AUDITORY SYNTHESIZING ABILITIES OF CHILDREN WITH VARYING DEGREES OF ARTICULATORY PROFICIENCY

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ABSTRACT

AUDITORY SYNTHESIZING ABILITIES OF
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By

Daniel Walter Davison

The process of speech acquisition necessitates many well developed sensory skills. If there is a breakdown in one or more of these skills, one possible resultant condition is misarticulation.

The present study explored one of these skills, that of auditory synthesis. For this study the term auditory synthesis was defined as follows: that ability to retain, analyze and combine sound sequences into meaningful words. Three matched groups of school age children with varying degrees of articulatory proficiency were used as subjects.

A test was constructed composed of twenty words, each consisting of three phonemes. A one-second silent interval was placed between each phoneme. A first-half second-half correlation was performed to determine test reliability, with a resultant $\underline{r}$ = .85. The test was then submitted to the Spearman-Brown Prophesy formula with a resultant $\underline{r}$ = .92. It was felt that this correlation was sufficient to consider the test reliable.

The test was then given to the three groups of children. Statistical analysis indicated that there were no significant differences in the abilities of the three groups to synthesize. No statistically significant correlation was found between auditory synthesis score and articulation score.

On the basis of the results of this study the following conclusions were made: the process called auditory synthesis does not constitute an important ingredient in successful development of adequate articulation. It indicates further that the time and energy spent in therapy focussed around this auditory factor could be better spent in other activities.

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CHAPTER ONE

INTRODUCTION

Articulatory disorders have long been a source of concern to speech pathologists. Much research has been done on the causes and treatment of such disorders. Much of this research deals with effective means of correcting the various forms of articulatory disorders, both organically and functionally based. The amount of research as to the causes of articulation defects is formidable. Many of the questions raised by experimenters, however, are still unanswered. The amount of information gleaned by researchers is useful and important, but the need for more studies and experimentation is clearly evident. Whenever we deal with human beings and their problems, the job of gathering useful and factual information that can be formulated into general theory becomes a monumental task. The answers are available, but the means of acquiring them are at best elusive.

Two-thirds of all the disorders of speech are of the articulatory type.[1] The largest percentage of cases, for

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[1]White House Midcentury Conference, Journal of Speech and Hearing Disorders, XVII (March, 1952), 129-137.

most speech therapists, is of this type.[2] It has been recently published that 5 per cent of American children have some type of disorder of speech which affects articulation.[3] These percentages, although relative to the means used in gathering them, are significant in that they point up the need for more research as to the causes and treatment of this type of speech disorder.

If the speech clinician is to work successfully with the bulk of his case load, he must be equipped with adequate knowledge as to the causes and treatment of the disorder. The continuation of large caseloads for speech clinicians and the relative ineffectiveness of the therapy that is undertaken is, in part, due to the lack of knowledge about what they are asked to deal with. The other factors which inhibit the clinician's success are not to be taken lightly, but answers to these problems may be inherent in the knowledge gained as to the causes and successful treatment of the articulation problem.

It has become evident to this researcher that the lack of success in therapy often breeds discouragement and

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[2] Charles Van Riper and John V. Irwin, <u>Voice and Articulation</u> (Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1958), p. 1.

[3] U.S., Department of Health, Education and Welfare, Public Health Service, <u>NINDB Research Profile: No. 4; Hearing, Language, and Speech Disorders 1967</u>, Publication no. 1156, p. 1.

further lack of success rather than challenge and research related to better methods of therapy. This generalization, although open to debate, is operative in many cases.

The specific area under investigation in this study is auditory synthesizing. Its import has been discussed and researched by several in the field. The importance of such research is evident when one explores what is involved in a child's learning a specific sound sequence in such a manner so as to produce a meaningful word. His auditory memory span must be intact as well as his ability to discriminate one phoneme from another. To go a step further, he must perceive a temporal sequence and recognize where each sound belongs in the sequence. When there is a breakdown in one or more of the parts, the whole must suffer; thus, misarticulation results. The question then is this: is there a breakdown in articulation because of the child's inability to analyze and combine sound sequence, to synthesize auditorily?

The present study explores this question in a scientific manner. This will be done by using three groups of school age children with varying degrees of articulatory skill. A more detailed explanation will be found in Chapter Three.

It is necessary at this time to discuss briefly the speech system in terms of a model. Fairbanks[4] indicates in his discussion of a mechanical model of the speech system that the use of the term "functional" serves no useful purpose. This seems reasonable in that the term "functional articulatory defect" is often a manifestation of the inadequacy of our knowledge of the causal and operant factors in the disorder. Fairbanks further explains that the terms <u>organic</u> and <u>functional</u> are one in terms of the model. He describes the acoustic end product of speech as resulting from the fractional portions of the individual phonemes and the perception of the over-all unit output. Thus, speech itself is monitored both during and after it is produced. This twofold monitoring permits modification of the articulators as they are functioning to produce a predictable and desirable output immediately. In the acquisition of speech the auditory component normally serves as the main component with the motor aspect playing a secondary role to audition.

The motor component serves as an aid to the auditory component and helps direct production. This component, however, cannot totally take the place of the auditory component as is exemplified in the speech of the deaf and hard-of-hearing.

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[4] Grant Fairbanks, "Speech as a Servo System," <u>Journal of Speech and Hearing Disorders</u>, XIX (May, 1954), 133-139.

Defective articulation which arises from an auditory deficiency may be caused either from a defective model which guides the output or from the comparative mechanism. This study will not be concerned with an inadequate motor mechanism but rather with the inadequate model and comparative mechanism. It would seem reasonable to assume that the defect originally arose from a failure of the comparative mechanism from which the original auditory image or model had to be derived. A substandard function of some component of the speech servo-system would then appear to be a possible cause of many functional articulatory disorders.

The ability to monitor aurally is considered to be important in the articulation process by Van Riper,[5] Ainsworth,[6] Davis,[7] and others. This auditory process, as mentioned earlier, forms the general theme of the present study.

Purpose of the Study

In reviewing studies dealing with this monitoring system it has become clear to this investigator that more

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[5] Charles Van Riper, Speech Correction; Principles and Methods (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1954).

[6] Stanley Ainsworth, Speech Correction Methods (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1948).

[7] S. F. Davis, The Correction of Defective Consonant Sounds (Boston: Expression Co., 1937).

detailed research must be done on the auditory function before the theory is validated or dismissed. This study was designed to investigate the idea that one of the principal mediating factors in a small group of articulatory defectives is the presence of some auditory deficiency or immaturity which permits continued defective articulation at the time when other children are perfecting their articulation abilities, especially an inability to synthesize discrete phonemes into meaningful words or sounds units. If the cause were physiological in nature, it might be expected to be present throughout life. Also, if during childhood defective phoneme production has become strongly fixed, the articulatory defect may continue for the life of the speaker. Articulatory defects may have as a causal factor deficiencies of the monitoring system not ascribed to an organic cause, faulty or inadequate learning, emotional reasons, or volitional misarticulations. For the present study all articulatory defects resulting from any of these causes will be called functional.

Mange[8] found a relationship between an ability to synthesize aurally and the number of articulatory errors. Other researchers have not indicated such direct relationships as Mange, as they have dealt with a measurement of

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[8]Charles V. Mange, "Relationships Between Selected Auditory Factors and Articulation Ability," Journal of Speech and Hearing Research, III (March, 1960), 67-74.

auditory discrimination ability and not with a measurement of the ability to synthesize aurally. The difference is inherent in the definitions of these two auditory factors. In auditory discrimination the emphasis is placed on the ability to distinguish one sound from another, whereas in synthesizing it is necessary to analyze and combine these sounds into meaningful words.

The present study explores further the ability to synthesize and explores whether it has any direct relationship to articulatory ability. The specific question asked, then, is this: is there a difference in the scores obtained by three groups of school age children with varying degrees of articulatory abilities on a test to synthesize monosyllabic words?

Out of this question developed the following hypotheses.

1. There is no significant difference in the auditory synthesizing abilities of those children with severe articulatory problems and those with mild articulatory problems.

2. There is no significant difference in the auditory synthesizing abilities of those children with severe articulatory problems and those with normal articulatory skills.

3. There is no significant difference in the auditory synthesizing abilities of those children with mild articulatory problems and those with normal articulatory skills.

4. There is no significant correlation between articulation score and synthesis score.

Definition of Terms

The following terms are found throughout the body of this paper.

Phoneme.--A group or family of closely related speech sounds all of which have the same distinctive acoustic characteristics in spite of their differences.

Auditory Synthesizing.--That ability to retain, analyze and combine sound sequences into meaningful words.

Organic Speech Disorder.--A speech disorder that arises when a defect of structure or tissue is present, regardless of whether the original cause was psychogenic or physiogenic.

Functional Speech Disorder.--A noticeable deviation from the "normal" pattern of speech behavior that is not caused by a traceable physical or organic impairment.

Substitution.--An exchange of one standard phoneme for another standard phoneme or an exchange of a nonstandard phoneme for the standard phoneme.

Distortion.--A modification of the standard phoneme to form an approximation of that phoneme but not an acoustically recognizeable sound unit.

Addition.--Interpolation of a sound in a word that does not belong in that word.

Ommission.--Deletion of a phoneme that is necessary to the acoustic end product of the word being used.

Auditory Memory Span.--The number of related or unrelated items that can be recalled immediately after hearing them presented.

Auditory Perception.--Mental awareness of sound.

Auditory Discrimination.--Ability to discriminate between sounds of different frequency, intensity, and pressure-pattern components; ability to distinguish one speech-sound from another.

CHAPTER TWO

REVIEW OF LITERATURE

Several facets of articulation research are pertinent to this paper: auditory discrimination, physical development, oral language development, auditory feedback, parental occupation, psychological and perceptual factors.

Auditory Discrimination

Sixty children were used by Kronvall and Diehl[1] in their study to determine whether speech defective children had more difficulty than normal children with speech discrimination tasks. Thirty of the children were normal and thirty were classified as having severe speech problems.

Three hypotheses were stated with one possibly being true: (1) a deficiency in auditory discrimination is the cause of some functional articulatory disorders, (2) some articulatory disorders cause poor auditory discrimination and (3) both functional articulatory disorders and

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[1]Ernest L. Kronvall and Charles F. Diehl, "The Relationship of Auditory Discrimination to Articulatory Defects of Children with No Known Organic Impairment," Journal of Speech and Hearing Disorders, XIX (September, 1954), 335-338.

deficiency in auditory discrimination are caused by some other condition.

It was felt, however, that some auditory discrimination techniques should be used as a part of the therapy process. They also noted that more research should be done on the actual mechanism of auditory discrimination.

Scheilfelbusch and Lindsey,[2] in producing a new test of sound discrimination, concluded the following: significant differences were found between the speech defective and the normal speaking groups in relation to sound discrimination. There were also significant differences in the different forms of discrimination. Speech defective children do not gain as much ability in sound discrimination as do normal children.

Three new tests were constructed and used by August and Frick[3] to judge one's own speech production. They applied these tests to twenty-seven subjects all with the /r/ in error. All subjects were between eight and ten years of age and had had previous speech therapy. Their rationale in producing these tests was that those presently used were not measuring what they proposed to measure.

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[2]R. L. Scheifelbusch and Mary Lindsey, "A New Test of Sound Discrimination," Journal of Speech and Hearing Disorders, XXIII (March, 1958), 153-159.

[3]Lester Aungst and James V. Frink, "Auditory Discrimination Ability and Consistency of Articulation of /r/," Journal of Speech and Hearing Disorders, XXIX (February, 1964), 76-85.

The three new tests were designed to measure (1) one's own speech when compared to another speaker (2) one's own speech when heard on a recording and (3) one's own speech while in the act of speaking. These tests and a traditional discrimination test were administered to all twenty-seven subjects.

The results of this study revealed that (1) the ability to discriminate as measured by the "traditional test" is unrelated to the ability to judge one's own speech productions as correct or incorrect, (2) the "traditional test" measures an ability which is not related to consistency of articulation, and (3) the ability to judge one's own speech productions as measured by the three new tests is significantly related to the consistency of articulation.

It would seem from the results of this study that when an individual must synthesize sounds into words or units, it is necessary first to hear then translate to an expressive movement such as saying the word or unit or writing it down.

Farquhar[4] administered a spontaneous picture articulation test to 300 kindergarten children. Of these three-hundred, 100 were chosen to take part in the study, fifty of whom were considered to have "mild" articulatory problems

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[4]Mary Stuart Farquhar, "Prognostic Value of Imitation and Auditory Discrimination Tests," Journal of Speech and Hearing Disorders, XXVI (November, 1961), 342-347.

and fifty with "severe" articulatory problems. Each group was given tests of imitation and auditory discrimination. A retest was given seven months later.

The results of this study indicated that children with mild articulatory problems could imitate and discriminate the correct form of a misarticulated sound with greater proficiency than the children who had severe articulation defects.

Winitz and Bellerose[5] used seventy-two fourth grade children in their study to evaluate discrimination learning as a function of three pretraining conditions. The pretraining conditions were (1) correct reinforcement, (2) incorrect reinforcement, and (3) no reinforcement. Discrimination learning itself involved a two bar successive discrimination of the /ʃɑ/ and /ça/.

They found no evidence to support the hypothesis that discrimination was reduced following incorrect reinforcement. Children that were assigned to the pretraining condition of incorrect reinforcement continued to utter the incorrect response when it was reinforced. It would seem that if the child were perceiving the sound incorrectly, he would possibly be reinforcing his own error.

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[5]Harris Winitz and Betty Bellerose, "Sound Discrimination as a Function of Pretraining Conditions," Journal of Speech and Hearing Research, V (December, 1962), 340-348.

Schultz[6] administered W-22 words to 181 hearing impaired patients. Each individual listened to one list and then responded by saying each word aloud.

He found that there was a marked tendency for highly familiar words to be substituted for incorrectly identified stimuli. It was also pointed out that present discrimination tests should be revised to minimize effect of word familiarity.

Weiner[7] reviewed several studies dealing with the relationships between external and model auditory discrimination and articulatory defects. These studies included tests of auditory discrimination, a definition of articulation defect, and the influence of age on articulation. The age factor seemed most important in determining the results of the study. A positive auditory discrimination-articulation relationship was found in almost every study involving children below age nine. No positive relationship was found in subjects above age nine.

In studies where four or more sounds were found in error, a positive relationship was found in discrimination ability and articulation defect. No relationship was found

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[6] Martin C. Schultz, "Word Familiarity Influences in Speech Discrimination," Journal of Speech and Hearing Research, VII (December, 1964), 395-400.

[7] Paul Weiner, "Auditory Discrimination and Articulation," Journal of Speech and Hearing Disorders, XXXII (January, 1967), 19-28.

for children with articulation defects of two or below. No mention was made of children with three sounds in error.

Two factors were found which seemed to have considerable support: (1) auditory discrimination is developmental in character and (2) children from more favored socioeconomic groups turn in better performances on tests of this nature.

Lichtenberg[8] used three groups of children in his study: (1) normal hearing and speaking, (2) normal hearing and speech defective and (3) hard of hearing. Each group was tested on their ability to discriminate vowel and consonant sounds. They were then given sound auditory training and retested three to four months later.

The results among the three groups for vowel discrimination were not significant. However, there was a significant difference found in consonant discrimination by the normal hearing and speaking and the hard of hearing groups. No difference was found for the normal hearing speech defective group.

Cohen and Diehl[9] found that a group of elementary grade children with severe functional articulation speech

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[8]Frances S. Lichtenberg, "A Comparison of Childrens Ability to Make Speech Sound Discrimination," The Volta Review, LXVIII (June, 1966), 426-434.

[9]Julian Cohen and F. Charles Diehl, "Relation of Speech-Sound Discrimination Ability to Articulation-Type Speech Defects," Journal of Speech and Hearing Disorders, XXVIII (May, 1963), 187-190.

defects show significantly more errors in speech sound discrimination than a matched group of normal-speaking children.

They reported that the "normal" group had 12.73 mean number of errors while the experimental group had 28.83 mean errors. It was reported that maturation improved ability but that the speech defective subject was still inferior to the normal speaking child at each age level. Their study pointed out that little if any improvement in speech sound discrimination is made between the second and third grade. They do report, however, that some improvement is made from the first through the third grades.

The authors admonished the reader to incorporate speech-sound discrimination tests as a part of articulation testing. They did not, however, suggest ways to improve speech-sound discrimination abilities of these children.

Sherman and Geith[10] found that a group of kindergarten children ranked high on both the Templin Speech Sound Discrimination Test and on the Templin-Darley Picture Articulation Test. A group of kindergarten children matched on age, sex and intelligence to the first group scored low on both the above tests.

The evidence gathered by this testing supports the hypothesis that children of kindergarten age who differ on

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[10] Dorothy Sherman and Annette Geith, "Speech Sound Discrimination and Articulation Skill," Journal of Speech and Hearing Research, X (June, 1967), 269-277.

the Templin Speech Sound Discrimination Tests also differ in articulation ability.

The differences in this study were significant and tend to support the feeling that sound discrimination abilities are closely connected to defective articulation.

Somers, Meyer and Fenton[11] investigated the relationship between pitch discrimination in school age children and functional articulation errors in grades three through twelve. Sixty-five subjects having either articulation errors on /r/ or /s/ were used in this study. This group was matched with a comparable group of normally speaking subjects.

It was found that children with functional misarticulations are poorer in mean pitch discrimination than normals. No evidence of a difference was found between the group that misarticulated /r/ and the group that misarticulated /s/.

Eisenson, Kastein, and Schneiderman[12] used two groups of subjects to investigate the differences in

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[11] Ronald Sommers, William J. Meyer, and Ann K. Fenton, "Pitch Discrimination and Articulation," Journal of Speech and Hearing Research, IV (March, 1961), 56-60.

[12] Jon Eisenson, Shulamith Kastein, and Norma Schneiderman, "An Investigation Into the Ability of Voice Defectives to Discriminate Among Differences in Pitch and Loudness," Journal of Speech and Hearing Disorders, XXIII (December, 1958), 577-582.

responding to subtests of the Seashore Measure of Musical Talent. Group One was composed of ninety subjects with voice disorders and Group Two was composed of eighty-seven control subjects.

The voice defective group was found to perform significantly poorer on discrimination tasks (except for loudness discrimination) than the control group. A difference was found in the ability to discriminate aurally for pitch differences a fact which could explain why the voice disorder was present.

In Prins'[13] study of twenty-six children with functional defects of articulation, a functional relationship between certain kinds of errors of articulation and sound discrimination ability was found. His clinical judgment was that discrimination ability cannot be meaningfully evaluated independently of the language process. He states further that speech sound discrimination ability is closely related to the articulatory movement feedback which an individual receives as he speaks.

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[13]David Prins, "Relations Among Specific Articulatory Deviations and Responses to a Clinical Measure of Sound Discrimination Ability," Journal of Speech and Hearing Disorders, XXVIII (November, 1963), 382-387.

In Schlanger and Galanowsky's[14] study 85 mentally retarded and 86 normal subjects were given tests to measure their auditory discrimination abilities. The chronological age range for all subjects was from 4 years 6 months to 10 years 6 months. They found that there were significant correlations between chronological age and auditory discrimination test scores and between mental age and auditory discrimination test scores.

The authors felt that the mentally retarded group were handicapped over and above their mental retardation by environmental factors. Articulation and all auditory discrimination test scores were significantly related in the retarded group. This did not hold true with the normal group. For them, significant correlations were found only on the nonsense syllable test and on articulation scores.

Developmental Factors

Trapp and Evans[15] tested 54 children on non-verbal tasks from the Wechsler test. There were 18 in each of

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[14]Bernard Schlanger and Gloria Galanowsky, "Auditory Discrimination Tasks Performed by Mentally Retarded and Normal Children," Journal of Speech and Hearing Research, IX (September, 1966), 434-440.

[15]E. Philip Trapp and Janet Evans, "Functional Articulatory Defect and Performance on a Nonverbal Task," Journal of Speech and Hearing Disorders, XXV (May, 1960), 176-180.

three groups: (1) those with normal articulation skills (2) those with mild articulatory problems, and (3) those with severe articulatory problems.

After testing and computing results, it was found that those subjects with mild articulatory problems performed better than those with normal articulatory skills or those with severe articulation problems. They reported that normals had a combined score of 21.69 while the severe group had a score of 21.02; these are compared to a score of 23.73 for the mild group.

It would seem from these results that dividing subjects into articulatory groups is most productive for research purposes.

Everhart[16] did a clinical analysis of 110 elementary children having articulatory deviations. He found no significant relationship between articulatory defectiveness and onset of holding head up, onset of walking, onset of talking, onset of voluntary control of the bladder, eruption of first tooth, grip, height, weight, and handedness. He did find, however, a positive correlation between the factor of low intelligence and the incidence of articulation disorders.

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[16]Rodney W. Everhart, "The Relationship Between Articulation and Other Developmental Factors in Children," Journal of Speech and Hearing Disorders, XVIII (December, 1953), 332-338.

Dickson[17] compared two groups of youngsters with articulation defects. The two groups were composed of those who spontaneously outgrew their articulation errors and those who maintained them. He compared them on motor proficiency, auditory discrimination, and personality of parents.

He found those who did not outgrow articulation errors were inferior in motor proficiency. He also found that their mothers were more emotionally immature and unstable than the mothers of the control group.

Milisen[18] states quite clearly that those conditions that precipitate and maintain articulation defects after speech has developed are just an extension of factors which have inhibited an attitude of communication. These factors that Milisen eludes to have not all been discovered. The present study hopes to uncover one more in the chain.

In Everhart's[19] review of the literature on articulation he points out seven areas he considers important:

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[17]Stanley Dickson, "Differences Between Children Who Spontaneously Outgrow and Children Who Retain Functional Articulation Errors," Journal of Speech and Hearing Research, V (December, 1962), 263-271.

[18]Robert Milisen, "A Rationale for Articulation Disorders," Journal of Speech and Hearing Disorders, Monograph Supplement, No. 4 (December, 1954), 5-17.

[19]Rodney W. Everhart, "Literature Survey of Growth and Developmental Factors in Articulatory Maturation," Journal of Speech and Hearing Disorders, XXV (January, 1960), 59-69.

(1) there appears to be a positive correlation between intelligence and articulation; (2) increasing chronological age is important in articulatory development; (3) reading and articulatory maturation appear to be inextricably associated as parts of the linguistic function; (4) no significant differences were discovered between Negro and white boys having dyslalia in respect to developmental factors; (5) statistics show that articulatory defects are more prevalent among boys than girls; (6) in some instances, articulatory difficulty may be caused by failure to establish unilateral dominance in the cerebral hemispheres; (7) most of the authors reporting in the review feel that speech generally does not develop until large muscular mechanisms have matured sufficiently.

It is interesting to note that only fleeting comments were made to developmental auditory factors in this review.

Winitz and Lawrence[20] found that girls were better on a sound learning task than boys were. They concluded from their study that differences in articulation ability may be due to some rather complex reinforcement contingencies that have operated in the past or still operate. For when learning conditions are made similar, differences

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[20]Harris Winitz and Martha Lawrence, "Childrens Articulation and Sound Learning Ability," Journal of Speech and Hearing Research, IV (September, 1961), 259-269.

between children with good articulation and those with poor articulation are not apparent in rate or level of learning. They also felt that it would seem reasonable to assume that certain yet undisclosed learning difficulties in the past played some part in the differences in articulatory abilities.

Oral Language Development

VanDemark and Mann[21] measured the difference between two groups of children in regard to their oral language skills. Fifty children were in each group. One group was composed of normals and one group was composed of speech defectives. They measured (1) mean length of response, (2) standard deviation of response length, (3) number of one word responses, (4) mean of five longest responses, (5) number of different words, (6) structural complexity score and (7) type-token ratio. Each subject was also administered the Wechsler Intelligence Scale for Children. All subjects were matched on the basis of age, sex, socioeconomic status, and intelligence.

The only score that was significant between groups was the structural complexity score. The experimental group

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[21]Ann VanDemark and Mary Mann, "Oral Language Skill of Children with Defective Articulation," Journal of Speech and Hearing Research, VIII (December, 1965), 409-414.

received a mean score of 55.34 while the control group received a score of 65.79.

Winitz and Lawrence[22] compared two groups of kindergarten children on their sound learning abilities. The experimental group was composed of six male and six female subjects with poor articulation. The normal group was composed of six male and six female subjects with good articulation. Each child was asked to imitate 60 sounds. It was found that girls were superior to boys in this respect. They found no positive relationship between ability to learn sounds and articulation ability.

Powers[23] states that causal patterns and their temporal relation to the speech learning process are the cause of articulatory defects. These causal factors may be simple or complex. They may lie in any of four areas: physical, intellectual, environmental, or emotional.

Anatomical, motor, sensory, and intellectual variables are probably in operation more often as predisposing factors. Environment, learning, personality, and emotional variables are more often superimposed on the predisposing factors as precipitating and perpetuating agents.

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[22] Winitz and Lawrence, loc. cit.

[23] Margaret Hall Powers, Handbook of Speech Pathology, ed. by Edward Travis (New York: Appleton-Century-Crofts, Inc., 1957), 707-768.

These comments, although eminating from a thorough review of the literature, still do not answer the question of what causes articulation problems.

Steer and Drexler[24] tested their hypothesis that later articulation ability could be predicted from the type of articulatory disorders that were present when a child entered kindergarten. They found that the most predictive measures were found in the (1) total number of errors present, (2) errors when in the final position, (3) errors of omission in the final position, and (4) errors of /f/ and /l/. Their research, although interesting, did not ascertain the types of auditory factors which cause some to improve and others to struggle for a semblance of articulatory efficiency.

Delayed Auditory Feedback

Sixteen male subjects were chosen by Fairbanks and Guttman[25] to test the effect that delayed auditory feedback had on articulation abilities. Each subject was asked to read an identical prose statement seven times. The first

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[24] M. D. Steer and Hazel G. Drexler, "Predicting Later Articulation Ability from Kindergarten Tests," Journal of Speech and Hearing Disorders, XXV (December, 1960), 391-397.

[25] Grant Fairbanks and Newman Guttman, "Effects of Delayed Auditory Feedback Upon Articulation," Journal of Speech and Hearing Research, I (March, 1958), 12-22.

time allowed them to become familiar with the material. For the other six readings the individuals read the passages with ear phones on and feedback was delayed as follows: 0,0.1,0.2,0.4,0.8, and 0 seconds. Their performances were recorded on each reading.

As the time delay was presented, correct readings became distorted. It was found that a delay of 0.2 seconds caused the greatest disturbance in word rate, increased total reading time, and reduced the number of correct words spoken.

It was found that delayed auditory feedback not only induced articulatory disturbances but selectively varied the number of disturbances of certain types in relation to the specific interval of delay. Substitutions induced by delay tended to involve improbable phonetic elements, to be monophonemic, and to occur in stressed syllables.

Omissions were high in frequency of occurrence when delay was involved. Additions were the most distinctive characteristic of the peak disturbances. About 70 per cent of the additions were repetitive. This study points out the importance of the auditory ingredient in the articulatory process.

Fillenbaum[26] used 80 normal subjects and presented them with binaurally asynchronous delayed auditory feedback

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[26]Samuel Fillenbaum, "Delayed Auditory Feedback With Different Times at Each Ear," Journal of Speech and Hearing Research, VII (December, 1964), 369-371.

as compared with synchronous delayed auditory feedback. It was found that asychronous delayed auditory feedback with a 0.1 second difference does not yield results different from those under synchronous delayed auditory feedback with a 0.2 second delay interval.

Parental Occupation

Weaver, Turbee and Everhart[27] gathered occupational information for the parents of 594 first grade children. On the basis of these data they came to these conclusions: (1) paternal occupational status is significantly related to early speech maturation (more of the children in the study without dyslalia came from homes in upper occupational groups); (2) children from the two lowest occupational classes were affected significantly with articulatory defects.

Psychological and Perceptual Factors

Summers,[28] in a study of a group of college students, found that initial sounds were more easily perceived in

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[27] Carl Weaver, Catherine Turbee, and Rodney Everhart, "Paternal Occupational Class and Articulatory Defects in Children," Journal of Speech and Hearing Disorders, XXV (May, 1960), 171-175.

[28] Raymond Summers, "Perceptive vs Productive Skills in Analyzing Speech Sounds from Words," Journal of Speech and Hearing Disorders, XVIII (June, 1953), 140-148.

words, vowels were perceived more accurately than consonants, production and analysis of sounds were done more accurately in the final position. He also found that little difficulty was found in discrimination of speech sounds and that those sounds that were difficult to discriminate were sounds which tended to be difficult to perceive and difficult to analyze and produce. He found that speech sound discrimination was correlated with speech sound analysis production. Subjects most often combined the sound being studied with one of the adjacent sounds in the word if they produced an error. It was found that the highest correlation was between speech sound perception and speech sound analysis production.

Although this study was undertaken with college age subjects and none had speech defects, it does point out the complexities of sound perception and analysis.

Lowe and Campbell[29] studied 16 subjects on their ability to perform succession and ordering tasks. Eight of the subjects were categorized as aphasoid and eight as normal.

They reported a range from 15 to 30 msec for the normals on succession tasks with a mean of 18.5 msec. The range of succession scores for the aphasoid group was from 18 to 80 msec with a mean of 35.8 msec. The succession-task

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[29] Audrey D. Lowe and Richard Campbell, "Temporal Discrimination in Aphasoid and Normal Children," Journal of Speech and Hearing Research, VIII (September, 1965), 313-314.

stimuli consisted of two 15-msec 1KHz pulses with 5-msec rise/fall times. The time between pulse onsets was varied for each subject to determine the minimum time separation needed to perceive the pulses as successive (judgments of "one sound" versus "two sounds"). The order-task stimuli were two 15-msec pulses, one 2,200Hz and the other 400Hz. The time between pulse onsets was varied to determine the minimum time separation necessary for the subjects to place the pulses in their proper order of pitch. The subjects made judgments as to whether the last sound was high or low. The order scores for the aphasoid group ranged from 55 msec to 700 msec with a mean of 357 msec.

The authors found no statistically significant differences between aphasoid and normal children on the succession tasks. A significant difference was found on the order task at the .005 level.

Postman and Rosenzweig[30] concluded in their study that redundancy facilitates perceptual recognition on the basis of reduced stimulus cues. It would seem from this information that improvement in word recognition can be achieved through the strengthening and differentiation of verbal habits. They state that both linguistic behavior and perceptual recognition of words are influenced by this factor.

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[30] Leo Postman and Mark K. Rosenzweig, "Perceptual Recognition of Words," Journal of Speech and Hearing Disorders, XXII (June, 1957), 245-253.

Mange[31] performed various auditory tests on two groups of school age children. One group had normal articulation abilities, whereas the experimental group was composed of children with functional misarticulations of /r/ but not /s/.

He found that there was a significant, but low, partial correlation between phonetic word synthesis ability and number of articulation errors. He did not find any significant relationships between other auditory abilities and number of articulation errors.

This study points out that synthesis ability appears to be related to number of errors but not to normalcy or defectiveness. It also points out that while pitch discrimination appears to be related to normalcy or defectiveness of articulation, it is not related to number of articulatory errors.

The control groups in this study achieved significantly higher scores than the experimental group in discrimination of pitch. There were, however, no significant differences between mean scores of the control and experimental groups on other auditory abilities tested. In all cases the control group achieved numerically higher mean scores.

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[31] Charles V. Mange, "Relationships Between Selected Auditory Perceptual Factors and Articulation Abilities," Journal of Speech and Hearing Research, III (March, 1960), 67-74.

Broadbent's[32] review of several research studies adds some interesting comments relevant to the present study. He states that three main areas are involved in selective listening. First, some central rather than sensory factors are involved when two messages are presented to the ears at the same time. Secondly, the rate of receiving messages is important. Comments regarding this area are also relevant in that they point out the increased difficulty of perception if the message units are complex or if they have more intellectual meaning for the subject. Thirdly, when some information must be discarded, it is not discarded at random. Thus, if information is irrelevant or not directed to the thought being presented, it should be placed in a different context or through a different modality.

The information presented above is directed toward a psychology of perception of sounds. The inference is that many are less practiced at perception; thus, practice may improve the ability to perceive sounds or words. It would seem from this information that time factors and relevance of information would make a significant difference in a child's perception of sound.

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[32] D. E. Broadbent, Perception and Communication (London: Pergamon Press, Ltd., 1958), pp. 34-35.

Twenty-four children were used by Smith[33] in his attempt to investigate storage and processing of stimuli. He used 12 children with nonorganic articulation problems and 12 with normal speech. Each subject was required to recall single, sequential, and simultaneous digit sets. They were also involved in stringing beads in a pattern, as demonstrated by the examiner.

He found that those children with nonorganic speech problems were inferior to children with normal speech in single, sequential and simultaneous digit sets. There did not seem to be a difference in the abilities of the groups on bead patterning recall tasks. This would seem to indicate that they had no difficulty with short-term storage. This information was further dismissed by the author when he reported that there were significant differences in the abilities of the groups for immediate recall of three and five digits.

Van Riper[34] attributes persistence of articulatory disorders to an inability of many children to perceive that words are composed of a series of sounds. They are not able to distinguish between the word parts and the whole.

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[33] Curtis R. Smith, "Articulation Problems and Ability to Store and Process Stimuli," <u>Journal of Speech and Hearing Research</u>, X (June, 1967), 348-353.

[34] Charles Van Riper, <u>Speech Correction; Principles and Methods</u> (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1954), pp. 122-123.

Van Riper and Irwin[35] make two suggestions: (1) existing tests of speech sound discrimination are testing speech sound discrimination in a crude and oblique fashion, and (2) poor discrimination may be only one of many factors which contribute to faulty articulation. These authors also question whether poor phonetic discrimination is a general ability which is related to auditory perception or whether it is specifically directed to sounds made erroneously.

Van Riper and Irwin also discussed the term "Vocal Phonics" which is synonymous with the present author's reference to auditory synthesis. They feel that vocal phonics is probably based mainly on natural ability, but it can be learned.

Liberman's et al.[36] paper on a motor theory of speech perception points out that because of the interactions and constraints inherent in the mechanism of the vocal tract, the encoding of motor commands into shapes and movements is often a complex transformation. Motor commands operate ahead of these complications and are therefore able

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[35]Charles Van Riper and John V. Irwin, <u>Voice and Articulation</u> (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1958), p. 25.

[36]Alvin Liberman et al., <u>A Motor Theory of Speech Perception</u>, a paper presented by Speech Transmission Laboratory, Royal Institute of Technology, Stockholm, Sweden, 1962.

to escape this recoding process. He therefore feels that neural commands to the articulators provide the simplest relationship to phoneme perception.

CHAPTER THREE

EXPERIMENTAL PROCEDURES

A test was designed and constructed to measure the abilities of three different groups of school age subjects to synthesize monosyllabic words from discrete phonemes. This was done by constructing a tape of the phonemes with a one second interval between each phoneme.

The three groups were composed of second and third grade children from three parochial schools. Each group had a different level of articulatory ability. The groups were matched as to sex, intelligence, age, reading level, previous formal speech training, and exposure to phonetic teaching methods.

Test Composition and Construction

It was evident from the beginning planning stages of this research that there was no formal test available for the examiner's use. Mange[1] designed a test of this nature to measure the synthesizing abilities of children in his study.

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[1]Charles V. Mange, "Relationships Between Selected Auditory Factors and Articulation Ability," Journal of Speech and Hearing Research, III (March, 1960), 67-74.

It was felt by this examiner that this test was not an adequate measure because Mange composed his words by producing isolated phonemes and then joined them together to form words.

Twenty words were chosen from the Thorndike-Lorge list[2] and the Bucks County 1185 Common Words list.[3] Appendix A contains a list of these words. All twenty words contained three phonemes and all phonemes were continuant sounds. Continuant sounds were used because of their more distinguishable quality on magnetic tape. The three phoneme length of the words was maintained (1) so that the test would be uniform throughout, (2) so that words would be within the subject's receptive vocabulary, and (3) so that the job of cutting and splicing would be easier. Each word was one syllable in length. There was no vowel-consonant pattern used when choosing the words. When the words were recorded, the examiner was careful not to record a word that sounded similar to or had a beginning or ending sound the same as the word that preceded it.

The examiner listened to the test words and made a judgment as to which words sounded similar. Four speech

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

[3]Morton Botel, Botel Predicting Readability Level (Chicago: Folett Publishing Co., 1962).

clinicians were then asked to listen to the tape and make the same judgment independently.

The test words were one grade level or more below the average reading level of the groups tested. This was done to insure that each subject would be familiar with the word because this study was not concerned with measuring the subject's auditory vocabulary.

Originally more than twenty words were chosen from the above mentioned lists. Many of them were discarded and not included in the test because they had elements that might confuse the subjects.

In order to determine the reliability of the test a first-half second-half correlation was performed, with a resultant $\underline{r}$ = .85.[4] This $\underline{r}$ was then submitted to the Spearman-Brown Prophesy Formula[5] with a resultant $\underline{r}$ = .92. It was felt that this correlation was sufficient to consider the test reliable.

The test itself was made on a Rheem Caliphone recorder, model 3200. The tape used was one-half Mil. Scotch brand magnetic recording tape. One Mil. leader tape was used for the splicing. The tape speed for both recording and playback was seven and one-half inches per second. The following method was used in constructing the test tape.

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[4]Allen L. Edwards, Statistical Methods for the Behavioral Sciences (New York: Rinehart and Co., Inc., 1960), p. 502.

[5]Ibid., pp. 176-177.

Each word was recorded on the tape approximately twenty-five seconds apart. The tape was then rewound, and the tape was turned past the recording head by hand. It is possible with this recorder to disengage the drive mechanism for the reels but to leave the head on. As the first phoneme of the first word was past the recorder head and before the second phoneme started a right angle cut was made from the tape. This was done so that the preceding consonant or vowel would not be repeated prior to the following vowel or consonant. The tape reels were then removed from the recorder and a one second piece of leader tape was spliced between the two halves. The first and second phonemes of the first word were then separated. The reels were then placed on the recorder and turned by hand until the second phoneme of the first word was finished. Then the same process was repeated. At the end of the third phoneme exactly twenty-five seconds were measured off before the second word was started. This was done to insure each subject would have adequate time to write the word during the actual testing situation. A time of twenty-five seconds was chosen because of the results of an earlier pilot study. The remaining nineteen words were cut and spliced in the same manner. A second tape was made of the following lead-in phrase: "Get ready for the next word." This tape was played so that the word "word" ended exactly five seconds before the beginning of each test word. It was recorded on the test tape with the aid of a stop watch to insure exact timing. The loudness level during the test construction was set at a level to insure adequate reproduction of each word. The setting was uniform for all words. The room where both tapes were made was an Industrial Accoustic Company (IAC) testing suite. This was done to eliminate any external noises which may have caused a distortion on the test tape.

Subject Selection

Thirty second and third grade students were chosen for this study. There were ten in each of the three groups. The thirty subjects were chosen from three Catholic parochial schools. This method was used because phonetic teaching methods are more uniform there than in the public schools.

Each group of ten was composed of seven boys and three girls. All three groups were matched as to sex, age, exposure to phonetic teaching methods, reading level, hearing, and intelligence. Data used for matching on age and intelligence are found in Appendix B. Matching on the basis of sex was done since sex differences on phonetic discrimination tasks was reported by Mange.[6] There were twenty-one boys and nine girls in the final study.

The age level of the groups was held within seven years five months to nine years. This was done so that at

[6]Mange, op. cit., p. 72.

the oldest age a standardized and acceptable measuring device was available. Each group was administered the Templin-Darley Screening Test of Articulation.[7] This test required each subject to say fifty different words by naming pictures on cards provided. Within the fifty items there were twenty-five single phonemes, twenty-two two-consonant blends, and four three-consonant blends. Appendix C contains a list of the words used. Test-retest reliabilities of this test are reported by Templin to be between .93 and .99 on single age groups of young children. Before this test was administered by the examiner, a tape was made of two children with defective articulation. The two subjects were asked to say words on the Templin-Darley screening test. The examiner then scored these tests. Three qualified speech clinicians were then asked to listen to this tape and score it. Each speech clinician was allowed to listen to the tape as many times as was needed to complete his scoring. It was decided that if two of the three judges indicated that a subject's articulation was normal or in error, it was considered as such. In about 85 per cent of the judgments there was unanimous agreement among the judges. Agreement was reached in more than 98 per cent of the judgments.

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[7]Mildred C. Templin and Frederic L. Darley, The Templin-Darley Tests of Articulation (Iowa: State University of Iowa, 1960).

The examiner's judgment of the words were then compared with the criterion judgments. These comparisons yielded 98.0 per cent agreement on normal production, 89.0 per cent on distortion, 95.6 per cent agreement on substitutions, 63.2 per cent on additions, and 100 per cent agreement on omissions. The low score obtained on additions is not significant because of the relatively few errors of this type in the sample.

The test was then administered to the subjects and scored. The results were used to place the subjects in their various groups. Group one was composed of ten subjects with a score of 50. This group was called "normals." Group two was composed of ten subjects with a range in score from 37.7 to 49 which is in a range between one and four standard deviations below the mean for eight-year-olds. This group was designated as those with "mild articulatory defects." Group three was composed of ten subjects with scores below 37.5 which is at least four standard deviations below the mean for eight-year-olds. This group was designated as those with "severe articulatory defects."

It was felt necessary to attempt to control the amount of exposure to phonetic teaching methods that each subject had had. This was done within as close a degree as possible by choosing all the subjects from a Catholic parochial school. It was found in these parochial schools that the teaching methods were similar. It was felt with this approach that the examiner would not have to match children from different rooms or schools, thus giving a greater number of qualified subjects to choose from.

Each group was matched on reading level. The information of each subject's reading level was found in his permanent file. The test used to gain this information was a standardized group test used by the Arch-Dioceses of Detroit. The gathering of this information was done to insure that each child and his control had equal word familiarity.

The articulatory defective subjects were all assumed to be of the commonly accepted functional type since examination of school records, records of the referring clinicians and an examination by the experimenter revealed no organic or structural conditions which might lead to an articulatory defect. None of the subjects selected had received previous speech therapy.

Each subject was given a hearing test. This procedure was adopted since this test required accurate perception of many speech sounds with frequency components throughout a wide range. Each subject was required to respond to all frequencies produced by an audiometer from 250Hz through 8KHz at 10 db ASA in both ears. All subjects who failed this test were excluded from the study.

Each subject was then given an auditory memory for speech sounds test. This test was constructed by the examiner from information gathered from a study by Metraux.[8] She found that an eight-year-old should have an auditory memory of at least 3.45 vowel sounds and 2.65 consonant sounds. The form for the test used is similar to the one that Metraux used. See Appendix D for a complete presentation of the test. It was not found necessary by this investigator to pursue Metraux's test to its full three series and include as many speech sounds as were designated, as her norms indicated that children of the age group used in this study did not obtain scores above the eight sound series.

The auditory memory test was recorded by this examiner on 1.0 Mil. recording tape using a Rheem Caliphone tape recorder, model 3200. The intensity level was kept constant insofar as possible during recording and play back by utilizing the V.U. meters built in the recorder. The tape was prepared in and IAC sound proof room.

This testing procedure was necessary to assure that each child could remember the individual phonemes of the test words and the present test was not measuring auditory memory. All subjects were excluded from the study if they failed to remember four vowel sounds and three consonant sounds.

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[8]Ruth W. Metraux, "Auditory Memory Span for Speech Norms for Children," Journal of Speech Disorders, IX (April, 1944), 31-38.

All of the remaining subjects were administered an individual intelligence test. The test used was the Peabody Picture Vocabulary Test.[9] It is a standardized test with a high correlation with both the Stanford Binet form LM and the Wechsler Intelligence Scale for Children. All groups were then matched on intelligence level within fifteen I.Q. points. No subjects were included in the study if they had an I.Q. below ninety or above one-hundred-twenty. The relationship between intelligence and the scores obtained on the test used in this study was expected to be low; however, this relationship had not been determined previously. Consequently, it seemed advisable to control for the influence of this factor.

Each subject was given a spelling test of the test words one week prior to the actual testing. This was done to insure that each child could spell the test words and so that the examiner could become familiar with the common errors in spelling for each subject.

The address and telephone number for each subject was obtained. Each subject's parents or guardians were called and asked whether they would permit their child to take part in the study. Each subject was then given a note to take home describing the study and was asked to return a

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[9] Lloyd M. Dunn, Peabody Picture Vocabulary Test (Minneapolis: American Guidance Service, Inc., 1965).

portion of this note which contained a release for their child to be transported to and from the testing site. See Appendix E for a sample of the letter.

Test Administration

Five subjects at a time were administered the test. It was necessary to limit the number tested at one time to control (1) the noise level, (2) the opportunity for cheating, (3) crowding of the test room, and (4) the relative distance from the test apparatus.

The subjects were seated equidistant from the speaker to guarantee that each subject was receiving the same level of sound at the ear. This distance was predetermined by the use of a sound level meter. Each desk was partly enclosed on the sides to insure that observation of a neighbor's paper was very difficult.

The actual testing was done in the parochial school which the child attended. This was done so that each subject would feel at ease. Saturday morning was chosen for the test time so that the normal noise level in the school would be absent.

After the subjects were seated, they were given a record sheet for their answers. See Appendix F for a sample of the record sheet. Each sheet was color coded to insure accurate gathering of the data. Each subject was given two pencils, sharpened just prior to the test. Each sharpened pencil was run over a rough piece of paper to dull the point somewhat. This was done so that the record sheets would not be cut and so that a broken pencil could be avoided. The subjects were then asked to write their names in the blank provided.

Each subject was then given a detailed briefing on what was expected of him. They were asked (1) not to say outloud any of the words that they recognized, (2) not to talk to their neighbors, (3) not to look on their neighbor's paper, and (4) to sit quietly during and after the presentation of each word. They were given instructions as follows:

> You will hear three speech sounds, one after another. These sounds make a word. You are to listen carefully and try to put the sounds together in the order that they are given to make a word. If you know what the word is, write it after the number on your answer sheet. If you do not know what the word is make an X after the number. You will have enough time to write the word down, so don't hurry.

It was decided not to let the subjects ask questions of the examiner during the testing as it would (1) slow down the testing time, (2) enable the subjects to overhear the examiner while helping other subjects, and (3) cause confusion in the testing situation.

Ten words were presented on the tape. Then the subjects were asked to turn in their record sheets to the examiner. He talked with the subjects individually and verified their spelling of the words. The subjects were then given a second sheet and again asked to record their names in the blank provided. The next ten words were played and the subject's answers were verified. The subjects were then excused and the tape was run back to the start. The children were asked not to discuss the testing with their classmates. The next group of subjects was then brought in and the procedure was repeated.

Groups one, three and five were tested at 9:00 a.m. and groups two, four and six were tested at 10:00 a.m. The morning hours were chosen since it was felt that the children would be more alert during the morning hours.

CHAPTER FOUR

RESULTS

Test results for each subject were tabulated by the following method: for each word synthesized correctly the subject was given one point. No credit was given for words if they contained extra sounds or if the sounds were in the wrong order. Table 1 contains a listing of these scores.

Table 1. Number of words synthesized correctly

	Normals	Mild	Severe
1.	4	1	4
2.	5	4	10
3.	8	5	10
4.	11	12	12
5.	9	7	7
6.	12	3	6
7.	2	9	1
8.	2	2	1
9.	9	5	1
10.	5	6	3

The above data were then submitted to the ranking procedure as outlined in Siegel.[1] A listing was then made

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

of all rankings. Table 2 contains a listing of these scores.

Table 2. Rank scores

	Normals	Mild	Severe
1.	6	2.5	2.5
2.	6	6	2.5
3.	11	8.5	2.5
4.	14.5	11	8.5
5.	14.5	14.5	11
6.	21	14.5	17.5
7.	23	17.5	17.5
8.	23	19.5	25.5
9.	27	23	25.5
10.	29	29	29
	R_1=175	R_2=146	R_3=144

The total data were submitted, after correcting for ties, to the Kruskal-Wallis One-Way Analysis of Variance by Ranks.[2]

This procedure yielded and H = .7533 which is not significant at the .05 level of confidence. To be significant at the .05 level of confidence H would have to be equal to or greater than 5.99.

Because of the nonsignificant nature of the results for words, the following null hypothesis was formulated:

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[2] Ibid., p. 186.

> There is no significant difference in the abilities of three groups of school age children with varying degrees of articulatory skill to recognize sounds presented on tape in proper sequence.

The data were then reevaluated for the number of sounds correctly recorded. Each subject was given credit for one sound (1) if it was correct for the word produced and (2) if it was in the right position in the transcription no matter what preceded or followed it. Table 3 contains a listing of these scores.

Table 3. Number of sounds synthesized correctly

	Normals	Mild	Severe
1.	33	5	23
2.	25	21	36
3.	33	30	41
4.	48	47	41
5.	42	33	36
6.	46	30	30
7.	9	33	11
8.	14	22	9
9.	35	19	8
10.	31	29	12

These data were then submitted to the same ranking procedure as were the words. Table 4 contains a list of these rankings. These data were then submitted to the Kruskal-Wallis One-Way Analysis of Variance by Ranks.[3]

[3] _Ibid_.

Table 4. Rank scores for sounds

	Normals	Mild	Severe
1.	3.5	1.0	2.0
2.	7.0	8.0	3.5
3.	12.0	9.0	5.0
4.	17.0	10.0	6.0
5.	19.5	13.0	11.0
6.	19.5	15.0	15.0
7.	22.0	15.0	23.5
8.	27.0	19.5	23.5
9.	28.0	19.5	25.5
10.	30.0	29.0	25.5
	R_1=183.5	R_2=139.0	R_3=140.5

This procedure yielded and H = .82621 which was not significant at the .05 level of confidence. To be significant at the .05 level of confidence H would have to be equal to or greater than 5.99.

Articulation and synthesis scores for each subject were then submitted to a correlation procedure. This procedure yielded and *r* = .1736 which was not significantly different from a correlation of 0.0 at the .05 level of confidence.[4] To be significant at the .05 level of confidence *r* would have to be equal to or greater than .361.

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[4]Allen L. Edwards, Statistical Methods for the Behavioral Sciences (New York: Rinehart and Company, Inc., 1960), p. 502.

Discussion

The results of this study do not allow one to reject the null hypotheses presented in Chapter One. Neither do they allow one to reject the null hypothesis stated earlier in this chapter.

The ability to synthesize auditorily is considered important by both Van Riper[5] and Mange.[6] They feel that this ability is necessary in order to improve upon articulatory skill.

Van Riper has stated that many children with articulation problems have difficulty in synthesizing words auditorily. In his discussion of this hypothesis he gives a listing of norms, which he himself recognizes as being inadequate to support his hypothesis.

The present study does not support the hypothesis forwarded by Van Riper. It also does not support the idea that there is a need for involving this type of training in the therapeutic setting. It would seem that the speech pathologist could spend his time with other activities directed toward remediation of the articulatory disorder.

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[5]Charles Van Riper, Speech Correction: Principles and Methods (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1948), pp. 126, 194-195.

[6]Charles V. Mange, "Relationships Between Selected Auditory Factors and Articulation Ability," Journal of Speech and Hearing Research, III (March, 1960), 67-74.

The present study's findings are in disagreement with Mange's findings on auditory synthesis. He found a significant but low, partial correlation between phonetic word synthesis ability and number of articulation errors.

Mange's difference may be due to the fact that he used a limited population in terms of articulation defect. The subjects in his experimental group had functional misarticulation of /r/ but not /s/. The methods used in producing the test words were also different from the present study. He produced sounds in isolation then connected them to produce words. This procedure may have made each sound of longer duration than those of the present study, thus giving the subject a better chance to identify the sound than in a more normal presentation of the word.

CHAPTER FIVE

SUMMARY AND CONCLUSIONS

Two-thirds of all the disorders of speech are of the articulatory type. This group composes the largest percentage of cases that the public school speech clinician works with. This large group of children constitutes a great challenge to the practicing school speech clinician. The lack of knowledge regarding successful remediation techniques breeds discouragement to many in the field. The need for more information regarding the cause and treatment of this disorder is clearly evident.

The process of speech acquisition necessitates many well developed sensory skills. If there is a breakdown in one or more of these skills, one possible resultant condition is misarticulation.

Fairbanks[1] indicates that the motor component only serves as an aid to the auditory component. He stresses that the motor component alone is not sufficient to insure adequate articulatory development.

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[1] Grant Fairbanks, "Speech as a Servo System," Journal of Speech and Hearing Disorders, VIII (May, 1954), 133-139.

It is considered important to monitor aurally by several others in the field. If this auditory process is disturbed, the predictable misarticulations result. The question then is this: what auditory functions are important in determining success or failure in the development of adequate articulatory production?

In reviewing the literature this investigator found many studies dealing with auditory discrimination. Some found a direct relationship between the ability to discriminate aurally and articulation. Others were not successful in establishing such a relationship, whereas others hinted but did not demonstrate this relationship.

At least two of these investigations dealt with auditory synthesis or the ability to analyze and combine sounds into words or sound units. One investigator found a relationship between an inability in this area and misarticulations. The other hypothesized that this is significant but did not demonstrate it statistically.

The present investigator became interested in this area and designed a study to measure the importance of this auditory factor and its import on degree of articulation defectiveness. The following hypotheses were formed.

1. There is no significant difference in the auditory synthesizing abilities of those children with severe articulatory problems and those with mild articulatory problems.

2. There is no significant difference in the auditory synthesizing abilities of those

children with severe articulatory problems and normal articulatory skills.

3. There is no significant differences in the auditory synthesizing abilities of those children with mild articulatory problems and normal articulatory skills.

4. There is no significant correlation between articulation score and synthesis score.

Three groups of school age children were used to measure this factor. The groups ranged from those with normal articulation abilities down to those with severe articulatory defects. A test was developed that contained twenty words consisting of three phonemes each. Each word was divided into phonemes with a one second interval between each sound. These words were recorded on magnetic tape. This tape was played to each group, and the subjects were asked to identify the various words presented.

The scores obtained by each group on the number of words and sounds correctly identified were submitted to statistical analysis. No significant differences were found for either words or sounds at the .05 level of confidence. No significant correlation, at the .05 level of confidence, was found between articulation and synthesis scores.

Conclusions

The results, though disquieting to the examiner, indicate that the process called auditory synthesis does not constitute an important ingredient, as measured by this approach, in successful development of adequate articulation. It indicates further that the time and energy spent in therapy focussed around this auditory factor might be better spent in other activities which have thus far demonstrated themselves to be more useful.

Implications

Since there were no significant differences found among the groups tested, the question arises whether there would have been differences noted if the groups were different. The following questions are presented to demonstrate possible differences in group composition or technique:

1. Will there be a significant difference in the scores obtained by children with different types of articulatory problems, i.e., substitutions, distortions, additions, or omissions?
2. Will there be a significant difference in the scores obtained by children with different sounds in error, i.e., lisps, /r/ distortions, etc.?
3. Will there be a significant difference in the scores obtained by children if the individual phonemes of the test words are prolonged?
4. Will there be a significant difference in the scores obtained by children if the interval between phonemes is shortened or lengthened?

5. Will there be a significant difference in the scores obtained if the mean age level of the groups used was reduced by two years while holding all other matching data constant?
6. Will there be a significant difference in the scores obtained if the mean age level of the groups used was increased by two years while holding all other matching data constant?
7. Will there be a significant difference in the scores obtained if one sex were used to form the groups?
8. Will there be a significant difference in the scores obtained if the group composition was limited to one socioeconomic level?

APPENDICES

APPENDIX A

WORDS USED IN AUDITORY SYNTHESIS TEST

1.	easy	11.	them
2.	fill	12.	safe
3.	ever	13.	shall
4.	fish	14.	man
5.	less	15.	sun
6.	offer	16.	nose
7.	same	17.	shore
8.	near	18.	laugh
9.	seem	19.	some
10.	miss	20.	save

APPENDIX B

DATA FOR MATCHING ON AGE AND INTELLIGENCE

Subject	Group**	Grade	B.D. mo.-day-yr.	Age	M.A.*	%*	I.Q.*
D.Z.	M	2	7-1-59	8-9	8-5	39	95
J.M.	S	2	9-3-60	7-8	10-4	92	120
R.H.	S	2	11-5-59	8-5	7-10	50	99
V.M.	M	2	5-13-60	7-11	8-3	55	102
P.M.	M	3	6-27-59	8-10	7-10	28	90
C.D.	S	3	4-9-59	9-0	10-4	71	109
A.K.	M	3	9-17-59	8-7	11-0	89	118
C.R.	M	3	3-13-59	9-0	8-5	39	95
C.D.	S	3	8-23-59	8-8	10-8	84	114
R.H.	S	3	4-29-59	9-0	9-5	57	103
J.A.	N	2	7-29-60	7-9	8-11	76	109
C.S.	N	2	3-16-60	8-1	7-1	34	92
S.K.	M	3	9-26-59	8-7	8-11	50	100
P.D.	N	2	9-15-59	8-7	8-1	31	91
D.S.	N	2	1-15-60	8-3	10-5	92	120
J.N.	N	2	1-30-60	8-3	10-0	87	116
P.H.	S	1	7-12-60	7-9	7-3	40	93

APPENDIX B--Continued

Subject	Group**	Grade	B.D. mo.-day-yr.	Age	M.A.*	%*	I.Q.*
T.B.	N	3	10-25-59	8-6	8-7	44	96
G.C.	N	3	8-20-59	8-8	10-5	75	111
C.C.	S	2	11-20-60	7-5	8-11	91	120
C.M.	N	2	5-8-60	7-11	7-1	34	92
J.J.	S	2	5-26-60	7-11	8-3	55	102
W.G.	M	3	8-7-59	8-9	10-8	84	114
D.G.	M	2	8-4-60	7-9	7-3	40	93
D.B.	M	3	8-28-59	8-9	9-8	64	104
S.Y.	M	3	9-1-59	8-8	7-11	24	90
B.M.	S	2	2-20-60	8-3	9-8	84	114
E.F.	S	2	3-25-60	8-2	7-10	50	100
J.W.	N	3	7-24-59	8-10	11-4	91	119
S.B.	N	3	7-16-59	8-10	10-10	87	116

*Peabody Picture Vocabulary Test.

**N-normals; M-mild; S-severe.

APPENDIX C

WORDS USED IN ARTICULATION TESTING

Single Phonemes

7. bird [ɝ]
13. music [ju]
28. rabbit [r] I
28. arrow [r] M
29. leaf [l] I
31. valentine [v] I
32. thumb [θ] I
32. bathtub [θ] M
32. teeth [θ] F
33. there [ð] I
33. feather [ð] M
33. smooth [ð] F
35. zipper [z] I
36. sheep [ʃ] I
36. dishes [ʃ] M
36. fish [ʃ] F
37. television [ʒ] M
41. yellow [j] I
41. onion [j] M
42. chair [ʧ] I
42. matches [ʧ] M
42. watch [ʧ] F
43. jar [ʤ] I
43. engine [ʤ] M

Two Consonant Blends*

44. presents [pr]
45. bread [br]
46. tree [tr]
47. dress [dr]
48. crayons [kr]
49. grass [gr]
50. frog [fr]
51. three [θr]
52. shredded wheat [ʃr]
76. planting [pl]
78. clown [kl]
79. glass [gl]
80. flower [fl]
85. snake [sn]
96. smoke [sm]
97. spider [sp]
98. stairs [st]
99. sky [sk]
100. sled [sl]
101. sweeping [sw]
109. twins [tw]
110. queen [kw]

*Beginning of words.

APPENDIX C--Continued

Three Consonant Blends

120. splash [spl]
121. sprinkling can [spr]
122. string [str]
123. scratch [skr]

Key: I = Initial position; M = Medial position; F = Final position.

APPENDIX D

AUDITORY MEMORY TEST

Name:________________________ B.D.________________ Age:_____
last first mo. day year

Practice

[a, oʊ] pause 3 seconds

[eɪ, ɔ] pause 3 seconds

[u, æ] pause 3 seconds

[i, aɪ] pause 3 seconds

Break

First you will hear one sound. Ready?
(pause 2 seconds)

[ɑ] Score:______

Break

Now you will hear two sounds. Ready?
(pause 2 seconds)

[aɪ, ɪ] Score:______

Break

Now you will hear three sounds. Ready?
(pause 2 seconds)

[ɔ, u, æ] Score:______

Break

Now you will hear four sounds. Ready?
(pause 2 seconds)

[eɪ, æ, i, a] Score:______

Break

Now you will hear five sounds. Ready?
(pause 2 seconds)

[æ, u, ɔ, i, aɪ] Score:______

Break

Now you will hear six sounds. Ready?
(pause 2 seconds)

[ou, eɪ, a, u, i, æ] Score:______

Break

Now you will hear seven sounds. Ready?
(pause 2 seconds)

[a, i, æ, eɪ, aɪ, ɔ, ɪ] Score:______

Break

Now you will hear eight sounds. Ready?
(pause 2 seconds)

[eɪ, æ, i, a, aɪ, u, ou, ɔ] Score:______

Break

Consonants

These are practice sounds. Ready?
(pause 2 seconds)

[kʌ, fʌ] pause 3 seconds

[pʌ, tʌ] pause 3 seconds

[sʌ, ʃʌ] pause 3 seconds

Now you will hear one sound. Ready?
(pause 2 seconds)

[pʌ] Score:______

Break

Now you will hear two sounds. Ready?
(pause 2 seconds)

[fʌ, kʌ] Score:______

Break

Now you will hear three sounds. Ready?
(pause 2 seconds)

[ʃʌ.fʌ.pʌ] Score:______

Break

Now you will hear four sounds. Ready?
(pause 2 seconds)

[sʌ.kʌ.fʌ.tʌ] Score:______

Break

Now you will hear five sounds. Ready?
(pause 2 seconds)

[pʌ.ʃʌ.kʌ.tʌ.sʌ] Score:______

Break

Now you will hear six sounds. Ready?
(pause 2 seconds)

[fʌ.tʌ.ʃʌ.kʌ.sʌ.pʌ] Score:______

Break

Now you will hear seven sounds. Ready?
(pause 2 seconds)

[ʃʌ.kʌ.sʌ.tʌ.pʌ.ʃʌ.kʌ] Score:______

Break

Now you will hear eight sounds. Ready?
(pause 2 seconds)

[sʌ.ʃʌ.kʌ.fʌ.sʌ.tʌ.kʌ.pʌ] Score:______

Break

Hearing screening results:____________________

APPENDIX E

LETTER SENT TO SUBJECTS' PARENTS

Date

Dear Mr. and Mrs. ____________________________

Your child has been chosen to be part of a research study on the causes of articulatory problems. This study is being done as part of the requirements for a Master of Arts degree in speech pathology from Michigan State University.

The format of this study has been discussed with your child's principal, and she is in full accord with its purpose and mode of operation.

In the final paper your child's name will not be used and none of the data gathered on him will give clues as to his identity.

May I have your permission to include your child in one of my groups? May I also have your permission to perform various tests on your child? To perform some of these tests it will be necessary to have your child present at his school on three Saturday mornings. These test sessions will be approximately one hour in length.

If I have your permission to use and test your child for my study, please sign the enclosed form and return it to your child's school.

If you have any questions regarding this study please call me at the "Detroit Hearing and Speech Center" 341-1353 between the hours of 8:30 a.m. and 4:30 p.m. or at my home after 9:30 p.m. any evening but Friday or Saturday.

Sincerely,

____
Daniel W. Davison

APPENDIX F

RECORD SHEET

Code ☐

Name:____________________, __________________________________
last first middle

Date:____________________ Time of Testing____________________

1. ______________________________________
2. ______________________________________
3. ______________________________________
4. ______________________________________
5. ______________________________________
6. ______________________________________
7. ______________________________________
8. ______________________________________
9. ______________________________________
10. ______________________________________

Record sheet number

____

APPENDIX G

COMPARISON OF MEANS FOR ALL THREE GROUPS ON CA, MA, I.Q., PERCENTILE, GRADE AND SCORES OBTAINED ON AUDITORY SYNTHESIS TEST

Group**	CA	MA*	I.Q.*	%*	Grade	Scores Words	Scores Sounds
N	8-4	9-3	106	65	2.4	6.7	31.6
M	8-3	8-6	103	59	2.2	5.4	26.9
S	8-5	9-3	106	61	2.7	5.5	24.7

*Peabody Picture Vocabulary Test.

**N-normals; M-mild; S-severe.

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