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Relationship of auditory short-term memory and articulation ability of eight-year-olds

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This study investigated the relationship of auditory short-term memory and articulation ability of eight-year-old children to determine if a relationship existed between auditory short-term memory ability and articulation ability. The specific question posed was: Is there a statistically significant difference in the auditory short-term memory ability of eight-year-olds with three or more phoneme errors and eight-year-olds with no phoneme errors?

A total of thirty-two subjects were individually administered

the Templin-Darley Screening Test of Articulation (Templin and Darley, 1960), the Auditory Memory Span Test (AMST), Forms I and II (Wepman and Morency, 1973a), and the Auditory Sequential Memory Test (ASMT), Forms I and II (Wepman and Morency, 1973b). The subjects responded verbally to each of the tests. Each subject obtained a score for each test of the AMST and the ASMT. Each experimental subject obtained a score for the number of phoneme errors on the articulation test.

The experimental group subjects were identified by the school speech pathologist; and the classroom teacher selected subjects of the same sex and academic ability for the control group. Each subject in the investigation was evaluated during one twenty to twenty-five minute session. All subjects had normal hearing acuity as determined by a pure-tone hearing acuity screening test. The Templin-Darley Screening Test of Articulation (Templin and Darley, 1960) was administered to determine articulation ability; and the AMST (Wepman and Morency, 1973a) and the ASMT (Wepman and Morency, 1973b) were administered to determine auditory short-term memory ability.

Two groups, a control and an experimental, were chosen according to the results of the Templin-Darley Screening Test of Articulation (Templin and Darley, 1960), that is, the first thirty-two paired children made up the population for this study. The control group was comprised of sixteen children, eight years of age, who displayed no phoneme errors. The experimental group consisted of sixteen children, eight years of age, who displayed three or more phoneme errors. The groups were matched for sex, classroom, and academic performance.

The AMST and ASMT scores of the two groups were compared, using

a one-tailed t test of unrelated means. The results indicated no statistically significant difference existed between the two groups at the .05 level of confidence. Additionally, there were no statistically significant differences at the .05 level of confidence when the increasing number of articulation errors were compared to the test scores on the AMST and the ASMT.

In examining the data in this study, it was concluded: 1) There was no statistically significant difference in the auditory short-term memory ability, in either span or sequencing, between eight-year-old children with "mild" to "moderate" articulation deficits and eight-year-old children with no articulation deficits; 2) there was no statistically significant difference in auditory short-term memory ability between eight-year-olds with three phoneme errors and eight-year-olds with more than three phoneme errors; and 3) there was no statistically significant difference between the AMST, Forms I and II, and the ASMT, Forms I and II.

Results of this study imply generalizations should not be made about the auditory short-term memory ability of eight-year-old children based on their articulation deficits. Auditory short-term memory span and sequence ability, and articulation ability do not appear to be significantly related at this age level.

RELATIONSHIP OF AUDITORY SHORT-TERM MEMORY AND ARTICULATION ABILITY OF EIGHT-YEAR-OLDS

by

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INTRODUCTION AND STATEMENT OF THE PROBLEM

I. INTRODUCTION

Language is the social instrument which enables man to formulate and communicate his ideas with others. In order to express language, man must first perceive incoming stimuli, particularly through the auditory channels, and then process the information received. The auditory perceptual process, audition, is a sequential development of at least three auditory levels: acuity, understanding, and discrimination and retention (Wepman, 1960). Within this third level, discrimination and retention (memory), is auditory short-term memory, which may be critical for speech and language development (Saxman and Miller, 1973).

Auditory short-term memory has two levels of function: auditory memory span and auditory sequential memory (Fudala, 1975). The articulation aspect of expressive language is critical to intelligibility and dependent upon auditory short-term memory (Wepman and Morency, 1973a). Articulation defects are the speech disorders most frequently encountered by speech pathologists and comprise over 75 percent of all speech problems (Van Riper, 1972).

Over the years, researchers have been unable to identify a single underlying cause for articulation deficiencies (Winitz, 1969). Much attention has been given to the relationship between auditory short-

term memory and articulation defects (Locke and Kutz, 1975).

The role of auditory short-term memory in speech and language acquisition is not well understood. Auditory short-term memory could be an important factor underlying faulty articulation and crucial to correct speech production (Smith, 1967). Studies investigating auditory short-term memory have neither supported nor rejected a link between articulation problems and auditory short-term memory. The relationship remains unproven (Locke and Kutz, 1975).

Various auditory short-term memory span and sequence tests, along with many types of stimuli, have been used to measure auditory short-term memory. While some controversy exists as to whether tests of auditory short-term memory span and auditory short-term sequential memory are interchangeable (Turiads, Wepman, and Morency, 1972; Fudala, 1975), these researchers have all acknowledged span and sequence to be a portion of auditory short-term memory. Evidence did support the age of eight to be the time children have generally acquired accurate articulation of speech sounds, as well as developed auditory discrimination and retention (memory) (Berry and Eisenson, 1956; Morency, Wepman, and Haas, 1970; Templin, 1957; Wepman, 1960). Studies have failed to investigate the relationship between auditory short-term memory and defective articulation specifically in the eight-year-old population, which would seem to be the critical level to investigate.

II. STATEMENT OF THE PROBLEM

This study was designed to investigate the relationship of auditory short-term memory and articulation ability of eight-year-olds.

The specific question investigated was: Is there a statistically significant difference in the auditory short-term memory ability of eight-year-olds with three or more phoneme errors and eight-year-olds with no phoneme errors?

III. DEFINITION OF TERMS

The following terms were used operationally, as defined, in this study:

Auditory perception (audition)

Auditory perception includes acuity, the adequate and accurate reception of auditory stimuli; understanding, the interpretation of stimuli; and auditory discrimination and memory, which includes auditory short-term memory and the ability to sequence sounds (Lindamood and Lindamood, 1970; Van Riper and Irwin, 1958; Wepman, 1960).

Auditory short-term memory

Auditory short-term memory is the ability to retain and immediately recall auditory stimuli. This includes auditory short-term memory span and auditory short-term sequential memory (Morency, 1967; Fudala, 1975).

Auditory short-term memory span

Auditory short-term memory span is the ability to retain and immediately recall auditory stimuli in any order regardless of the

order of presentation. The stimuli include all verbal forms of communication such as speech phonemes, words, or digits (Wepman and Morency, 1973a).

Auditory short-term sequential memory

Auditory short-term sequential memory is the ability to retain and immediately recall auditory stimuli in the exact sequential order the stimuli were presented. The stimuli include all verbal forms of communication such as speech phonemes, words, or digits (Wepman and Morency, 1973b).

Deficient articulation/articulation deficit

Deficient articulation or an articulation deficit is the judgment made about an individual's speech due to the omissions, substitutions, and/or distortions of speech sounds (phonemes) (Morency, Wepman, and Haas, 1970).

Normal articulation

Normal articulation is the ability of an individual to correctly produce speech sounds (phonemes), i.e., no substitutions, omissions, or distortions of speech sounds exclusive of pronunciation errors.

Phoneme

A phoneme is a specific speech sound.

Phoneme error

A phoneme error is a misarticulation of a specific phoneme in the initial, medial, and/or final positions of a word, by omissions, substitutions, and/or distortions.

CHAPTER II

REVIEW OF THE LITERATURE

Etiology of articulation disorders has been a source of study for many years. No single cause has been found to exist (Winitz, 1969). A deficiency in auditory perceptual skills, which includes auditory short-term memory, has received much inquiry over the years (Bradley, 1976). Among the factors which may contribute to faulty articulation, auditory short-term memory may be the least understood (Smith, 1967).

This review will be limited to research which has dealt most directly with the relationship between auditory short-term memory and articulation ability. In order to establish how researchers have dealt with this relationship over the past several years, a selection of studies from the 1930s to the present will be discussed.

I. LITERATURE OF THE 1930s

Robbins (1935) tested the auditory memory spans of children with impaired speech and concluded that out of eighty-six subjects tested, 45 percent had retarded memory spans. In this study, subjects were tested for their memory for both digits and syllables.

Blankenship (1938) reviewed over one hundred references to explore the knowledge of memory span and concluded there was little real knowledge available. He based his conclusion on the diverse

methods of testing, the many kinds of materials used, the different groups of subjects used, the different methods of scoring, and several other contributing factors. Stimuli used to test auditory memory span included letters, digits, sentences, related words, and nonsense syllables. From his review, Blankenship (1938) reported memory span was affected by both extrinsic and intrinsic factors; however, since all kinds of results have been claimed for each variable, conclusions cannot be drawn as to which factors are intrinsic and which are extrinsic until materials and methods are controlled.

II. LITERATURE OF THE 1940s

From a normative study based on children's auditory memory span for speech sounds, Metraux (1944) tested 414 school children between the ages of four and thirteen years. Both consonant and vowel sounds were given from a phonograph record player and the subject was asked to immediately repeat what was heard. The main findings of her study were: The scores for both the vowels and consonants gradually increased with age, indicating auditory memory span increased with age; there was no significant sex difference; there was no significant correlation between mental age and auditory memory span; and administration of either consonants or vowels first made no significant difference in test results, indicating fatigue and lowered attention span did not contribute to the lower scores on the consonant tests at various age levels. Additional follow-up study was needed to determine whether a significant difference existed in the auditory memory span of children with speech defects and children with normal articulation.

III. LITERATURE OF THE 1950s

Powers (1957) reviewed a number of studies concerning the relationship between auditory short-term memory and articulation ability. From the review Powers concluded: Where investigators carefully controlled for age and intelligence, generally there was no difference in auditory short-term memory ability between a group of defective speakers and a group of normal speakers. He further concluded, although auditory memory varied among individuals, there was no significant difference in boys and girls. Since none of the studies reported a composite measure of auditory skills, Powers suggested a carefully matched normal speaking population and a defective speaking population should be given a battery of auditory tests for this purpose. From the test battery perhaps more complex relationships between auditory and articulatory ability could be discerned.

IV. LITERATURE OF THE 1960s

Mange (1960) reviewed the Fairbanks speech model in which speech production was compared to a servosystem, and concluded audition was the primary control in the speech servosystem. In order to test the hypothesis that one of the principal causative factors contributing to articulatory defects is the presence of some auditory deficiency, Mange tested seventy children between nine and twelve years of age. To serve as the experimental and control groups, a group of thirty-five children with a functional misarticulation of /r/ were matched by classroom, intelligence, age, and sex to a group of thirty-five normal speaking children. Stimuli included discrimination of pitch, loudness,

quality, rate of auditory perception, and phonetic word synthesis, i.e., the meaningful interpretation of auditory stimuli under conditions of distortion. Mange concluded there were no statistically significant differences in the auditory abilities tested.

Wepman (1960) stated 80 percent of childhood articulatory defects were due to the dysfunction of auditory discrimination and retention (memory) of speech sounds. His conclusion was based on certain clinical observations which, he felt, related to auditory short-term memory:

1. Auditory short-term memory is a process of maturation.

2. Slow development of auditory short-term memory relates positively to articulation defects.

According to Wepman then, in order for a child to monitor his speech and make the necessary adjustments, mature auditory short-term memory skills must be developed.

Following an extensive review of the literature regarding the relationship of articulatory adequacy, age, and certain tests of auditory discrimination, Gillespie (1961) concluded the relationship between auditory behavior and articulation needed additional exploration. Specifically, testing procedures are needed for early identification of deficiencies in auditory skills; also, a clearer understanding of auditory discrimination and auditory memory span is imperative. To do this, research must direct itself to validating pertinent test stimuli and controlling for variables.

In 1966, Hendon conducted a study of forty children between the ages of seven and nine years to compare auditory memory span, auditory

discrimination ability, and vocal phonic synthesis ability. Ten children were placed in each of four groups: a normal population; a reading defective population; an articulation defective population; and an articulation-reading defective population. Auditory memory span was tested with immediate recall of digits. Hendon reported a difference favoring normals between the normal population and the articulation defective population; however, she found that the difference was not statistically significant for auditory memory span.

Smith (1967) compared twelve normal speaking children with twelve children who had nonorganic articulation problems. The children were between the ages of six and nine years and were matched in age, sex, and intelligence. The investigator tested the two groups, using both auditory and visual stimuli, in order to compare short-term memory ability for the recall of single-, sequential-, and simultaneous-digits. Results showed the children with articulation defects to be inferior to the normal population. Smith concluded further research was needed with larger populations to support his findings.

V. LITERATURE OF THE 1970s

Saxman and Miller (1973) tested fifty-six children between the ages of five years, six months, and six years, seven months, in which they compared the auditory short-term memory of twenty-eight children with articulation deficits and twenty-eight children with normal articulation. The subjects were instructed to repeat digits, random-words, and sentence strings, from four to ten units in length. The

auditory stimuli were presented at a rate of one item per second. In spite of Saxman and Miller's rigor to use only subjects with a marked articulation deficit, i.e., children who performed one standard deviation below the norms for their age group and sex on the Templin-Darley Diagnostic Test of Articulation (Templin and Darley, 1960), they could report no significant difference in the auditory short-term memory ability of the two groups in their immediate verbal recall of either words or digits. In reviewing their study, Saxman and Miller concluded their rate of stimulus presentation may have been too slow to test auditory short-term memory. If the auditory stimuli had been presented at the rate of two items per second, as used by the Illinois Test of Psycholinguistic Abilities (Kirk, McCarthy, and Kirk, 1968), the results may have supported a causal relationship between poor auditory short-term memory and articulation deficits.

In 1973, Wepman and Morency published two instruments designed to test auditory short-term memory ability of children five, six, seven, and eight years of age. The Auditory Memory Span Test (Wepman and Morency, 1973a) was standardized on a population of approximately twelve hundred children and based on their ability to retain and immediately recall single-syllabled, spoken words in a progressively longer series. A second test, the Auditory Sequential Memory Test (Wepman and Morency, 1973b), was standardized on a population of over one thousand children and based on their ability to retain and immediately recall in exact order, spoken digits in a progressively longer series. The authors did not find a significant difference between the span and sequence scores on these two tests and concluded the two

tests could be used interchangeably. Based on earlier research of Wepman (1960), Morency (1967), and Turiads, Wepman, and Morency (1972), a strong positive relationship has been shown between auditory short-term memory span and sequence ability and children's development of speech, language, and learning to read. Both tests have two forms with high reliability reported between Forms I and II for each of the age groups.

CONCLUSIONS

A review of the literature investigating the relationship between auditory short-term memory and articulation deficiencies displayed a wide variety of stimulus material used, such as letters, digits, nonsense syllables, words, consonants, vowels, and so forth. There was no consistency in the: rate of stimulus presentation, i.e., one-half second presentation or one second presentation; manner of presentation, i.e., letters, digits, words, and so forth, were not presented in any particular order; age of the subjects (five through twelve years); or testing instruments, i.e., actual tests used. In most studies, the type of articulation errors was not reported. Therefore, based on the vast variety of methods used for investigating auditory short-term memory and its relationship to articulation deficiencies, the fact that these studies reported conflicting results is understandable.

To date, investigators have not extensively researched the eight-year-old population to investigate the relationship between auditory short-term memory and articulation deficiencies, using

similar auditory short-term memory tests with appropriate half-second stimuli presentations of digits and words. Selection of this age group would eliminate both the articulation and auditory short-term memory maturation factors, which most researchers consider to be complete at this time (Berry and Eisenson, 1956; Morency, Wepman, and Haas, 1970; Templin, 1957; Wepman, 1960).

This investigator believes it would be appropriate to research this relationship further by contrasting eight-year-old children with normal articulation to eight-year-old children with three or more articulation errors. To compare the results objectively, measures of both span and sequence utilizing tests of immediate auditory memory must be carefully controlled. The study should control for stimulus material, subjects, and testing procedures, such as rate of presentation.

CHAPTER III

METHODS AND PROCEDURES

I. METHODS

Description of Subjects

Subjects for this study consisted of thirty-two eight-year-old students from the Durham, John Hopkins, Phil Lewis, Metzger, and Charles F. Tigard Elementary Schools in Washington County, Oregon. These subjects were divided into an experimental and a control group. Each experimental subject was matched with a control subject of the same sex, classroom, and academic performance. The experimental group consisted of sixteen subjects, each with three or more articulation errors. The control group consisted of sixteen subjects with no articulation errors. Prior to participation in the study, a signed parent permission form was received on each subject (Appendix A).

Excluded from this investigation were children who displayed any known physical handicaps as reported by the classroom teacher. Speech pathologists were working with six of the experimental subjects for articulation deficiencies; however, subjects were not being taught auditory short-term memory skills. All subjects in both groups passed a pure-tone audiometric screening test, administered by this examiner, by responding positively to presentations at 20 dB HL for the frequencies of 500Hz, 1000Hz, 2000Hz, 4000Hz, 6000Hz, and 8000Hz bilaterally.

A portable Maico Ma-16 was used to conduct the audiometric screening of the subjects and was calibrated to the investigator's hearing, which is normal.

A child was excluded from this investigation if a history of hearing impairment was reported during the six months prior to testing. This information was obtained from the parents by including the following question on the Parent Permission Form (Appendix A): Has your child complained of frequent or continuous earaches in the past six months? One child was eliminated prior to testing because of ear problems reported by the parents. The matching control group subject was automatically eliminated from the study.

A total of seventy Parent Permission Forms were sent to parents. The first thirty-two subjects who met the testing requirements were included in this investigation. Only one parent denied permission for her child's inclusion in this research project.

Group Selection

All subjects were administered the Templin-Darley Screening Test of Articulation (Templin and Darley, 1960) by the investigator (Appendix B). This fifty-item test was chosen because it is well standardized and has a high correlation with the diagnostic test by the same authors. The subjects were divided into two groups based on their performance on the articulation test. The first sixteen subjects with three or more articulation errors on the screening test were placed in the experimental group; and the subjects matched to each experimental subject by sex, classroom, and academic performance, displaying no articulation errors, were placed in the control group.

Group Comparison Testing

Subjects for both the control and experimental groups were given the following tests by this investigator:

1. Auditory Memory Span Test (AMST) (Wepman and Morency, 1973a). To assess auditory short-term memory span ability, the AMST was administered to each subject (Appendices C and D). Both Forms I and II of this test were given, based on the authors' critique that a more reliable estimate may be produced by using Form I for instruction. Test-retest reliability was r .92 between the two forms. The test was administered by giving the verbal stimulus: "I'm going to read some words to you. All I want you to do is repeat the words I read when I'm all through . . . CAR—BIRD. . . . Now, you say those words. . . ." The test consisted of sixty nouns arranged in five sets with three repetition items of varying length, beginning with two words in each of the three items in the first set and ending with six words in each of the three items in the final set. Sixty is the total number of points which could be scored on this test.

2. Auditory Sequential Memory Test (ASMT) (Wepman and Morency, 1973b). To assess auditory short-term memory sequence ability, the ASMT was administered to each subject (Appendices E and F). Both Forms I and II were given, based on the critique that a more reliable estimate may be produced by using Form I for instruction. Test-retest reliability was reported as r .82 between the two forms. The test was administered by giving the verbal stimulus: "I'm going to say some numbers to you. Listen very carefully, and when I'm through, say them right after me exactly as I said them." The test consisted of seventy

digits arranged in seven sets, beginning with two digits in each of the first two sets and ending with eight digits in the last two sets. Seventy is the total number of points which could be scored on this test.

Following administration of both the AMST and the ASMT, tests were scored according to the manual of instructions.

II. PROCEDURES

Administration

All subjects included in this study were assessed by this investigator for auditory acuity, articulation proficiency, and auditory short-term memory span and sequence ability. The testing was conducted in a quiet room with the examiner and one subject present at a time. First, the subject's hearing acuity was screened. Next, the Templin-Darley Screening Test of Articulation (Templin and Darley, 1960) was administered to determine the subject's articulation proficiency. Then, the AMST, Forms I and II, were given in accordance with standard procedures. Finally, following standard procedures, the ASMT, Forms I and II, were administered. The testing took place in one session and required approximately twenty to twenty-five minutes of time per subject.

Data Analysis

After each form was scored according to the manual of instructions, the mean and standard deviation of the raw scores were calculated for both the experimental and control groups to compare their performances. A one-tailed *t* test for unrelated measures was used to

evaluate the performance of the two groups.

CHAPTER IV

RESULTS AND DISCUSSION

I. RESULTS

The purpose of this study was to investigate the relationship of auditory short-term memory and articulation ability of eight-year-olds. The specific question the study sought to answer was: Is there a statistically significant difference in the auditory short-term memory ability of eight-year-olds with three or more phoneme errors and eight-year-olds with no phoneme errors?

Performances on the Auditory Memory Span Test (AMST), Forms I and II, and on the Auditory Sequential Memory Test (ASMT), Forms I and II, were compared for two groups of children: a control group who demonstrated no articulation errors and an experimental group who demonstrated three or more phoneme errors.

The means and standard deviations of the AMST, Forms I and II, and the ASMT, Forms I and II, were calculated for the control group and the experimental group (Table I). A one-tailed *t* test for unrelated measures was used to determine if the difference in performance between the groups was statistically significant.

When comparing the experimental and control groups, it is to be noted the *t* value for each of the tests was not statistically significant at the .05 level of confidence. There was no statistically significant difference between the experimental and control groups in

TABLE I

MEANS, STANDARD DEVIATIONS, AND VALUES OF *t* FOR AMST AND ASMT, FORMS I AND II SCORES

Measure	Mean	S.D.	*t* Value	d.f.
ASMT I				
Control	29.75	6.48		
Experimental	28.81	10.83		
Difference	0.94		0.29*	30
ASMT II				
Control	28.19	6.06		
Experimental	28.06	8.91		
Difference	0.13		0.01*	30
AMST I				
Control	23.75	6.15		
Experimental	24.94	9.33		
Difference	-1.19		0.41*	30
AMST II				
Control	25.12	6.04		
Experimental	24.62	11.03		
Difference	0.50		0.15*	30

*Not significant at the .05 level of confidence

auditory short-term memory ability.

To determine if an order effect existed between the administration of Forms I and II of each test, the difference between the raw scores of Forms I and II was calculated and the mean and standard deviation determined for the differences of each test (Table II). *T* tests

for differences between means were calculated for the two forms of each test within each group. No significant differences, beyond the .05 level of confidence, were found between the scores of Forms I and II on either test taken by either the control or experimental group.

TABLE II

MEANS, STANDARD DEVIATIONS, AND VALUES OF *t* FOR ORDER EFFECT OF FORMS I AND II SCORES OF AMST AND ASMT

Measure	Mean	S.D.	*t* Value	d.f.
ASMT I - ASMT II				
Control	1.94	6.04		
Experimental	0.75	5.03		
Difference	1.19		0.08*	30
AMST I - AMST II				
Control	-1.12	3.70		
Experimental	0.31	4.16		
Difference	-1.43		-0.99*	30

*Not significant at the .05 level of confidence

To determine if either group exhibited more order effect, a *t* test for differences between means was applied to the means of the differences between Forms I and II (Table III). No significant difference was found at the .05 level of confidence between either group's difference of scores means, which indicated there was no difference in order effect between the control and experimental groups.

The relationship between the correct articulation scores and the

TABLE III

MEANS, STANDARD DEVIATIONS, AND VALUES OF *t* FOR ASMT AND AMST WITHIN GROUP COMPARISON

Measure	Mean	S.D.	*t* Value	d.f.
Control				
ASMT I - ASMT II	1.94	-1.12		
AMST I - AMST II	6.04	3.70		
Difference	-4.10		0.81*	30
Experimental				
ASMT I - ASMT II	0.75	5.03		
AMST I - AMST II	0.31	4.16		
Difference	0.44		0.26*	30

*Not significant at the .05 level of confidence

raw scores on the ASMT and the AMST for the experimental group was explored by comparing the number of correct articulations on the Templin-Darley Screening Test of Articulation (Templin and Darley, 1960) and the combined scores from Forms I and II of the ASMT and the AMST (Table IV). The resultant correlation coefficient indicated no statistically significant relationship at the .05 level of confidence.

II. DISCUSSION

The data in this study suggested there was no statistically significant difference in auditory short-term memory ability, in either span or sequence, between eight-year-old children with "mild" to "moderate" articulation errors and eight-year-old children with no

TABLE IV

EXPERIMENTAL GROUP COMPARISON BETWEEN ARTICULATION ERRORS AND ASMT AND AMST

Related Measures	r Value
Articulation errors X (ASMT I + ASMT II)	0.01*
Articulation errors X (AMST I + AMST II)	0.09*

*Not significant at the .05 level of confidence

articulation errors. Further, the data do not suggest that auditory short-term memory ability might differ relative to the number of phoneme errors demonstrated by a child with an articulation deficit (3 to 21 articulation errors).

Using both the experimental and control groups together to obtain a large enough n, the reliability coefficient between Forms I and II of the AMST is 0.75 as compared to 0.92 on the original test data. The reason there is less of a reliability coefficient in this investigation may be due to the smaller population used in this study or the fact that Wepman used a different method of selecting his subjects to substantiate the test. The reliability coefficient also was not reported separately for the eight-year-old population; therefore, no direct comparison between this investigation and Wepman's original testing was possible for this age group.

Again, combining the experimental and control groups to obtain a large enough n, the reliability coefficient between Forms I and II of the ASMT was 0.82 as compared to 0.89 on the original test data.

Although this investigation had a lower level of significance than the original test correlation, rules for test-retest reliability consider anywhere from 0.8 up to be a high correlation (Hays, 1973).

Results of this investigation support the findings of Metraux (1944), Powers (1957), Mange (1960), and Saxman and Miller (1973) that there was no causal relationship between articulation deficits and poor auditory short-term memory ability. However, conclusions based on the results of this investigation should remain guarded due to the small sample of eight-year-old children tested. As Gillespie (1961) suggested, there appears to be a need for further exploration into the relationship of auditory short-term memory and articulation ability. This view was shared by Morency (1967), Morency and Wepman (1973), Smith (1967), Wepman (1960), and Wepman, Morency, and Haas (1970), who all reported a causal relationship did exist between nonorganic articulation problems and poor auditory short-term memory ability.

Results of this study imply generalizations should not be made about the auditory short-term memory ability of eight-year-old children based on their articulation deficits. Auditory short-term memory span and sequence ability, and articulation ability do not appear to be significantly related at this age level.

CHAPTER V

SUMMARY AND IMPLICATIONS

I. SUMMARY

This study investigated the relationship of auditory short-term memory and articulation ability of eight-year-old children to determine if a relationship existed between auditory short-term memory ability and articulation ability. The specific question posed was: Is there a statistically significant difference in the auditory short-term memory ability of eight-year-olds with three or more phoneme errors and eight-year-olds with no phoneme errors?

A total of thirty-two subjects were individually administered the Templin-Darley Screening Test of Articulation (Templin and Darley, 1960), the Auditory Memory Span Test (AMST), Forms I and II (Wepman and Morency, 1973a), and the Auditory Sequential Memory Test (ASMT), Forms I and II (Wepman and Morency, 1973b). The subjects responded verbally to each of the tests. Each subject obtained a score for each test of the AMST and the ASMT. Each experimental subject obtained a score for the number of phoneme errors on the articulation test.

The experimental group subjects were identified by the school speech pathologist; and the classroom teacher selected subjects of the same sex and academic ability for the control group. Each subject in the investigation was evaluated during one twenty to twenty-five minute session. All subjects had normal hearing acuity as determined by

a pure-tone hearing acuity screening test. The Templin-Darley Screening Test of Articulation (Templin and Darley, 1960) was administered to determine articulation ability; and the AMST (Wepman and Morency, 1973a) and the ASMT (Wepman and Morency, 1973b) were administered to determine auditory short-term memory ability.

Two groups, a control and an experimental, were chosen according to the results of the Templin-Darley Screening Test of Articulation (Templin and Darley, 1960), that is, the first thirty-two paired children made up the population for this study. The control group was comprised of sixteen children, eight years of age, who displayed no phoneme errors. The experimental group consisted of sixteen children, eight years of age, who displayed three or more phoneme errors. The groups were matched for sex, classroom, and academic performance.

The AMST and ASMT scores of the two groups were compared, using a one-tailed *t* test of unrelated means. The results indicated no statistically significant difference existed between the two groups at the .05 level of confidence. Additionally, there were no statistically significant differences at the .05 level of confidence when the increasing number of articulation errors were compared to the test scores on the AMST and the ASMT.

In examining the data in this study, it was concluded: 1) There was no statistically significant difference in the auditory short-term memory ability, in either span or sequencing, between eight-year-old children with "mild" to "moderate" articulation deficits and eight-year-old children with no articulation deficits; 2) there was no statistically significant difference in auditory short-term memory ability

between eight-year-olds with three phoneme errors and eight-year-olds with more than three phoneme errors; and 3) there was no statistically significant difference between the AMST, Forms I and II, and the ASMT, Forms I and II.

II. IMPLICATIONS

Clinical

Based on this investigation of the eight-year-old population, remediation in auditory short-term memory ability, in either span or sequence, as an effort to deal indirectly with articulation deficits, would not be recommended without first documenting the deficit by administration of the AMST and the ASMT.

Research

In this study, eight-year-old children displaying three or more phoneme errors did not differ significantly in auditory short-term memory ability from eight-year-old children with no articulation errors. Although only a small number of subjects were tested in this study, the experimental group subjects displayed a minimum of three phoneme errors and a maximum of twenty-one phoneme errors, with no reportable difference as to their auditory short-term memory ability on the tests administered. Perhaps further research with a larger population of eight-year-olds, using these same tests, would not be justified as articulation habit patterns may have masked auditory short-term memory maturation for this age group. Since the AMST and the ASMT were developed for the five-, six-, seven-, and eight-year-old population, research using this study design to contrast these

populations might be more fruitful.

Any replication of this study should include auditory short-term memory span and sequence tests, and one-half second stimulus presentation, which is compatible with the Illinois Test of Psycholinguistic Abilities (Kirk, McCarthy, and Kirk, 1968) and the findings of Saxman and Miller (1973).

Further research is needed into the type of stimulus used, and whether or not the presentation of digits versus words is actually interchangeable.

Finally, development and standardization of an auditory memory test battery are needed. The test battery should include auditory short-term memory span and sequence tests and an articulation test. A complete battery may prove helpful to identify specific components of auditory short-term memory which may overlap and contribute to a child's difficulty with articulation.

SELECTED REFERENCES

ADAMS, J. A., Human Memory. New York: McGraw-Hill (1967).

ANDERSON, VIRGIL A., Improving the Child's Speech. New York: Oxford University Press (1935).

AUNGST, L. F., and FRICK, J. V., Auditory discrimination ability and consistency of articulation of /r/. Journal of Speech and Hearing Disorders, 29, 76-85 (1964).

BEEBE, H. H., Auditory memory span for meaningless syllables. Journal of Speech Disorders, IX, 273-276 (1944).

BERRY, MILDRED F., and EISENSON, JON, Speech Disorders: Principles and Practices of Therapy. New York: Appleton-Century-Crofts (1956).

BLANKENSHIP, A. B., Memory span: A review of the literature. Psychological Bulletin, XXXV, 1-25 (1938).

BRADLEY, ALANA F., A study of the relationship between articulation proficiency and auditory conceptualization ability. Unpublished Master's thesis, Portland State University (1976).

CRAIK, F., Modality effects in short-term storage. Journal of Verbal Learning and Verbal Behavior, 8, 658-664 (1969).

CROWDER, R., and MORTON, J., Precategorical acoustic storage. Perception and Psychophysics, 5, 365-373 (1969).

FUDALA, J., Short term memory through special education students. Seminar presented at the Oregon-Washington Speech and Hearing Association Fall Conference, Portland, Oregon, October 10, 1975.

GILLESPIE, JUDITH, Relationship of articulatory adequacy, age, and certain tasks of auditory discrimination. Unpublished Master's thesis, Vanderbilt University (1961).

HALL, M. E., Auditory factors in functional articulatory speech defects. Journal of Experimental Education, 7, 110-132 (1938).

HAYS, W. L., Statistics for the Social Sciences. New York: Holt, Rinehart and Winston (1973).

HENDON, MARILYN K., Auditory memory span, auditory discrimination, and vocal phonic synthesis in an articulation defective, a reading defective, an articulation-reading defective, and a normal population. Unpublished Master's thesis, Vanderbilt University (1966).

KIRK, S. A., McCARTHY, J. A., and KIRK, W. D., Illinois Test of Psycholinguistic Abilities. Urbana, Ill.: University of Illinois Press (1968).

LINDAMOOD, CHARLES H., and LINDAMOOD, PATRICIA C., Conceptualization of auditory patterns. Paper presented at the International Reading Association Conference, Anaheim, California (1970).

LOCKE, J. L., Discrimination learning in children's acquisition of phonology. Journal of Speech and Hearing Research, 11, 428-434 (1968).

LOCKE, J. L., and KUTZ, K. J., Memory for speech and speech for memory. Journal of Speech and Hearing Research, 18, 176-191 (1975).

MANGE, C. V., Relationships between selected auditory perceptual factors and articulation ability. Journal of Speech and Hearing Research, 3, 67-75 (1960).

METRAUX, RUTH W., Auditory memory span for speech sounds of speech defective children compared with normal children. Journal of Speech and Hearing Disorders, 7, 33-37 (1942).

_____., Auditory memory span for speech sounds: Norms for children. Journal of Speech and Hearing Disorders, 9, 31-38 (1944).

MILLER, G. A., Some psychological studies of grammar. American Psychologist, 17, 748-762 (1962).

MILLER, G. A., and SELFRIDGE, J., Verbal context and recall of meaningful material. American Journal of Psychology, 63, 176-185 (1950).

MORENCY, ANNE, Auditory modality research and practice. Paper presented at the International Reading Association Convention, Seattle, Washington (1967).

MORENCY, ANNE, and WEPMAN, J. M., Early perceptual ability and later school achievement. Elementary School Journal, 73, 6, 323-327 (1973).

MORENCY, ANNE, WEPMAN, J. M., and HAAS, S. K., Developmental speech inaccuracy and speech therapy in the early school years. Elementary School Journal, 70, 219-224 (1970).

MORENCY, ANNE, WEPMAN, J. M., and WEINER, P. M., Studies in speech: Developmental articulation inaccuracy. Elementary School Journal, 67, 329-337 (1967).

POWERS, M. H., Functional disorders of articulation symptomatology and etiology. In L. E. Travis (Ed.), Handbook of Speech Pathology. New York: Appleton-Century-Crofts, Inc. (1957).

REID, GLADYS, Etiology and nature of functional articulatory defects in elementary school children. Journal of Speech Disorders, 12, 143-150 (1947a).

ROBBINS, S. D., Relation between the short auditory memory span disability and disorders of speech. Laryngoscope, XLV, 545-553 (1935).

SAXMAN, JOHN H., and MILLER, JON F., Short-term memory and language skills in articulation deficient children. Journal of Speech and Hearing Research, 16, 109-120 (1973).

SMITH, C. R., Articulation problems and ability to store and process stimuli. Journal of Speech and Hearing Research, 10, 348-353 (1967).

TEMPLIN, MILDRED C., Certain Language Skills in Children. Minneapolis: University of Minnesota Press (1957).

TEMPLIN, MILDRED C., and DARLEY, F. L., Templin-Darley Tests of Articulation. Iowa City: Bureau of Educational Research and Service, Division of Extension and University Services (1960).

TRAVIS, L. E., and RASMUS, B. J., Speech sound discrimination ability of cases with functional disorders of articulation. Quarterly Journal of Speech, XVII, 217-226 (1931).

TURIADS, D., WEPMAN, J. M., and MORENCY, A., A perceptual test battery: Development and standardization. Elementary School Journal, 72, 351-361 (1972).

VAN RIPER, C., Speech Correction: Principles and Methods (4th Ed.). Englewood Cliffs, N.J.: Prentice-Hall (1963).

_____., Speech Correction: Principles and Methods (5th Ed.). Englewood Cliffs, N.J.: Prentice-Hall (1972).

VAN RIPER, C., and IRWIN, J. V., Voice and Articulation. Englewood Cliffs, N.J.: Prentice-Hall (1958).

WEINER, PAUL S., Auditory discrimination and articulation. Journal of Speech and Hearing Disorders, 32, 19-28 (1967).

WEPMAN, J. M., Auditory discrimination, speech and reading. Elementary School Journal, 60, 325-333 (1960).

WEPMAN, J. M., and MORENCY, A., Auditory Memory Span Test. Chicago: Language Research Associates, Inc. (1973a).

WEPMAN, J. M., and MORENCY, A., Auditory Sequential Memory Test. Chicago: Language Research Associates, Inc. (1973b).

WEPMAN, J. M., MORENCY, A., and HAAS, S. K., Developmental speech inaccuracy and speech therapy in the early school years. Elementary School Journal, 70, 219-244 (1970).

WINITZ, H., Articulatory Acquisition and Behavior. New York: Appleton-Century-Crofts (1969).

APPENDIX A

PARENT PERMISSION FORM

Dear Parent or Guardian:

I am a Portland State University graduate student doing a research project in Speech and Hearing Science. I have received permission from the School District to test eight-year-old students in an attempt to find out whether there is a relationship between speech ability and memory skills. The results of this study should help the teacher and other professionals plan programs for children. Each child will receive a pure tone hearing test, Templin-Darley Test of Articulation, Auditory Memory Span Test (AMST), and Auditory Sequential Memory Test (ASMT). The hearing test simply consists of your child raising his/her hand when a sound is heard. The Templin-Darley Test of Articulation asks your child to name pictures. The AMST and ASMT consists of sets of words and numbers which your child is asked to repeat back to the examiner.

The tests will take fifteen to thirty minutes of your child's time. No names will be used in the results of this study.

I am requesting permission for your child to participate in the project outlined above. Will you please help me by filling in the form below indicating your approval to test your child and return it to your child's teacher as soon as possible. Thank you very much for your help.

Sincerely,

Winona E. Hoffinger

NAME OF STUDENT_____

Has your child complained of frequent or continuous earaches in the past six months? ____YES ____NO

My child has my permission to participate in the study conducted by Mrs. Hoffinger.

PARENT'S SIGNATURE_____

Date_____

APPENDIX B

TEMPLIN-DARLEY SCREENING TEST OF ARTICULATION

RECORD SHEET

Key: Mark correct sound (√); substitutions with sound substituted; omitted sounds (-); distorted sounds (x); no response (nr).

	I	M	F				
1. i___	19.m___	___	___	r-blends	Syllabic ɚ	Non-Syllabic ɚ	Other 2-element Blends
2. ɪ___	20.n___	___	___	44.pr-___	53.-mɚ___	64.-ɚm___	109.tw-___
3. ɛ___	21.ŋ	___	___	45.br-___	54.-nɚ___	65.-ɚn___	110.kw-___
4. æ___	22.p___	___	___	46.tr-___	55.-pɚ___	66.-ɚp___	111.-zm___
5. ʌ___	23.b___	___	___	47.dr-___	56.-bɚ___	67.-ɚb___	112.-ŋk___
6. ə___	24.t___	___	___	48.kr-___	57.-tɚ___	68.-ɚt___	113.-dʒd___
7. ɝ___	25.d___	___	___	49.gr-___	58.-dɚ___	69.-ɚd___	114.-mp___
8. ɚ___	26.k___	___	___	50.fr-___	59.-kɚ___	70.-ɚk___	115.-nt___
9. ɑ___	27.g___	___	___	51.θr-___	60.-gɚ___	71.-ɚg___	116.-nd___
10. ɔ___	28.r___	___		52.ʃr-___	61.-fɚ___	72.-ɚf___	117.-kt___
11. ʊ___	29.l___	___	___		62.-ðɚ___	73.-ɚθ___	118.-pt___
12. u___	30.f___	___	___		63.-ʃɚ___	74.-ɚtʃ___	119.-ft___
13. ju___	31.v___	___	___			75.-ɚdʒ___	3-element blends
14. oʊ___	32.θ___	___	___	l-blends	Vowel l 81.-pl̩___	88.-lp___	120.spl-___
15. aʊ___	33.ð___	___	___	76.pl-___	82.-bl̩___	89.-lb___	121.spr-___
16. eɪ___	34.s___	___	___	77.bl-___	83.-tl̩___	90.-lt___	122.str-___
17. aɪ___	35.z___	___	___	78.kl-___	84.-kl̩___	91.-lk___	123.skr-___
18. ɔɪ___	36.ʃ___	___	___	79.gl-___	85.-gl̩___	92.-lf___	124.skw-___
	37.ʒ	___	___	80.fl-___	86.-fl̩___	93.-lθ___	125.-kst___
	38.h___	___			87.-sl̩___	94.-lz___	126.-mpt___
	39.ʍ___	___		s-blends 95.sm-___-sm___			127.-mps___
	40.w___	___		96.sn-___		ɚ, ɝ, and vowel l with blends	128.-ntθ___
	41.j___	___		97.sp-___-sp___			
	42.tʃ___	___	___	98.st-___-st___		102.-stɚ___	
	43.dʒ___	___	___	99.sk-___-sk___-ks___		103.-skɚ___	106.-ŋkl̩___
				100.sl-___		104.-mbɚ___	107.-ŋgl̩___
				101.sw-___		105.-ɝst___	108.-lfθ___

Note: The items followed by double lines constitute the 50-item Screening Test.

APPENDIX C

AUDITORY MEMORY SPAN TEST, FORM I
JOSEPH M. WEPMAN & ANNE MORENCY

Name_____

Date_____

Age_____years_____months

Examples: (Do not Score) Car—Bird . . . Bat—Shoe

SCORING: Circle credit for correct answer.
Cross out credit if incorrect.

						Credits
belt	house					2
school	ghost					2
book	stair					2
horse	men	bed				3
hair	wife	room				3
head	thing	knife				3
chair	end	cave	dog			4
guy	cross	fish	way			4
top	lady	wall	boat			4
table	duck	wood	boy	cloud		5
rope	grass	night	hand	ship		5
bush	home	men	barn	kind		5
tree	day	rock	feet	time	side	6
cat	shirt	light	place	snow	door	6
fire	girl	lot	sun	place	lion	6

Score_____
Total of Circled Credits

Rating Scale Range_____

To interpret Score turn to page 3 in Manual.

APPENDIX D

AUDITORY MEMORY SPAN TEST, FORM II

JOSEPH M. WEPMAN & ANNE MORENCY

Name_____

Date_____

Age_____years_____months

Examples: (Do not Score) Car—Bird . . . Bat—Shoe

SCORING: Circle credit for correct answer.
Cross out credit if incorrect.

						Credits
stair	belt					2
house	ghost					2
school	book					2
knife	horse	head				3
thing	hair	room				3
men	bed	wife				3
wall	boat	chair	end			4
cave	dog	guy	cross			4
fish	way	top	lady			4
men	barn	kind	table	duck		5
wood	boy	cloud	rope	grass		5
night	head	ship	bush	home		5
sun	place	lion	tree	day	rock	6
feet	time	side	cat	shirt	light	6
lace	show	door	fire	girl	lot	6

Score_____
Total of Circled Credits

Rating Scale Range_____

To interpret Score turn to page 3 in Manual.

APPENDIX E

AUDITORY SEQUENTIAL MEMORY TEST, FORM I
JOSEPH M. WEPMAN & ANNE MORENCY

Name_____

Date_____

Age_____years_____months

Examples: (Do not score) 7—3 . . . 8—4

SCORING: Circle credit for correct answer.
Cross out credit if incorrect.

	Credits
6—9	2
8—3	2
4—7—2	3
5—9—1	3
8—5—3—1	4
3—9—8—6	4
4—3—1—9—5	5
8—1—6—9—2	5
5—2—7—4—9—6	6
9—2—1—7—3—5	6
4—6—2—1—8—9—3	7
8—6—1—2—9—7—5	7
4—7—1—8—5—3—9—2	8
2--1--7--5--8--4--9--3	8

Score_____
Total of Circled Credits

Rating Scale Range_____

To interpret Score turn to page 3 in Manual.

APPENDIX F

AUDITORY SEQUENTIAL MEMORY TEST, FORM II
JOSEPH M. WEPMAN & ANNE MORENCY

Name_____

Date_____

Age_____years_____months

Examples: (Do not score) 7—3 . . . 8—4

SCORING: Circle credit for correct answer.
Cross out credit if incorrect.

	Credits
7—2	2
9—1	2
6—3—4	3
2—9—6	3
1—7—4—2	4
9—7—5—3	4
6—4—1—3—9	5
7—2—5—8—4	5
3—8—4—2—7—9	6
2—9—7—5—3—8	6
1—4—2—9—3—8—6	7
7—2—9—6—3—5—8	7
7—1—4—9—3—6—5—8	8
4—9—6—3—8—5—7—1	8

Score_____
Total of Circled Credits

Rating Scale Range_____

To interpret Score turn to page 3 in Manual.