21}$$

The Stimulability Score indicates the percentage of test sounds which the testee continues to misarticulate after the examiner has correctly produced the test sound three times. This score is obtained by using a formula in which the letter V represents the number of incorrectly produced sounds which were misarticulated after voice stimulation.

$$\text{Stimulability Score} = 100 \times \frac{21-V}{21}$$

The Improvement Index indicates the percentage of correction of misarticulated sounds. This index is found by employing the following formula in which A represents the Articulation Score and S represents the Stimulability Score:

$$\text{Improvement Index} = 100 \times \frac{S-A}{S}$$

---

[1] Ibid., p. 708.

The picture test which was constructed for this investigation is called the Descriptive Articulation Test. This test is composed of twenty-one frequently misarticulated consonant sounds. All test sounds are presented in the medial position only. An Articulation Score (A), Stimulability Score (S) and an Improvement Index (I) may be obtained with the test. The test form is presented in Appendix C.

Judged Severity is defined as listener reaction to the speech samples of functional articulatory disorders. These reactions are indicated along a nine-point scale in which one represents least severe articulation and nine represents most severe articulation.

The ungrouped rating scale used in the study is a nine-point scale along which the judges ratings of the speech samples are placed. The grouped rating scale is a nine-point scale which has been divided into three groups of 3 points each and each group has been given a verbal description. The above rating scales are presented in Appendices D and E.

The trained speech therapists involved in the study are graduate students in the area of Speech and Hearing Science in the Department of Speech at Michigan State University.

Organization of the Thesis

Chapter I contains the statement of the problem which led to the present study. Sub-headings include an introduction to the study and the purpose for the study. The hypotheses considered in this study along with the importance of the study are also discussed in Chapter I. This chapter concludes with the definitions of certain terms used in the study. The review of the literature pertinent to this study composes Chapter II. Chapter III discusses the materials, subjects, equipment and procedures employed in the collection of the data for the study. The results of the study are presented in Chapter IV along with a discussion of these results. Chapter V consists of a summary of the study and conclusions drawn from the study. Implications for further research are also discussed in this final chapter.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

Many speech therapists may hold their own views in regard to the efficiency of and indeed, the possibility of effectively quantifying articulation defects. Some research studies have been done in the area of quantification and articulation testing. Among them are studies by Perrin,[1] Morrison,[2] Parobeck,[3] Jordan,[4] and Carter and Buck.[5] These and other studies have investigated

---

[1]Elinor Horwitz Perrin, "The Rating of Defective Speech by Trained and Untrained Observers," Journal of Speech and Hearing Disorders, 19 (1954), p. 48.

[2]Shelia Morrison, "Measuring the Severity of Articulation Defectiveness," Journal of Speech and Hearing Disorders, 20 (1955), p. 347.

[3]Donna J. Parobeck, "An Investigation of the Utility of Wood's Articulation Index as an Independent Measure of Articulation Proficiency," (unpublished M.A. thesis, Bowling Green State University, 1956).

[4]Evan P. Jordan, "Articulation Test Measures and Listener Ratings of Articulation Defectiveness," Journal of Speech and Hearing Research, 3 (1960), p. 303.

[5]Eunice T. Carter and McKenzie Buck, "Prognostic Testing for Functional Articulation Disorders Among Children in the First Grade," Journal of Speech and Hearing Disorders, 23 (1958), p. 124.

directly or indirectly the applicability of quantification to diagnostic articulatory testing.

The studies discussed in the remainder of this chapter are organized chronologically as far as possible under major headings and sub-headings which are relevant to the present study.

Incidence of Articulatory Disorders.--Investigations into the incidence of speech defects among public school children have revealed that a substantial incidence of such defects do exist. Of these children with speech defects those with functional articulatory defects comprise the majority.

In 1916, Wallin conducted an investigation by means of a questionnaire among the public school pupils in St Louis. Of the 89,057 pupils included in the study 2.8 per cent or 2,536 were judged by their teachers as having speech defects.[1]

Louttit made a survey of speech defects among the public schools in Indiana in 1936.[2] Questionnaire blanks were sent to the principals of 3,717 public schools in the state. Of the 1,223 blanks which were returned the gross incident of speech defects among a represented enrollment

---

[1] J.E. Wallace Wallin, "A Census of Speech Defectives Among 89,057 Public School Pupils: A Preliminary Report," School and Society, 3 (1916), p. 213.

[2] C. M. Louttit and E. C. Hall, "1936 Survey of Speech Defects Among Public School Children of Indiana," Journal of Speech Disorders, 1 (1936), p. 73.

of 199,839 children was 3.7 per cent. And of those children said to have speech defects 79 per cent had articulatory disorders.

The report of a speech survey during the school year 1940-1941 made by Mills and Streit in Holyoke, Massachuetts among the first three grades revealed 73.2 per cent as the total incidence of misarticulated sounds.[1]

Seventy per cent of the speech defects in children are of the articulatory type. This was the finding of Wood in his study involving parental maladjustment and functional articulatory defects among children.[2]

These and other similar studies have led to an agreement that speech defects of an articulatory nature are the most prevelant in school children. In order to detect more accurately such articulatory problems special articulation tests have been developed. In addition to the standard tests many speech therapists prefer to devise their own individual tests.

Articulation Testing.--According to Templin the articulation of speech sounds is assessed for two purposes:

---

[1]A. C. Mills and H. Streit, "1942 Report of a Speech Survey - Holyoke, Massachuetts," Journal of Speech Disorders, 7 (1942), p. 161.

[2]Kenneth S. Wood, "Parental Maladjustment and Functional Articulatory Defects in Children," Journal of Speech and Hearing Disorders, 11 (1946), p. 256.

(1) "to determine correctness or incorrectness of specific sounds" and (2) "to determine the general adequacy of articulation,"[1] However, Templin regards the chief purpose of testing as screening individuals with acceptable articulation from those with unacceptable articulation. She developed a non-diagnostic articulation test for ages three through eight which measured the child's spontaneous utterance in response to a picture, his utterance repeated after the examiner and his repeated utterance without the picture. The test consisted of fifty items. Norms were obtained for this test on 480 subjects.[2]

The diagnostic type of test is more comprehensive than the non-diagnostic articulation test. This type of test was utilized in the Carter and Buck study concerning a method for the prognostic testing of functional articulation disorders among first grade children.[3] The children were administered three tests. Test one was designed to evoke a spontaneous response. Test two was an imitation type test in which the child was asked to watch the examiner, listen carefully and to repeat the word in the same manner it was presented. The third test utilized the same sounds

---

[1]Mildred C. Templin, "A Non-Diagnostic Articulation Test," Journal of Speech and Hearing Disorders, 12 (1947), p. 392.

[2]Mildred C. Templin, "Norms On a Screening Test of Articulation for Ages 3-8," Journal of Speech and Hearing Disorders, 18 (1953), p. 323.

[3]Carter and Buck, op. cit.

in tests one and two but in nonsense syllables. Their basic reason for employing test three was to evaluate the child's ability to change a defective articulation pattern instantaneously.[1]

Prognostic Testing of articulatory disorders has been used with younger children. Farquhar investigated the prognostic value of imitative and auditory discrimination tests with kindergarten children.[2]

Maturation and Testing.--Studies seem to show that physical maturation does appear to have some effect on functionally misarticulated sounds.

In 1942 Roe and Milisen administered a modification of the Detroit Articulation Picture Test to 1,989 children in grades one through six in the public schools of nine Indiana cities. One of their conclusions was that the "mean number of errors decreased as the grade level increased."[3]

A continuation of the above study was done by Sayler with grades seven through twelve.[4] The data showed a

---

[1]Carter and Buck, op. cit., p. 127.

[2]Mary Stuart Farquhar, "Prognostic Value of Imitative and Auditory Discrimination Tests," Journal of Speech and Hearing Disorders, 26 (1961), p. 342.

[3]Vivian Roe and Robert Milisen, "The Effect of Maturation Upon Defective Articulation in Elementary Grades," Journal of Speech and Hearing Disorders, 7 (1942), p. 50.

[4]Helen K. Sayler, "The Effect of Maturation Upon Defective Articulation in Grades Seven through Twelve," Journal of Speech and Hearing Disorders, 14 (1949), p. 207.

minimal amount of improvement between grades seven and ten and between grades ten and eleven. There was practically no change between grades eleven and twelve.

The Steer and Drexler study was a longitudinal study of the articulation of 93 kindergarten children over a five year period of time. They concluded that "if the tests (articulation tests) were administered at the beginning and end of the kindergarten year, allowing more time for maturational effects, the predictive value of the improvement scores would be strengthened."[1]

These studies suggest that during the child's younger years maturation is taking place relatively rapidly. Significant changes can be detected in the child's ability to correctly articulate any functionally misarticulated sounds which he might have. As maturation slows down, comparatively little improvement can be noted in the correction of functionally misarticulated sounds.

Stimulability and Articulation Testing

Comprehensive diagnostic articulation testing includes a stimulability test. In such a test the child is stimulated with his misarticulated sound several times; then he is asked to produce the sound himself. This test was

---

[1]M. D. Steer and Hazel G. Drexler, "Predicting Later Articulation Ability From Kindergarten Tests," Journal of Speech and Hearing Disorders, 25 (1960), p. 397.

designed to indicate the child's ability to improve his misarticulated sounds. According to Milisen often "children are able to improve as many as 85 per cent of their misarticulated sounds after receiving only a few integral stimulations."[1] Milisen stresses the importance of vividness, forcefulness, and completeness in stimulation as the reproduction of the sound by the child is dependent upon the effectiveness of the stimulation. He regards the Stimulability Test as one which records the changes occuring in response to stimulation for each misarticulated sound in isolation, nonsense syllables, and words.[2]

Templin's Non-Diagnostic Articulation Test also contains a stimulability test. One of the measures obtained in her test was the child's utterance of his misarticulated sound repeated after the examiner.[3]

Though called by a different name the Carter and Buck Prognostic Test for Functional Articulation Disorders includes a stimulability test. Test two of the Carter and Buck test is called an Imitation Test. The child being tested is asked to watch the examiner, to listen carefully

---

[1]Robert Milisen, "Methods of Evaluation and Diagnosis of Speech Disorders," Handbook of Speech Pathology, ed. Lee Edward Travis, (New York: Appleton-Century Crofts, Inc., 1957), p. 291.

[2]Robert Milisen, "A Rationale for Articulation Disorders," Journal of Speech and Hearing Disorders, Monograph Supplement 4 (1954), pp. 10, 14.

[3]Templin, op. cit., p. 393.

and to repeat the word in the same manner as it was presented to him.[1]

In their follow-up study to the Carter and Buck study Steer and Drexler employed the same procedure. They believed that "one way of measuring the child's ability to learn better speech patterns is to stimulate the child with the correct sound and to observe how many of his errors he can modify or eliminate.[2]

The Prognostic value of imitative and auditory discrimination tests was investigated by Farquhar. Among her conclusions she found that children with severe articulatory defects could receive profit from strong stimulation of the sound in isolation before the sound is presented to them in words.[3]

Measurement and Articulatory Defects

Introduction.--Early research in the area of articulatory defects did not emphasize exact measurement as such. The evaluation of articulatory defects was largely subjective. In an effort to establish satisfactory accuracy in articulation testing, Henderson suggests that four statistical measures be determined. They are "consistency of the examiner's judgements, objectivity in the examiner's

---

[1]Carter and Buck, op. cit.

[2]Steer and Drexler, op. cit.

[3]Farquhar, op. cit., p. 346.

judgements, consistency of subject responses and the coefficient of reliability."[1] Recognizing the need for more objectivity in articulation testing Henderson recommends that extensive and well controlled research be initiated by way of "determining the best technique for establishing objectivity in judgement and setting up standards of consistency and objectivity in judgement."[2]

In a study of maturation and articulation defects in the elementary grades Roe and Milisen simply noted the number of defective sounds. In addition to concluding that the mean number of errors decreased as the grade level increased they also noted that the percentage of children making various kinds and degrees of errors decreased from the first grade to the sixth grade on 80 per cent of the sounds tested.[3]

An attempt at more objectivity in the measurement of articulatory defects was made in 1943 by Curry, Kennedy, Wagner and Wilke when they constructed a phonographic scale to measure defective articulation.[4] The scale was

---

[1]Florence M. Henderson, "Accuracy In Testing The Articulation of Speech Sounds," Journal of Educational Research, 31 (1938).

[2]Ibid.

[3]Roe and Milisen, op. cit.

[4]Robert Curry, Lou Kennedy, Loretta Wagner and Walter Wilke, "A Phonographic Scale for the Measurement of Defective Articulation," Journal of Speech and Hearing Disorders, 8 (1943), p. 123.

constructed with steps along a scale of defectiveness from normal to unintelligible speech. Using the method of paired comparisons a group of twenty-five judges selected the better of two recorded speech samples. The resulting phonographic scale was then made available commerically. This scale was designed so that the quality of articulation of a speech defective could be rated against the scale samples.

Later Research.--In 1946 a weighted index of sounds was devised by Wood.[1] His objective was to obtain a numerical evaluation of articulatory ability. An Articulation Index bases on the relative frequency of occurrence of a given sound in the speech of children was devised. The study was conducted with 50 children who were considered functional articulatory cases. The Articulation Index obtained was the sum of relative weights of the sounds that the child could articulate correctly. This was done equally for sounds appearing in initial, medial and final positions.

Two years later Henrikson presented an analysis of Wood's Articulation Index. His study questioned the occurrence of sounds in the speech of children in equal frequency for each position. Two of his conclusions were:

---

[1]Kenneth S. Wood, "Parental Maladjustment and Functional Articulatory Defects in Children," Journal of Speech and Hearing Disorders, 11 (1946), pp. 255-275.

> . . .Prorating consonant sounds on the assumption that they occur equally or approximately equally in all positions in a word is not justified and that using such a prorating as the basis for constructing an index of progress is not justified and the value of conclusions drawn from using such an index is correspondingly questionable.[1]

In defense of his Articulation Index Wood gives two factors which he regards as necessitating equal prorating.

> Initial and final consonants in words tend to become medial when words are combined in the phrase units which characterize speech. . .It has been observed that a person who learns an initial [t] has in part learned the medial and final [t] even though he has not at a given point developed the ability or habit of producing it in the last two positions.[2]

However, he does say that in a more exact numerical expression which will more nearly represent the social adequacy of an individual's speech one cannot overlook the fact that some consonant sounds occur more frequently in the language than do others.

Just as phonemes are practically meaningless by themselves Wood maintains that merely counting the number of defective phonemes has limited meaning. An auditory concept and mastery of a sound is not indicated when the sound is produced in isolation, syllables or words. However, his study did indicate that an individual's ability

---

[1]Ernest H. Henrikson, "An Analysis of Wood's Articulation Index," Journal of Speech and Hearing Disorders, 13 (1948), p. 235.

[2]Kenneth S. Wood, "Measurement of Progress in the Correction of Articulatory Speech Defects," Journal of Speech and Hearing Disorders, 14 (1949), pp. 173, 174.

to pronounce a sound correctly in an isolated word in response to pictorial or object stimuli often adequately represents his ability to produce the sound accurately in connected speech. He concludes that the final test in measuring articulatory progress is "whether or not the sounds are consistently produced correctly in the stream of spontaneous speech."[1]

Parobeck investigated the utility of the Wood Articulation Index in measuring articulation proficiency. A fifteen-point scale was divided into five groups of three points each. In addition each group was given a verbal description as follows: Group I - Normal speech, Group II - Mildly defective speech, Group III - Moderately severe articulatory defect, Group IV - Severe articulatory defect and Group V - Very severe articulatory defect. Using picture stimuli Parobeck tested the articulation of 52 children. A three minute segment of each child's speech was taped and judged. Parobeck also rated the speech samples. The average correlation between Parobeck's rating of the speech samples and that of her three judges was $r = .92$.[2]

Barker lists five criteria concerning the usefulness of an measure of articulation. "(1) It should include a

---

[1] Ibid., p. 171.

[2] Parobeck, op. cit.

consideration of all speech sounds. (2) It should represent speech adequacy in a quantitative manner. (3) It should be numerically accurate and allow for statistical manipulation. (4) It should be simple and convenient to use. (5) It should be easily interpreted."[1] Barker's study investigated the correlation between an Articulation Score based on the relative frequency of occurrence of all speech sounds with the subjective evaluations of an individual's articulatory proficiency. The correlation between the judges' ratings and the Articulation Score based on the three consonant positions was r= .94. The correlation was r= .94 when only initial and final syllable positions were used. She assumes that if this correlation is high enough the Articulation Score is a valid measure of articulatory proficiency.

In 1962 Barker and England followed up her earlier study with some further developments. This study added consonant blends and consonant and [r] sounds. A simplified form for faster computation was employed. A comparison of the simplified form and the judges ratings indicated a Pearson product moment correlation coefficient of .92.[2]

---

[1] Janet O'Neill Barker, "A Numerical Measure Of Articulation," Journal of Speech and Hearing Disorders, 25 (1960), p. 79.

[2] Janet Barker and Gene England, "A Numerical Measure of Articulation: Further Developments," Journal of Speech and Hearing Disorders, 27 (1962), pp. 23, 24.

Scaling and Articulatory Defects.--Studies involving scaling methods and procedures have been concerned with one or more of the following: equal appearing intervals, successive intervals, randomization-of-segments and/or direct magnitude estimation.

A study by Sherman and Moodie placed particular emphasis on the method of equal appearing intervals. A nine-point scale extending from one for least severe to nine for most severe was employed. High fidelity tape recordings five seconds in length of the continuous speech of children between five and ten years of age were made using the test items. The speech segments represented a range of articulation from normal to severely defective. On the basis of the results they concluded that the method of equal appearing intervals is most useful for scaling articulation defectiveness. The scale values obtained by this method were said to be "reliable, relatively easy to compute, and in close agreement with the internally consistent scale values obtained by the method of successive intervals.[1]

In 1960 several procedures for scaling articulation were investigated by Sherman and Cullinan. The main purposes of this study were:

---

[1]Dorothy Sherman and C. Moodie, "Four Psychological Scaling Methods Applied to Articulation Defectiveness," Journal of Speech and Hearing Disorders, 22 (1957), pp. 698-706.

> (a)To evaluate the reliability of mean scale values of articulation defectiveness based upon single observer consecutive ratings at ten second intervals during one minute speech samples, (b)To evaluate reliability of individual observer ratings of articulation defectiveness based upon single ratings of one-minute speech samples and (c)To evaluate how well the scale values obtained by the above two procedures agree with each other and with the scale values obtained by the randomization-of-segments method.[1]

They found that the intra-class correlation coefficient for the group who rated at consecutive intervals was .89 and the intra-class correlation coefficient for the group who rated each sample as a whole was also .89. They also found that for both procedure a and b measures based upon individual observer responses were satisfactorily reliable.

Also in 1960 Prather investigated the scaling of defective articulation by direct magnitude estimation. The purpose was to study the psychological scaling method of direct magnitude estimation for obtaining measures of defectiveness of articulation along a ratio scale. The test items consisted of twenty-seven tape recorded five-second segments taken from the speeches of children. These speech segments ranged from normal articulation to severely defective articulation. Scale values were obtained from listener responses. These scale values were then compared with one another and with corresponding sets which had previously been obtained by the methods of equal

---

[1]Dorothy Sherman and W. Cullinan, "Several Procedures for Scaling Articulation," Journal of Speech and Hearing Research, 3 (1960), pp. 191-198.

appearing intervals, pair comparisons and constant sums. The results indicated that there was close correspondence between sets of scale values for all comparisons.[1]

Listener Rating and Articulatory Defects

Perrin sought to investigate whether there was any difference in the ratings of severity given to functional articulation defects by trained and untrained observers.[2] Disc recordings were made of fifteen children reading a prepared typewritten passage. These recordings were then paired (according to the procedure for paired comparisons) and presented to the groups of raters. The untrained group consisted of twenty-six students enrolled in an introductory psychology course. The trained group consisted of thirteen graduate students enrolled in a course in clinical methods. The rank order correlation obtained between the trained and untrained ratings was .82. Both trained and untrained observers agreed significantly within their rankings, but untrained observers were slightly more in agreement with themselves than trained observers. The correlation coefficients between rank order obtained from the actual count of articulation errors and the judges

---

[1]Elizabeth Moodie Prather, "Scaling Defectiveness of Articulation by Direct Magnitude-Estimation," Journal of Speech and Hearing Research, 3 (1960), pp. 380-392.

[2]Perrin, op. cit.

ranking were .98 for clinicians and .82 for non-clinicians.

Morrison recorded the conversational speech of 66 children between the ages of five and ten years. Using both naive and sophisticated observers the tape recorded speech samples were presented to them for rating along a nine-point scale of equal appearing intervals. Median scale values and measures of strength (Kendall's Q) relationship were obtained. Reliability coefficients were .97 for five second segments and .98 for ten second segments. Ratings of expert listeners correlated well with the ratings of naive listeners. The two major purposes of Morrison's study were:

> To investigate the reliability of measures of articulation defectiveness obtained by the method of equal-appearing intervals from responses of groups of observers to short segments of continious speech and to construct a severity scale of articulation defectiveness with recorded short segments of continuous speech.[1]

In 1955 Sherman and Morrison studied the reliability of the Morrison Scale with the following conclusions:

> (1) A trained individual observer can reliably rate defective speech on a one to nine-point scale by listening to a one minute sample of the speech.
> (2) Precise mean scale values of severity of defective articulation can be obtained from the responses of a trained individual observer.
> (3) Absolute values of ratings are not necessarily comparable from one observer to another.
> (4) Five second segments and ten second

---

[1]Morrison, op. cit.

> segments of defective speech can be rated equally reliably.[1]

An analysis of the relationships existing between some factors associated with defective articulation and listener reaction was the concern of an investigation by Jordan. The measures obtained from the test responses were (1)number of defective speech sounds, (2) frequency of these sounds in the language, (3)phonetic consistency of the speech sound errors, (4)type of sound error, (5)position and function of the misarticulated consonant sounds, (6)phonetic category of misarticulated sounds and (7)sounds misarticulated in blends. These measures were obtained from 150 children with articulatory deviations ranging from mild to severe. After an evaluation by means of a multiple regression analysis of the articulation test responses and the measures of articulation defectiveness from listener ratings of connected speech the results indicated that:

> (1)Articulation rest responses, under the conditions of this experiment, provide valid information on articulatory behavior in connected speech.
> (2)Reactions of listeners to articulation defectiveness are primarily dependent upon frequency with which articulation deviations occur and degree of articulation deviations.
> (3)Articulation test measures of the number of defective sounds and items are both

---

[1]Dorothy Sherman and Shelia Morrison, "Reliability of Individual Ratings of Severity of Defective Articulation," Journal of Speech and Hearing Disorders, 20 (1955), p. 358.

highly related to measures of defectiveness of articulation derived from listener responses to connected speech.[1]

In this chapter an attempt has been made to present briefly several aspects of articulation testing which were thought to be relevant to the present study.

[1] Jordan, op. cit., p. 319.

CHAPTER III

SUBJECTS, MATERIALS, EQUIPMENT AND PROCEDURES

Subjects

The subjects for this study consisted of twenty-five children with functional articulatory defects as defined in Chapter I. The sample was composed of 10 females and 15 males whose age range was from six to nine years. All of the subjects were enrolled in public elementary schools in Haslett, Michigan. Twenty-one of the subjects were taken from the first four grades of Central Elementary School. In addition to these, four subjects from the second grade at Wilkshire Elementary School were used. The entire sample was composed of children who were currently receiving speech therapy in their respective schools.

Materials and Equipment

The materials and equipment employed in this study are listed below.

1. The Descriptive Articulation Test defined and described in Chapter I was employed to obtain the raw data.

2. A model T1500 Wollensak tape recorder was utilized in recording connected speech from the subjects.

3. Twenty-one consonant picture cards containing pictures with the test sounds in the medial position were used in the Descriptive Articulation Test to elicit spontaneous responses from the subjects. (See Appendix A)

4. The samples of continuous speech of the subjects was recorded on Burgess magnetic recording tape.

5. One dozen Saturday Evening Post Pictures were available if needed to be used in eliciting a sample of free speech from the subjects.

6. The responses of each subject were recorded on an Articulation Test Score Sheet. Twenty-five such sheets were used. (See Appendix C)

7. The judges indicated their ratings of the speech samples on twenty-four rating sheets. (See Appendices D and E)

8. An Ampex tape recorder, model PR10, was employed in playing the speech samples through earphones to the judges.

Procedures

Each child was given the Descriptive Articulation Test which was composed of twenty-one consonant sounds. The test was administered to each child individually. The consonant sounds contained on the test were evoked by means of pictures of objects which contained the sound being tested in the medial position. This resulted in

an Articulation Score for each child. This score consisted of the per cent of test sounds which were misarticulated by the child.

The Stimulability Score was obtained in the following manner: For each sound misarticulated by picture stimulation the child was asked to listen carefully as the examiner repeated that particular sound three times in isolation. The child watched the examiner and was then asked to repeat the sound once. Each child's raw score consisted of the number of misarticulated sounds by picture stimulation which he also incorrectly articulated in isolation after vocal stimulation by the examiner.

After the administration of the Descriptive Articulation Test a sample of the child's connected speech was elicited through conversation with the child and/or with the use of the Saturday Evening Post pictures. A recording of this speech sample was made on magnetic audio tape. A magnetic audio tape containing a 30-second speech sample of each subject was edited from the tape of each subject's connected speech with a five-second silent interval between each recorded speech sample. The purpose of this silent interval was to allow the judges time to record their rating of each speech sample.

The tape of continuous speech samples was then played to a group of twelve judges who rated them according to the severity of articulation. These judges were graduate stu-

dents in the Speech and Hearing Science area of the Department of Speech at Michigan State University. They rated the twenty-five 30-second samples of speech on two occasions using a different type of rating sheet on each occasion. At the first rating a nine-point scale with the number 1 representing least severe articulation and the number 9 representing most severe articulation was used. The speech samples were rated on this continuum from least severe to most severe. Each sheet contained the following directions which were read to the judges:

> You are being asked to rate twenty-five 30-second speech samples in regard to severity of articulation only! You are to place your ratings along a nine-point scale which you will find below. One (1) represents least severe and nine (9) represents most severe. Please indicate your rating by refering to the scale and placing the number representing your rating beside the number of the appropriate speech sample. Give only one number for each speech sample. If you change your mind completely erase or strike out all previous marks.

On the second occasion of rating the speech samples the judge's rating sheet also employed a nine-point scale. This scale was constructed in a different manner. On this sheet the nine-point scale was divided into three rating groups and each group was given a verbal description. This was similar to the scale which was utilized in Parobeck's study. The groups and descriptions are given below.

Rating Group	Description	Rating
I	Least severe	1 2 3

Rating Group	Description	Rating
II	Moderately severe	4 5 6
III	Most severe	7 8 9

The judges were asked to place their rating of each speech sample beside the appropriate subject number. Only one rating was given for each speech sample. The rating sheets used in this experiment may be seen in Appendices D and E.

Summary.--Twenty-five children with functional articulation disorders were given the Descriptive Articulation Test which was composed of 21 consonant sounds. In addition, a 30-second speech sample of each child was obtained and recorded. An Articulation Score, Stimulability Score and Improvement Index was computed for each child.

The 30-second samples of each child's connected speech were rated on two separate occasions by twelve graduate students in Speech and Hearing Science. The first rating was done on a nine-point scale with the number one representing least severe and the number nine representing most severe. At the second rating the nine-point scale was divided into three groups and each group was given the descriptions least severe, moderately severe and most severe respectively. The Articulation Score, Stimulability Score, Improvement Index and mean rating for connected speech were recorded for each of the twenty-five children.

CHAPTER IV

RESULTS AND DISCUSSION

Results

As stated in Chapter I the present study had two purposes. They were, to devise a short, descriptive and comprehensive articulation test which could be used in describing the articulatory disorders of individuals and to suggest a method which might give a meaningful indication of the child's improvement.

Judges Ratings.--The twenty-five speech samples of children with articulatory disorders were rated by twelve judges. The results of the ratings are given below in Table I.

TABLE I

Mean, Range, Standard Deviation of Judge's Ratings

Rating	Range	Mean	Standard Deviation
I	1-9	3.39	1.90
II	1-9	3.77	2.10

At the first rating a nine-point scale was used with one representing least severe and nine representing most severe. The same nine-point scale was used at the second

ratings; however, the nine points were organized into groups of three. Each group was given a verbal description as follows: Group One - least severe; Group Two - moderately severe; and Group Three - most severe.

Descriptive Articulation Test Indices.--The test employed in this study was designed to yield an Articulation Score, a Stimulability Score and an Improvement Index. The formulae for calculating these indices are presented in Chapter I. The results of these indices for each of the twenty-five subjects are given below in Table 2.

TABLE 2

DESCRIPTIVE ARTICULATION TEST SCORE INDICES FOR SAMPLE

Subject	Articulation Score	Stimulability Score	Improvement Index
1	100	100	0
2	100	100	0
3	100	100	0
4	100	100	0
5	95	100	5
6	95	95	0
7	90	100	10
8	90	100	10
9	90	100	10
10	86	100	14
11	86	95	12
12	86	90	4
13	76	95	20
14	76	95	20
15	76	95	20
16	76	90	15
17	71	100	29
18	71	95	24
19	67	95	27
20	62	100	38
21	62	86	24
22	57	95	38
23	52	100	48

Subject	Articulation Score	Stimulability Score	Improvement Index
24	52	100	48
25	52	90	42

Four of the subjects tested received Articulation Scores of 100 per cent. Although receiving speech therapy these individuals were working primarily on "carry-over." The mean Articulation Score obtained from the sample was 79.72 per cent while the standard deviation of the Articulation Scores was 15.90 per cent. The twenty-five subjects yielded a mean Stimulability Score of 97.25 per cent with a standard deviation of 4.24 per cent. The mean Improvement Index was 24.08 per cent with a standard deviation of 11.31 per cent.

Hypotheses.--The following two hypotheses were tested in this present study:

(1) There is a relationship between the number of consonant sounds misarticulated and the judgement of the severity of that articulatory disorder along an ungrouped rating scale.

(2) There is a relationship between the number of consonant sounds misarticulated and the judgement of the severity of that articulatory disorder along a grouped rating scale.

To determine if a relationship exists between the number of consonant sounds misarticulated on the test and the judgement of the severity of the articulatory disorder

a Pearson product-moment correlation was obtained for each of the rating scales used. For the ungrouped nine-point rating scale the correlation coefficient (r) was .88. The correlation coefficient (r) for the grouped nine-point rating scale was .86.

A test for the significance of these correlations was made by testing the null hypotheses that each of the two observed correlation coefficients did not differ from zero. The respective F values computed for the correlations being tested were 3.39 for the judgements of articulatory severity by means of the ungrouped rating scale and 2.83 for the judgements of articulatory severity by means of the grouped rating scale. Both null hypotheses were therefore rejected at the .05 level of confidence. The rejection of the null hypotheses indicates that some type of relationship does exist between the number of misarticulated sounds and the judgement of the severity of the articulatory disorder by means of both the ungrouped rating scale and the grouped rating scale. Figures 1 and 2 illustrate the relationship between the Articulation scores obtained and the mean severity rating for each subject for each of the two ratings.

Discussion

From the analysis of the data obtained in this study it is shown that there is a significant relationship between Articulation Score and mean rating-scale values at

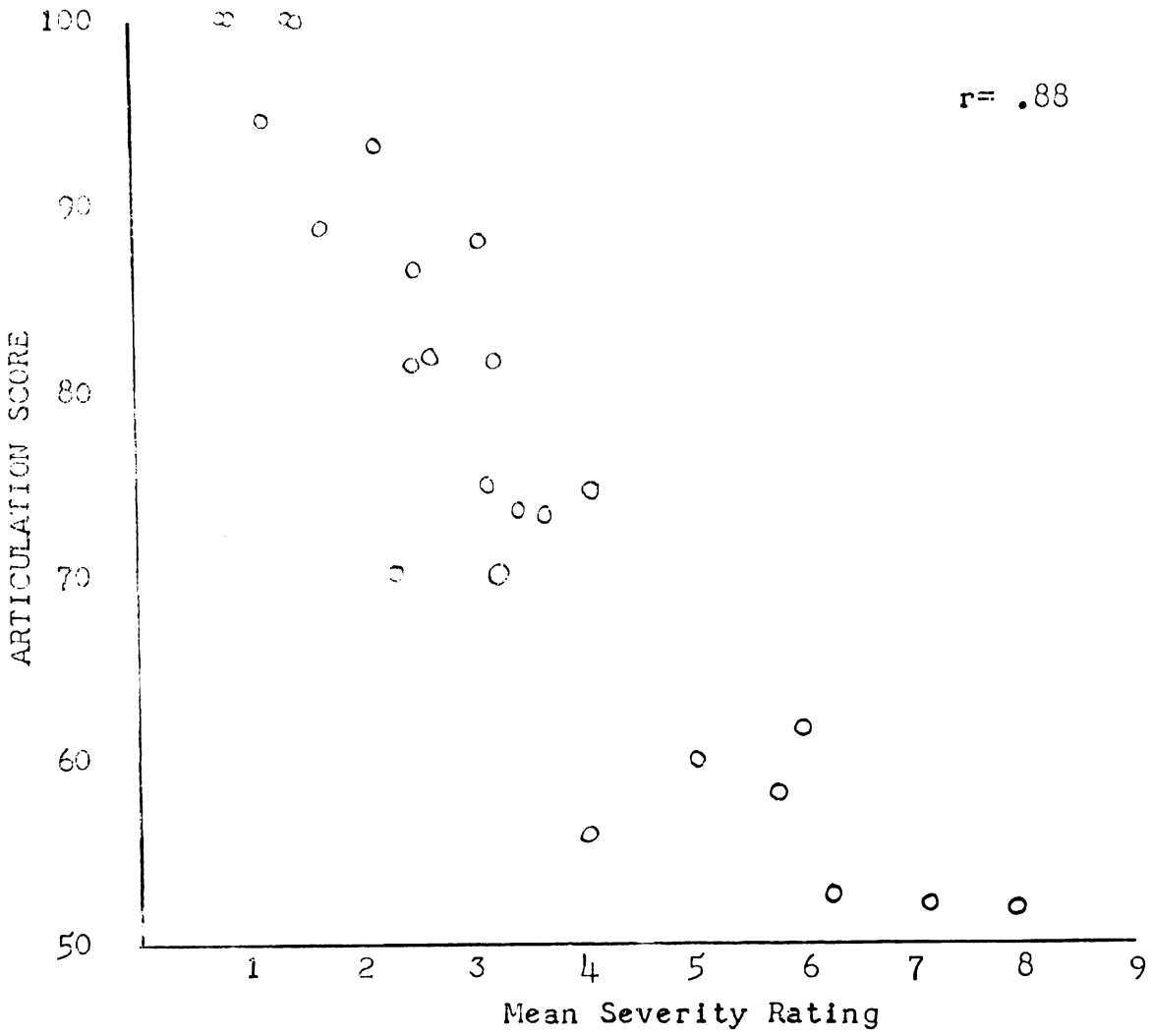


Fig. 1.--Relationship between mean severity ratings and the Articulation Score.

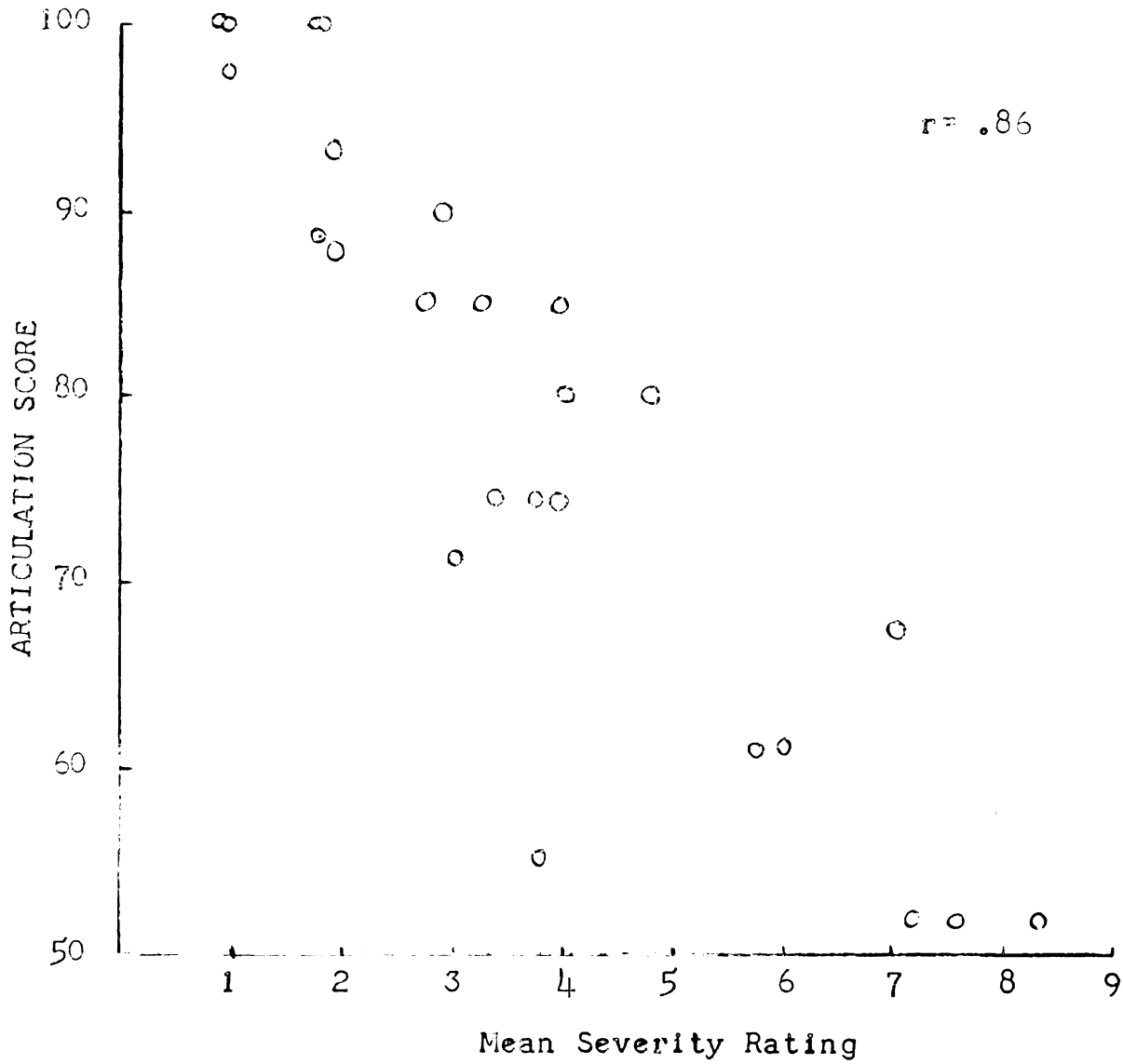


Fig. 2.--Relationship between mean severity ratings and the Articulation Score.

the .05 level of confidence.

The formula $100 \times \frac{S-A}{S}$ was used to obtain the Improvement Index for two reasons: (1) It would not give scores below zero or above 100 and (2) it expresses a person's improvement by auditory stimulation as a percentage of the best articulation score he can get (namely that obtained by auditory stimulation). It is thought that the Improvement Index may yield an estimate of the prognosis for speech therapy, but this would have to be demonstrated through subsequent longitudinal research.

As stated in Chapter I the test sounds were administered in the medial position only. This was done because in connected speech all sounds become medial with the exception of initial and final sounds. Wood maintains this point of view in his article on Measurement of Progress in the Correction of Articulatory Speech Defects.[1]

In accordance with Milisen's view that children are able to improve their misarticulated speech sounds after receiving stimulation, all subjects tested were able to make improvement on one or more of their misarticulated speech sounds after receiving voice stimulation. Nine of the subjects tested achieved a Stimulability Score of 100 per cent.

---

[1]Wood, "Measurement of Progress," op. cit.

Figures 1 and 2 indicate the mean rating given by the judges for each of the twenty-five subjects on the ungrouped and grouped rating scales respectively. It may be noted that with the grouped rating scale the judges tended to rate the articulatory defect as being more severe than when rating the same articulatory defect on an ungrouped rating scale. It was not determined in this study whether these slight differences in rating constituted a real difference or were simply chance differences.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

Speech defects of an Articulatory nature are very prevalent among public school populations. More than half of the case load of the public school therapist consists of children with articulatory defects. The majority of these children have functional articulatory defects. Testing for articulatory defects therefore becomes important to the therapist. A review of the literature reveals that various aspects of the problem of testing for articulatory defects have been studied including the using of some system of numerical notation to measure the severity of articulatory disorders.

In this study an attempt was made to devise a short but descriptive and comprehensive articulation test for use in articulation testing. A second purpose was to suggest a method whereby a meaningful index of the child's improvement might be obtained. The accomplishment of these purposes would aid the therapist in selecting a case load, noting the child's progress and in planning therapy for the child.

The hypotheses tested in this study concerned the

relationship between the number of consonant sounds misarticulated and the judgement of the severity of that articulatory disorder along an ungrouped rating scale and along a grouped rating scale.

Twenty-five subjects from two public elementary schools in Haslett, Michigan were utilized as subjects for the study. These children possessed functional articulatory disorders and were all currently receiving speech therapy.

The Descriptive Articulation Test which was constructed for this study was administered to each of the subjects. The test consisted of twenty-one pictures with the test sounds in the medial position. A recording of each child's free speech was obtained and recorded on audio tape. This tape was then edited and played to twelve judges who rated the speech samples along an ungrouped nine-point rating scale and along a grouped nine-point rating scale. Each of the three groups in the grouped rating scale was given a verbal description. The data gathered for each child consisted of an Articulation Score, a Stimuliability Score and an Improvement Index.

Conclusions

From the experimental design set forth in this study and the data obtained the following conclusions have been drawn:

1. There is a positive significant relationship at the .05 level of confidence between the number of consonant sounds misarticulated and the judgement of severity of the articulatory disorder using an ungrouped rating scale.

2. There is a positive significant relationship at the .05 level of confidence between the number of consonant sounds misarticulated and the judgement of severity of the articulatory disorder on a grouped rating scale.

Implications for Further Research.--In this study twenty-one of the most frequently misarticulated sounds were tested. The present research design was not concerned with the maturational appearance of speech sounds. A study utilizing a test in which the maturational appearance of sounds is considered might possibly yield different and more comprehensive results. Such a study might yield information which would be useful in testing the articulation of children below the age of eight.

The taped speech samples used in this study consisted of the subject's free speech. A study in which prepared passages containing the test sounds would allow control over the frequency of the test sounds appearing in the individual's speech sample and consequently might yield different ratings by judges.

As stated in Chapter IV further research in the form of a longitudinal study might reveal that the Improvement Index may also serve as an estimate of prognosis in therapy.

BIBLIOGRAPHY

Books

Anderson, Virgil A. Improving the Child's Speech. New York: Oxford University Press, 1953.

Johnson, Wendell, Spencer J. Brown, James Curtis, Clarence Edney and Jacqueline Keaster. Speech Handicapped School Children. 2nd rev. ed. New York: Harper and Row, 1956.

Van Riper, Charles and John Irwin. Voice and Articulation. Englewood Cliffs, N. J. : Prentice-Hall, Inc., 1958.

Articles and Periodicals

Barker, Janet O'Neill. "A Numerical Measure of Articulation," Journal of Speech and Hearing Disorders, 25 (1960), pp. 79-88.

Barker, Janet O'Neill and Gene England. "A Numerical Measure of Articulation: Further Developments," Journal of Speech and Hearing Disorders, 27 (1962), pp. 23-27.

Carter, Eunice T. and McKenzie Buck. "Prognostic Testing for Functional Articulation Disorders Among Children in the First Grade," Journal of Speech and Hearing Disorders, 23 (1958), pp. 124-133.

Chapman, Myfanwy E. et al. "Clinical Practice: Remedial Procedures," Journal of Speech and Hearing Disorders, Monograph Supplement 8 (1961), pp. 58-77.

Curry, Robert, Lou Kennedy, Loretta Wagner and Walter Wilke, "A Phonographic Scale for the Measurement of Defective Articulation," Journal of Speech and Hearing Disorders, 8 (1943), pp. 123-126.

Farquhar, Mary Stuart. "Prognostic Value of Imitative and Auditory Discrimination Tests," Journal of Speech and Hearing Disorders, 26 (1961), pp. 342-347.

Henderson, Florence M. "Accuracy In Testing The Articulation of Speech Sounds," Journal of Educational Research, 31 (1939),

Henrikson, Ernest H. "An Analysis of Wood's Articulation Index," Journal of Speech and Hearing Disorders, 13 (1948), pp. 233-235.

Jordan, Evan P. "Articulation Test Measures and Listener Ratings of Articulation Defectiveness," Journal of Speech and Hearing Research, 3 (1960), pp. 303-319.

Louttit, C.M. and E.C. Hall. "1936 Survey of Speech Defects Among Public School Children of Indiana," Journal of Speech Disorders, 1 (1936), pp. 73-80.

Milisen, Robert. "Methods of Evaluation and Diagnosis of Speech Disorders," Handbook of Speech Pathology, ed. Lee Edward Travis, New York: Appleton-Century Crogts Inc., 1957, pp. 267-309.

_____. "A Rationale for Articulation Disorders," Journal of Speech and Hearing Disorders, Monograph Supplement 4 (1954), pp. 5-18.

Mills, A. C. and H. Streit. "1942 Report of a Speech Survey-Holyoke, Massachuetts," Journal of Speech Disorders, 7 (1942), pp. 161-167.

Morrison, Shelia. "Measuring the Severity of Articulation Defectiveness," Journal of Speech and Hearing Disorders, 20 (1955), pp. 347-351.

Perrin, Elinor Horwitz. "The Rating of Defective Speech by Trained and Untrained Observers," Journal of Speech and Hearing Disorders, 19 (1954), pp. 48-51.

Powers, Margaret Hall. "Functional Disorders of Articulation: Symptomatology and Etiology," Handbook of Speech Pathology, ed. Lee Edward Travis, New York: Appleton-Century Crofts Inc., 1957, pp. 707-768.

Prather, Elizabeth Moodie. "Scaling Defectiveness of Articulation by Direct Magnitude-Estimation," Journal of Speech and Hearing Research, 3 (1960), pp. 380-392.

Roe, Vivian and Robert Milisen. "The Effect of Maturation Upon Defective Articulation In Elementary Grades," Journal of Speech and Hearing Disorders, 7 (1942), pp. 37-50.

Sayler, Helen K. "The Effect of Maturation Upon Defective Articulation in Grades Seven through Twelve," Journal of Speech and Hearing Disorders, 14 (1949), pp. 202-207.

Sherman, Dorothy and Catherine Moodie. "Four Psychological Scaling Methods Applied to Articulation Defectiveness," Journal of Speech and Hearing Disorders, 22 (1957), pp. 698-706.

_____ and Walter Cullinan. "Several Procedures for Scaling Articulation," Journal of Speech and Hearing Research, 3 (1960), pp. 191-198.

_____ and Shelia Morrison. "Reliability of Individual Ratings of Severity of Defective Articulation," Journal of Speech and Hearing Disorders, 20 (1955), pp. 352-358.

Steer, M. D. and Hazel G. Drexler. "Predicting Later Articulation Ability From Kindergarten Tests," Journal of Speech and Hearing Disorders, 25 (1960), pp. 391-397.

Templin, Mildred C. "Norms on a Screening Test of Articulation for Ages 3-8," Journal of Speech and Hearing Disorders, 18 (1953), pp. 323-331.

_____. "A Non-Diagnostic Articulation Test," Journal of Speech and Hearing Disorders, 12 (1947), pp. 393-396.

Wallin, J. E. Wallace. "A Census of Speech Defectives Among 89,057 Public School Pupils: A Preliminary Report," School and Society, 3 (1916),

Wood, Kenneth S. "Parental Maladjustment and Functional Articulatory Defects in Children," Journal of Speech and Hearing Disorders, 11 (1946), pp. 255-275.

_____. "Measurement of Progress in the Correction of Articulatory Speech Defects," Journal of Speech and Hearing Disorders, 14 (1949), pp. 171-174.

Unpublished Material

Parobeck, Donna J. "An Investigation of the Utility of Wood's Articulation Index as an Independent Measure of Articulation Proficiency," Unpublished M.A. Thesis, Bowling Green State University, 1956.

APPENDICES

APPENDIX A

SOUNDS AND STIMULUS PICTURES USED IN THE DESCRIPTIVE ARTICULATION TEST

	Sound	Picture
1.	[s]	pencil
2.	[z]	scissors
3.	[ʃ]	dishes
4.	[tʃ]	matches
5.	[ʒ]	television
6.	[dʒ]	orange box
7.	[ə]	birthday cake
8.	[ð]	feather
9.	[r]	carrot
10.	[l]	balloons
11.	[f]	telephone
12.	[v]	seven
13.	[k]	turkey
14.	[g]	wagon
15.	[j]	onions
16.	[p]	zipper
17.	[b]	baby
18.	[m]	hammer
19.	[n]	banana
20.	[ŋ]	rings
21.	[w]	sandwich

APPENDIX B

NUMBER OF SOUNDS MISARTICULATED BY PICTURE STIMULATION AND JUDGES RATINGS

Number Misarticulated Sounds	Mean First rating	Mean Second rating
10	8.00	8.42
10	7.33	7.08
10	6.33	7.42
9	3.83	3.08
8	5.67	6.08
8	5.08	5.83
7	5.91	6.92
6	3.25	3.50
6	2.42	2.75
5	3.42	3.75
5	3.08	3.08
5	3.66	4.08
5	3.92	4.83
3	2.42	3.25
3	3.08	3.00
3	2.58	4.17
2	1.50	2.00
2	2.42	2.33
2	2.75	3.17
1	1.17	1.17
1	1.83	2.33
0	1.00	1.00
0	1.50	2.00
0	1.00	1.00
0	1.50	1.92

APPENDIX C

ARTICULATION TEST SCORE SHEET

Name_____
Sex_____ Grade_____ Age_____

Articulation Score_____ Stimulability Score_____
Improvement Index_____

Sounds Tested

(- omission, sound substituted, 0 distortion, + addition)

	picture stimulation	voice stimulation		picture stimulation	voice stimulation
1.	[s] ____	____	12.	[v] ____	____
2.	[z] ____	____	13.	[k] ____	____
3.	[ʃ] ____	____	14.	[g] ____	____
4.	[ʒ] ____	____	15.	[j] ____	____
5.	[tʃ] ____	____	16.	[p] ____	____
6.	[dʒ] ____	____	17.	[b] ____	____
7.	[θ] ____	____	18.	[m] ____	____
8.	[ð] ____	____	19.	[n] ____	____
9.	[r] ____	____	20.	[ŋ] ____	____
10.	[l] ____	____	21.	[w] ____	____
11.	[f] ____	____			

1. Number misarticulated by picture stimulation (P) = ____
2. Number misarticulated by voice stimulation (V) = ____
3. Articulation Score $A = 100 \times \frac{21-P}{21}$
4. Stimulability Score $S = 100 \times \frac{21-V}{21}$
5. Improvement Index $I = 100 \times \frac{S-A}{S}$

APPENDIX D

LISTENER'S RATING SHEET

Name_____ Degree in progress_____

DIRECTIONS:

You are being asked to rate twenty-five 30-second speech samples in regard to severity of articulation only! You are to place your ratings along a nine-point scale which you will find below. One (1) represents least severe and nine (9) represents most severe. Please indicate your rating by refering to the scale and placing the number representing your rating beside the number of the appropriate speech sample. Give only one number for each speech sample. If you change your mind completely erase or strike out all previous marks.

least severe — most severe

1____2____3____4____5____6____7____8____9____

SPEECH SAMPLE NUMBER	SPEECH SAMPLE NUMBER
1.	13.
2.	14.
3.	15.
4.	16.
5.	17.
6.	18.
7.	19.
8.	20.
9.	21.
10.	22.
11.	23.
12.	24.
	25.

APPENDIX E

LISTENER'S RATING SHEET NO. 2

Name_____

Rating Group	Description	Rating
I	Least severe	1 2 3
II	Moderately severe	4 5 6
III	Most severe	7 8 9

Place the above rating values below in the appropriate space according to your rating of the speech sample. Only one rating for each sample.

SUBJECT NUMBER

1.	11.	21.
2.	12.	22.
3.	13.	23.
4.	14.	24.
5.	15.	25.
6.	16.	
7.	17.	
8.	18.	
9.	19.	
10.	20.	