PERFORMANCE OF ARTICULATORY-IMPAIRED CHILDREN ON SEVERAL PSYCHOLINGUISTIC MEASURES

Thesis for the Degree of Ph. D.
MICHIGAN STATE UNIVERSITY
PAMELA SEARS RIEDL
1975

This is to certify that the

thesis entitled

Performance of Articulatory-Impaired Children on Several Psycholinguistic Measures

presented by

Pamela Sears Riedl

has been accepted towards fulfillment
of the requirements for

Ph. D. degree in Audiology and Speech Sciences

Major professor

Date September 16, 1975

O-7639

ABSTRACT

PERFORMANCE OF ARTICULATORY-IMPAIRED CHILDREN ON SEVERAL PSYCHOLINGUISTIC MEASURES

By

Pamela Sears Riedl

Research has suggested that children with moderate to severe articulation problems tend to show inadequate auditory discrimination skills, and, when compared to normal speaking children on various language measures, show a less complex grammatical structure, poorer language comprehension, shorter spoken sentences, and so on. Further research was warranted to clarify the auditory discrimination skills of articulatory-impaired children and to explore the relationship between articulation, language, and auditory discrimination of these children.

The purpose of this study was to compare the responses of first grade articulatory-impaired and normal speaking children (1) to an auditory discrimination test and (2) to a sentence imitation task involving the factors of sentence length, sentence type, and word type.

Forty first-grade children selected from elementary schools in the Ingham County Intermediate school district of Michigan served as subjects. Twenty, 13 boys and 7

girls, mean age 6.3 years, had normal speech, language and hearing. The remaining twenty, also 13 boys and 7 girls, mean age 6.3 years, were selected from speech therapy classes from the same schools as the normal speakers, and had exhibited three or more articulation errors on McDonald's Screening Deep Test of Articulation. Subjects were tested on an individual basis.

At the beginning of the test session, the subject was administered the Wepman Auditory Discrimination Test. This test was chosen since it examines a child's ability to distinguish between word pairs which differ both phonemically and linguistically. This test was followed by the primary experimental stimuli of 54 sentences of which 18 were well-formed, 18 were anomalous, and 18 were ill-ordered in nature. Of each set of 18, 6 were 3 words in length, 6 were 5 words in length, and 6 were 7 words in length. Functor and contentive word types were present in each stimulus sentence. The sentences were presented by tape recorder in sound field to each subject. Standardized instructions were read by the experimenter requesting the subjects to repeat exactly what they heard. Errors of omission, substitution, addition, and word reversal were analyzed by a multifactor ANOVA routine.

Results indicated that (1) the auditory discrimination skills of the articulatory-impaired children were inferior to those of the normal speaking children, and (2) the main factors of articulation, sentence type, sentence length, and word type and their interactions were significant at various levels with respect to the error types observed. Articulatory-impaired children generally made more errors than normal speaking children, particularly for five- and seven-word well-formed and anomalous sequences.

Articulatory-impaired and normal speaking children were affected in a similar fashion by the factors of sentence type, sentence length, and word type. Generally, errors increased as sentence length increased. Errors were highest for ill-ordered sequences, followed by anomalous and well-formed sequences, respectively. More errors occurred for the functor word type than for contentive word type. These trends paralleled those of earlier studies. Since error rates for seven-word ill-ordered sequences were highest for both groups of subjects, seven items were considered to be past the automatic recall ability of the subjects and, therefore, subjects' short-term memory recall abilities did not appear to differ, regardless of their articulation proficiency.

Since normal speaking children did show better recall than articulatory-impaired children for five- and seven-word well-formed and anomalous stimuli, the difference in performance was attributed to a difference in subjects' language competence rather than a difference in short-term memory recall ability. Normal speaking children appear to be better able to use the semantic and/or syntactic structure present in well-formed and anomalous sequences to recall the longer phrases.

Based upon the results of this study, suggestions were offered for future research which will more thoroughly test the recall abilities of misarticulating children and further describe the relationship between the areas of auditory discrimination, phonology, syntax and semantics.

PERFORMANCE OF ARTICULATORY-IMPAIRED CHILDREN ON SEVERAL PSYCHOLINGUISTIC MEASURES

by

Pamela Sears Riedl

A THESIS

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

DOCTOR OF PHILOSOPHY

Department of Audiology and Speech Sciences

1975

To My Husband, Helmut,
and My Parents

ACKNOWLEDGEMENTS

I would like to express my gratitude to Dr. D. S. Beasley, Assistant Chairman of the Department of Audiology and Speech Sciences, who provided much time and effort as my thesis advisor. For their time, suggestions, criticisms, and general contributions to this dissertation, my thanks go to my committee members: Drs. D. Beasley, L. Deal, P. Walsh, and L. McIntyre. I also wish to express my thanks to Dr. J. Gill, Professor in the Department of Dairy Science, who was of great help concerning the statistical design and analysis of my dissertation.

I am indebted to the following for making it possible to carry out my research in the Ingham Intermediate School District of Michigan: David Haarer, Director of Special Education, and Kenneth Woodring, Special Assistant to the Director in the area of Speech and Language Impaired. I acknowledge my sincere appreciation to the speech and language pathologists whose cooperation and support were essential to this research project: Diane Wilson, Mary Chester, Betty Ferry, Sue Crino, and Margaret Palmer.

Finally, I would like to express my love and gratefulness to my husband, Helmut, whose support and encouragement was fundamental to the successful completion of this dissertation.

TABLE OF CONTENTS

LIST OF TABLES

Table		Page

Table | Page

Table		Page

LIST OF FIGURES

Figure Page

Figure | Page

CHAPTER I

INTRODUCTION

There has been increasing interest in recent years by speech and language pathologists, speech scientists, psycholinguists, and related specialists in the study of normal language development of children. Speech and language pathologists are concerned with the characteristics and causes of 'delayed' or abnormal language development and draw upon the linguists' and psycholinguists' descriptions of normal language acquisition and the speech scientists' descriptions of speech and language processing theories. There is an increasing need for research to integrate information from these fields of study.

Since language encompasses phonologic, syntactic, and semantic characteristics, a primary need exists for the study of the interrelationship of these three systems. If a disorder in one system effects a disorder in one or both of the other two systems, such a relationship has profound implications with respect to therapeutic treatment to be applied to children exhibiting such problems.

An example of such a relationship is that of phonological development to auditory discrimination ability, which has been investigated (Carrell, 1937; Mase, 1946; Farquhar, 1961; Aungst and Frick, 1964; Prins, 1963; and Cohen and Diehl, 1963). Results of such studies, however, have been conflicting and inconclusive (Powers, 1957). Positive correlations have occurred only in those studies which use children with four or more articulation errors. In spite of conflicting results in these studies, therapy which assumes a positive relationship between articulation disorders and auditory discrimination problems continues to be strongly supported (Weiner, 1967).

Results of several studies have suggested a possible developmental relationship between phonology and syntax (Menyuk, 1964; Vandemark and Mann, 1965; and Shriner, Holloway, and Daniloff, 1969). These investigators have studied grammatical development in children exhibiting articulatory disorders and have observed that children with articulatory errors use a grammatical structure which is less complex than children of the same chronological age with normal articulation. The association between articulatory deficits and syntax is discussed at length by Shriner, Holloway, and Daniloff (1969) with respect to current studies of coarticulation (Kozhevnikov and Chistovich, 1965; Ohman, 1967; and Daniloff and Moll, 1968), theories of generative grammar (Chomsky, 1957), language assessment (Menyuk, 1964; and Vandemark and Mann, 1965) and feedback (Liberman _et al_., 1963; and Smith, 1967). To briefly summarize their discussion, Shriner *et al*. (1969) suggested that defective auditory or proprioceptive feedback which leads to misarticulation may induce syntactic deficits. Coarticulation theorists have postulated that minimal "units" of coarticulation were of syllable size or larger, and perhaps even crossing word boundaries (Daniloff and Moll, 1968). As a result, these minimal units of coarticulation may be well-formed syntactic units. Therefore, errors of such syntactic units, associated with articulatory impairments due to improper monitoring of the feedback mechanisms, may lead directly to syntactic difficulties. Phonological errors, therefore, relate to and effect syntactic decoding and encoding processing problems. Syntactic encoding deficits have been observed in studies involving imitation tasks (Menyuk, 1964) and studies designed to elicit spontaneous speech through the use of pictures (Shriner *et al*., 1969). Generally, articulatory-impaired children produced sentences which contained fewer transformations and fewer words than children with normal articulation.

Speech resynthesis tasks have also demonstrated a performance difference between children with normal versus impaired articulation, and researchers have discussed such differences with respect to syntactic competence. Specifically, Shriner and Daniloff (1970) concluded that normal speaking children apply their knowledge of syntax and semantics to aid them in performing reassembly tasks of meaningful stimuli. Children with articulatory errors who "... typically exhibit abnormal use of the syntactic and semantic characteristics of language..." would not be able to reassemble meaningful stimuli as efficiently. Such a study was carried out by Beasley, Shriner, Manning, and Beasley (1973) using 120 children, half of whom exhibited articulatory errors. All subjects were asked to resynthesize 10 meaningful and 10 meaningless CVC stimuli which were distorted using 4 different inter-phonemic intervals (100, 200, 300, or 400 msec). Normal-speaking children performed significantly better than misarticulating children on the resynthesis of meaningful stimuli across all inter-phonemic interval levels. No significant difference was found for the two groups of subjects on the resynthesis of meaningless stimuli. This would indicate that the problem is not one of poorer auditory perception in the children who misarticulate, since they then would have performed more poorly on both resynthesis tasks (Shriner and Daniloff, 1970). Rather, the difference was attributed to the superior ability of the normal-articulating children to apply the rules of syntax and semantics in reassembling the stimuli.

However, resynthesis of artificially segmented words is not a task normally performed by children, so there is some reason to question the extent to which such tasks reflect the linguistic ability of children (Beasley et al., 1973). Artificially segmented words do not contain the factors of normal prosody and co-articulation. Therefore, they do not reflect normal speech and may not induce normal speech decoding and encoding processing. A task involving normal speech is needed which requires the subjects to apply their knowledge of the rules of syntax and/or semantics in order to perform adequately.

A sentence imitation task which controls for short-term memory parrotting effects offers one method of investigation. Repetition tasks of this nature have been used by linguists to study grammatical structure in children's language for descriptive purposes, but several of these studies have failed to control for the short-term memory recall ability of the subjects (Menyuk, 1964; Brown and Bellugi, 1964). Two recent studies (Beasley and Acker, 1971; and Beasley and Smith, 1972) employed a sentence repetition task to investigate the psycholinguistic variables of sentence length, sentence type, word type, and stress as they affect short-term memory recall of children. The task entailed verbal recall of well-formed sentences (syntactically and semantically meaningful), anomalous sentences (syntactically meaningful but semantically disrupted), and ill-ordered sentences (neither semantically nor syntactically meaningful). This task appears to offer a method for investigating syntactic ability of children. The first two sentence types should tax the subjects' abilities to use rules of syntax in order to recall the sentential strings, and the last sentence type should serve as a control for short-term memory parrotting effects. In other words, an ill-ordered sequence, which exhibits minimal semantic and syntactic meaning, may serve as a measure of the auditory memory span limit of the subjects. The use of syntactic and semantic linguistic cues to aid in recall is minimized with ill-ordered sequences; therefore, the task serves as a measure of the children's automatic recall of individual, linguistically unrelated items. The design of the study includes sentences of varying length (3-, 5-, and 7-words). The memory span limit was considered to be the point at which the children began omitting words from the ill-ordered strings.

The factor of word type, studied in the past relative to differential retention of functor words (articles, modifiers) and contentives (nouns, verbs, adjectives) (Brown and Fraser, 1963; McNeill, 1966; Scholes, 1970; Beasley and Acker, 1971; and Beasley and Smith, 1972), was considered a part of this research for comparison purposes. Generally, functor words are more often omitted than contentives as the task increases in difficulty.

Briefly, the purpose of this research was to compare the performance of normal-speaking and articulatory-impaired children (1) on an auditory discrimination test and (2) on a sentence repetition task which involved, simultaneously, the factors of sentence type (well-formed, anomalous, ill-ordered), sentence length (3-, 5-, and 7-words), and word type (functors versus contentives).

CHAPTER II

LITERATURE REVIEW

The review of literature pertinent to this study is divided into three sections: (1) language studies of misarticulating children, (2) auditory discrimination studies of misarticulating children, and (3) short-term memory and imitation tasks.

Language Studies of Misarticulating Children

Schneiderman (1955) noted that little evidence was available regarding the relationship between articulation proficiency and certain aspects of language ability. However, she speculated that children who exhibited retarded language development in the clinical situation also showed articulatory errors and that children with defective articulation were often delayed in speech onset. Earlier, Williams and McFarland (1937) had found a moderate relationship among such language measures as length of sentence, grammatical completeness and complexity, correctness of word usage, articulation ability, and chronological and mental ages of preschool children. Davis (1937), cited by Schneiderman (1955), obtained significantly poorer scores from 5½ year old misarticulating children than from children with adequate articulation on measures of sentence length and number of different words used. However, this difference disappeared by 6½ years of age. A later study by Yedinack (1949), using 7½ year old children, did not show significant correlations between articulation ability, intelligence, length of response, and grammatical complexity and completeness.

Schneiderman (1955) investigated the relationship between articulation ability and three language measures: spoken vocabulary, sentence length, and a rating given by the subjects' classroom teacher of each child's general ability to express himself verbally. Schneiderman's results indicated a trend toward an association between articulatory ability and language ability, but the trend was not independent of the age level of the child. The relationship was stronger at younger age levels and tended to disappear as age increased.

Spriestersbach, Darley, and Morris (1958) and Morris (1962) reported on the language skills of children with cleft lips and cleft palates. Spriestersbach et al. (1958), using three language indices of mean length of response (MLR), structural complexity score (SCS), and vocabulary size, tested the hypothesis that children with cleft palates are retarded in language development. Results indicated that of the forty subjects studied, 29 were below norms in MLR, 24 were below norms in structural complexity, and 17 were below norms in vocabulary development. The authors felt, however, that as a group the children used sentences similar in complexity as the normative groups and were not syntactically impoverished.

Morris (1962) compared the performance of cleft palate children to children with cleft lips on the language measures of MLR, variability of response length, SCS, index of spontaneity, and number of different words used. The children were also administered the Ammons and Ammons Full-Range Picture Vocabulary Test and the WISC Vocabulary Test. Morris found no significant difference between subjects with a cleft palate-only versus subjects with a cleft lip-only, but he did find that all of the subjects were significantly below normal in performance on the several measures used. In addition, Morris found articulation proficiency to be significantly related to MLR, mean standard deviation for MLR, mean of the 5 longest responses (M5LR), SCS, Ammons vocabulary test scores, the WISC vocabulary subtest scores, and number of different words used. Morris also suggested that articulation proficiency was related to defectiveness of articulation in connected speech.

Menyuk (1964) compared the grammar of misarticulating children to that of children with normal speech using a generative model of grammar as formulated by Chomsky (1957). The generative grammar has a tri-partite structure which incorporates (1) phrase structure (where kernel sentences are formulated from syntactic rules), (2) transformations (where more complex sentence types are generated by rules for addition and/or deletion, permutation, and substitution) and (3) morphology (where inflectional rules are applied).

Menyuk's experimental group of subjects had been diagnosed as exhibiting 'infantile speech' by their teachers and a speech clinician. No further detail was provided concerning the characteristics of their speech. The ten experimental subjects were matched with ten control group subjects on the basis of age (3.00 - 5.10 years), socio-economic status, and IQ. The control group of subjects demonstrated no articulatory errors. Menyuk hoped to determine what differences existed, if any, in the groups' uses of syntactic structures and whether the experimental group was using a more immature language pattern but following the same developmental process as the normal group. Menyuk obtained and recorded language utterances elicited under three stimulus situations: (1) responses to a projective test, (2) conversation with the experimenter who used a proscribed set of questions, and (3) conversation with peers. In the second part of the experiment, three children from both groups were asked to imitate sentences which contained examples of various transformation types, and four from each group were asked to repeat restricted structure forms. Finally, Menyuk compared the grammar of a two-year old subject to that of the youngest member of the infantile speech group to note similarities and dissimilarities in language structure. On the basis of her results, Menyuk observed that the term 'infantile' was a misnomer because the grammatical production of the oldest members of the 'infantile speech' (I.S.) group did not match the grammatical production of the youngest members of the normal speaking (N.S.) group. The three-year old I.S. child used more transformations and more restricted forms than the two-year old N.S. child; however, by the time the N.S. child was three years of age, he exceeded even the oldest I.S. child in grammatical production. She also found that children with infantile speech use the most generalized rules or first approximations to rules when formulating sentences. Specifically, their sentences incorporated transformations involving few operations and contained restricted forms which appear to be early approximations to completed rules of grammar. Finally, the N.S. group and the I.S. group were dramatically different on the sentence repetition task. Menyuk stated:

> In this study, the I.S. children (infantile speech) seemed to be either repeating the last things heard or applying the most general or elementary rules in perceiving and reproducing a sentence. Sentence length affected their ability to repeat. This was also the case with normal speaking subjects when the structure of the sentence was broken down (sentences in reverse word order). The N.S. children seemed to be using the syntactic structures of the sentence to repeat. Most of their non-repetitions were due to some modifications of transformations and corrections of restricted forms and not sentence length. (p. 119)

Language skills of children with defective articulation have also been investigated by Vandemark and Mann (1965).

They compared normal speaking versus articulatory-impaired children on the language measures of MLR, SCS, M5LR, number of different words used, type-token ratio, and standard deviation of response length. The fifty experimental subjects from grades three through six had failed to achieve the cut-off score for 8-year old children on the Templin-Darley Screening Test of Articulation. A control group was matched to the experimental group on the factors of age, hearing, sex, and socio-economic status, but demonstrated no articulation problems. Results indicated that, of the seven language measures studied, the groups differed significantly only on the structural complexity (SCS) factor. The authors concluded that articulatory-impaired children are not inhibited in amount of verbal output but do perform below normal speaking children in terms of grammatical completeness and complexity of response.

Shriner, Holloway, and Daniloff (1969) investigated the relationship of articulation to syntax development in children with severe articulatory problems. The experimental group of thirty elementary children in grades one through three had scored one or more standard deviations below the norm on the Templin-Darley Test of Articulation for their age and sex. The control group of thirty children matched the experimental group by sex, race, father's occupation and education level, and mental and chronological age. Fifty to sixty verbal responses were elicited from each child using picture material. The language samples were scored with the length-complexity index (Shriner, 1967; and Hurley, 1967) and an MLR was determined. A significant difference was observed between the two groups in the area of grammatical completeness. Further, the speech-defective group produced shorter phrases (reduced MLR) than the control group. Shriner _et_ _al_. concluded that the results of their study and the results of Menyuk (1964) and Vandemark and Mann (1965) suggest that misarticulating children exhibit underdeveloped syntactic structures. The age range covered by the above three studies was from 3 to 13 years of age. Shriner _et_ _al_. (1969) postulated, therefore, that the relationship between articulation and syntax is not a developmental one; i.e., regardless of the level of physical development, defective phonological production may result in and be associated with deficits in syntax.

Shriner _et_ _al_. (1969) offered several explanations for their results. Articulatory-impaired children may have uttered shorter sentences because of awareness of their problems. In other words, their awareness caused them to try to hide their articulatory defects from others. As these children uttered shorter sentences, thereby maintaining a reduced MLR, they failed to experiment with new, more elaborate aspects of syntax. This ultimately resulted in a lower SCS compared to that of normal children. Finally, they suggested that the deficit in syntax, i.e., the inability to produce well-formed sentences, probably entails phonetic errors. More specifically, misarticulation, caused by defective auditory and/or proprioceptive feedback, induced deficits in syntax. The authors suggested that minimal units of articulation may be well-formed syntactic units. If so, errors in articulation of these units would lead directly to syntactic difficulties. They related this suggestion to theories of coarticulation, which have indicated that articulatory performance involves production units larger in size than the phoneme. For example, coarticulation has been observed over four consonants preceding a rounded vowel (Daniloff and Moll, 1968), irrespective of word or syllable boundaries. Thus, if a child misarticulates a phoneme, then the misarticulation may have an effect on a larger syntactic unit, thereby effecting syntactic difficulties.

Both proprioceptive-kinesthetic and auditory systems may be involved in feedback between articulatory and syntactic levels of language production. Some research has indicated that articulatory-impaired children show speech sound discrimination problems (Weiner, 1967). However, no discrimination tests were administered to the subjects in Shriner's study, although the authors suggested that learned abnormal perception may be a possible avenue of distorted feedback.

Liberman, Cooper, Harris, and MacNeilage (1963) presented a theory of speech perception which can be applied to the construction of the relationship between syntax and articulation. They proposed that articulation serves as the mediating system in speech perception; that is, speech sounds are perceived by reference to neurological programs for the articulatory movements which produce the sounds. If such is the case and if incoming speech sounds are referred to defective articulatory programs, then the distorted feedback would lead to distorted syntactic decoding and subsequent encoding. The authors cautioned, however, that if one assumes a causal relationship between misarticulation and poorly developed syntax, the direction of the causal relationship remains obscure at present. A need for further research of this relationship is warranted.

Menyuk and Looney (1972) stated that certain children who are considered to have deviant language development can be used to study and compare central encoding and decoding processes towards language acquisition with normal children on certain linguistic tasks. The purpose of such studies would be to discern which aspects of language perception and/or production are affected by their language disorder. Criteria for the selection of the language-deviant children were that they exhibit (1) no peripheral auditory damage, (2) no vocal mechanism damage, (3) no abnormal hearing thresholds for pure tones and speech, (4) no abnormal motor development, (5) no CNS dysfunction, (6) no abnormal intelligence, and (7) no mental illness.

Menyuk and Looney felt that such studies could provide adequate descriptions of the language processing differences between children with normal and abnormal language development. Subsequently, various therapeutic techniques could be devised to modify the language disorders. Menyuk and Looney also stated that children developing language normally do not merely imitate when given tasks of repeating sentences (p. 265). Rather, their repetitions reflect their level of grammatical competence. They added that repetition techniques can be useful in determining syntactic competence of the groups under study.

Auditory Discrimination Studies of Misarticulating Children

According to Johnson, Darley and Spriestersbach (1963), speech sound discrimination may be causally related to clinical articulation problems. They noted that 25 years prior to the publication of their book investigators had reported that children with functional articulatory problems were inferior to normal speakers in speech sound discrimination ability. However, other investigators (Hall, 1938; and Mase, 1946) did not find such a difference when using more systematically matched groups of normal and non-normal speakers, tested under controlled conditions. Such conflicting results were summarized by Weiner (1967). He attributed the inconsistency of the findings to the fact that the various studies used different discrimination measures which required different types of responses from the children, different age groups of children, and different definitions and measurements of articulatory disorders exhibited by the subjects used.

Different discrimination tests involved different test formats, and responses required of the children varied from locating an incorrect sound or word in a sentence context (Hall, 1938; and Mase, 1946) to clapping their hands when the tester uttered the correct form of one of their own misarticulated sounds (Farquhar, 1961) to stating whether a pair of sounds were 'same' or 'different' from each other (Wepman, 1958). There were also picture discrimination tests. Obviously, these various responses taxed different skills. According to Weiner, the task of determining whether two sounds are the same or different involves a child's ability to remember what he has heard as well as his concept of the terms 'same' and 'different'. Discrimination tests using pictures measures the vocabulary skills of the children, thereby confounding intelligence with auditory discrimination ability. Weiner also noted that the discrimination stimuli varied from nonsense syllables to meaningful words, a fact which may have further confounded the data.

The use of different age groups was an important factor influencing the results of these studies. Auditory discrimination ability, which develops in a fashion similar to the development of articulatory skills, has been shown to improve as age increases, plateauing at approximately 9 years of age (Templin, 1943, 1957; and Wepman, 1958). Weiner (1967) emphasized that only those studies using subjects below nine years of age demonstrated a positive relationship between articulation and discrimination ability.

Finally, investigators varied in their definitions and measurements of articulatory disorders. Many studies described articulation problems in terms of number of error sounds. Of the studies using this criterion, some used children exhibiting only one error sound (Aungst and Frick, 1964), whereas others used a criterion of three (Carrell, 1937; Mase, 1946; and Prins, 1963) or more misarticulations (Kronvall and Diehl, 1954; and Cohen and Diehl, 1963). Some investigations, according to Weiner (1967), failed to indicate any specific number of misarticulations. Weiner observed that, in general, studies using a criterion of four or more errors demonstrated a positive relationship between speech sound discrimination ability and speech sound production.

There is psycholinguistic evidence which suggests that sound discrimination is closely bound to language processes. Berko and Brown (1960) and Liberman _et al_. (1961, 1957) found that children with normal articulation were best able to discriminate minimal sound differences when these differences were phonemic, signaling a different linguistic meaning, e.g. tap-cap. The semantic system of language helps to cue the children to minimal phonemic differences, which also represent different linguistic units. Wepman's Auditory Discrimination Test is a test used to determine a child's ability to recognize fine differences between English phonemes. A child hears pairs of words and must indicate whether the pair of words are the same or different. Phonemes within phonetic categories are contrasted. For example, stop plosives /p, t, k/ are paired in words such as pit-kit or cart-tart. This test, then, uses linguistic units as discrimination stimuli, and a subject's performance may depend on his language skills. Prins (1963) administered the Wepman Auditory Discrimination Test to 26 children with varying functional defects of articulation. He found that children whose articulation errors differed by one feature from the target sounds and by one degree in place of articulation did poorly on this test. In contrast, children exhibiting many articulation errors which departed more extremely from the target sounds in manner and place of articulation and voicing did not perform poorly as a whole. It seems that, in order to discriminate between minimally different sound units, a child must have the feature distinctions in his perceptual system. If a child's articulation error is characterized by a change in place of articulation, such as a /t/ for /p/ substitution, he might not be able to use place-change information to differentiate phonemes. Such a theory would be supported by Liberman et al. (1961), who hypothesized that articulatory movements mediate between the acoustic stimulus and its ultimate perception. If a particular articulatory feature has not been encorporated into his perceptual processing mechanism, the child's difficulty in producing and discriminating a sound with that feature may also effect a broader language problem. The defective auditory discrimination may represent defective auditory feedback which, according to Shriner et al. (1969), may lead to or be related to misarticulations inducing syntactic defects.

That auditory discrimination appears to relate significantly to language processes was stated by Prins as follows:

> From this standpoint, poor performance on tests of the Wepman type may be a function of early cognitive failures in identifying symbolic variations which are signalled by minimal acoustic change. As such, poor sound discrimination ability could be regarded as an effect of disturbance in the total language learning process rather than a primary auditory perceptual limitation. Clinically, this suggests that speech sound discrimination ability cannot be meaningfully evaluated as independent of language processes. (p. 385)

Marquardt and Saxman (1970) studied the relationship between language comprehension and auditory discrimination in 30 kindergarten children with numerous misarticulations and 30 normal speaking children. The Carrow Auditory Test for Language Comprehension and the Wepman Auditory Discrimination Test served as test instruments. The articulatory-impaired children showed deficit performances on both tests and their error scores were significantly correlated with number of misarticulations observed. The authors stated that language competence and auditory discrimination were significantly correlated within the articulatory-impaired group but not in the articulatory-proficient group. They concluded that their findings supported the argument that "...children with numerous misarticulations show syntax performance deficits for their age because of underdeveloped syntax knowledge" (p. 387). Their study supplemented the findings of others (Menyuk, 1964; Shriner et al., 1969; and Vandemark and Mann, 1965) by showing that syntax deficiencies seen in the verbal expression of children are also present in their syntax comprehension.

A study by Perozzi and Kunze (1971) considered the use of paired syllables rather than paired words (as in Wepman's test) as stimuli for testing speech sound discrimination skills (SSD) of children because (1) more speech sounds could be tested, (2) one avoided the problem of selecting words within the vocabulary of the children to be tested, and (3) tests such as Wepman's may not be difficult enough to ascertain differences in SSD skills among school-aged children. They used their own paired syllable discrimination test, Wepman's measure and the Illinois Test of Psycholinguistic Abilities (ITPA) as test instruments. Both SSD tests correlated highly to the ITPA results for their subjects. The authors concluded that (1) their results supported Prins's speculation and Rechner and Wilson's (1967) data regarding a close relationship between SSD and language and (2) language skills (as measured by the ITPA) and SSD skills were not independent.

Short-Term Memory and Imitation Tasks

A task of immediate verbal recall of auditorally presented sentential word strings necessarily involves the use of short-term memory. Investigators in the past have tried to relate articulation disorders to recall ability of verbal materials. Results have proved equivocal. Several studies indicated that articulatory-impaired children have shorter memory spans than children with normal articulation (Metraux, 1944; Robbins, 1942; and Thomas, 1959, as cited in Smith, C. R., 1967), whereas others found no such difference (Fontaine, 1958; and Hall, 1944). A clear relationship between the ability to recall verbal material and non-organic articulation problems has yet to be established. Assuming that the two groups of children have equivalent memory spans, it is pertinent to present general theoretical models of short-term memory processes as they relate to the present investigation. Of the various models presented in the literature (Aaronson, 1967; Broadbent, 1957; Pollack, 1959; and Sperling, 1963), one general model has been described by Smith (1972). The Smith model incorporated several concepts from other models. Table 1 summarizes the terms and their sources and Figure 1 is a schematic of the model as described by Smith (1972). The Smith model depicted memory as a two-stage process. The first stage, Stage 1 (Aaronson, 1967), is described as

Table 1. Terms and Sources Used to Describe the Processing Systems for Memory.

Short-Term Memory - Names and Characteristics
1. Stage 1 (Aaronson, 1967)
2. Sensory System (Broadbent, 1957)
3. Performance (Chomsky and Halle, 1968)
4. Primary Memory (Aaronson, 1967)
5. Automatic (Kirk, 1968)
6. Large Capacity (Aaronson, 1967)
7. Rapid Decay (Aaronson, 1967)
8. Parallel System (Aaronson, 1967)
Long-Term Memory - Names and Characteristics
1. Stage 2 (Aaronson, 1967)
2. Perceptual System (Broadbent, 1957)
3. Competence (Chomsky and Halle, 1968)
4. Secondary Memory (Aaronson, 1967)
5. Representational (Kirk, 1968)
6. Small Capacity (Aaronson, 1967)
7. Slow Decay (Aaronson, 1967)
8. Single Channel (Aaronson, 1967)

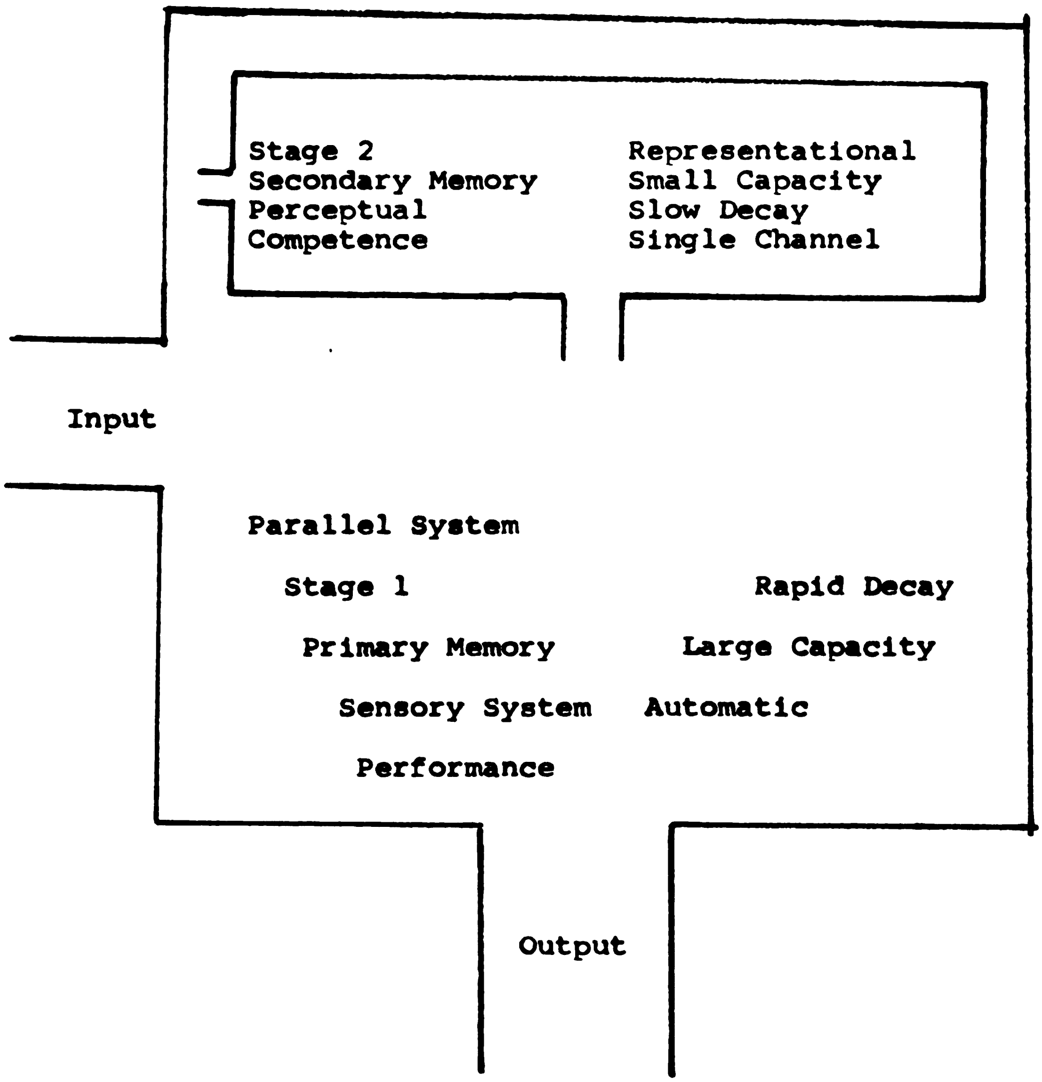


Figure 1. Memory Model Employing Various Concepts Associated with Memory Systems (adapted from Beasley and Smith, 1972).

a large-capacity, parallel processing system, characterized by rapid temporal decay of the input stimuli. This stage has also been called the sensory storage system (S-system) by Broadbent (1957). The stimuli eventually retained enters Stage 2 (Aaronson, 1967), which is also called the perceptual system (P-system) (Broadbent, 1957). Stage 2 is a small capacity system which processes one item at a time for long-term memory storage. Since Stage 1 represents short-term memory storage for automatic recall of material and Stage 2 represents long-term memory storage, Figure 1 links the term "performance" with Stage 1 and "competence" with Stage 2, terms which are defined by Chomsky and Halle (1968) with respect to language function. Performance refers to how a person <u>uses</u> his knowledge of a language as observed in his verbal expression of the language. One can, in other words, observe what structures of the language are present in the person's speech. However, this "performance" may not reflect the person's actual "competence" for the language in its entirety. Competence is the person's <u>knowledge</u> of the linguistic rules of the language (Chomsky and Halle, 1968). More simply, performance refers to use of a language and may be observed; competence refers to knowledge of the linguistic rules of language and is not directly observable.

One tries to make inferences about competence through a person's performance. Studies which have attempted to determine a child's language competence through his verbal expression have been carried out by several individuals (Menyuk, 1964; Brown and Fraser, 1964; Slobin and Welsh, 1967; Scholes, 1969; Shriner and Daniloff, 1969; Schuckers, Shriner, and Daniloff, 1973; Beasley and Acker, 1971; and Beasley and Smith, 1972). Unfortunately, some of these language studies have attempted to test the subjects' competence without satisfactorily controlling for short-term memory automatic recall ability. If the subjects were asked to imitate phrases given by the examiner, for example, the imitative responses may have represented automatic recall of the stimulus items, with no particular reliance upon the language competence portion of the memory system to perform the task. Any inferences to a subject's knowledge of the language based upon such responses would be questionable. The subject's dependence upon short-term memory must be controlled in order to obtain information bearing on language competence. Various techniques for controlling the short-term memory 'parrotting' effect have been employed in recent studies. These have included the insertion of acoustic pause-time segments within the stimuli (Scholes, 1969; and Shriner and Daniloff, 1970), the auditory reassembly of sentences and CVCs (Schuckers _et al_., 1973; and Beasley _et al_., 1973), and the use of varying sentence lengths and sentence types (Martin, 1968; Scholes, 1970; Beasley and Acker, 1971; and Beasley and Smith, 1972).

The first two control methods have been questioned relative to their usefulness in studies pertaining to language acquisition. Controlled insertion of acoustic pause-time between lexical items of systematically increased sentence lengths may not yield data directly relevant to language acquisition (Schuckers et al., 1973). The use of an auditory reassembly task to investigate grammatical factors in sentence retention is similarly dubious. Such tasks involve stimuli which do not resemble normal-sounding or normal-flowing speech. Therefore, the processing of such stimuli by the child may not be that used to process normal speech stimuli. Sentences are broken up by pause intervals between words, as in Schuckers' study (1973), no longer contain normal prosodic features (intonation and stress patterns). According to Schuckers et al. (1973), the smallest delay interval between words (125 msec) caused almost as many errors as the longest delay interval (750 msec). It is also important to note that the early repetitions of these sentences by Schuckers' subjects were sentences characterized by inserted pause times. The children, in other words, produced broken-sounding phrases lacking prosodic features. Thus, to study how children with articulatory errors process and reproduce normal speech stimuli, another method to control against parrotting effects was employed.

The third control method offers a more effective approach against short-term memory parrotting effects in imitation tasks. This method, used by Beasley and

Acker (1971) and Beasley and Smith (1972), involved the use of three language sequence compositions: well-formed, anomalous, and ill-ordered sentential strings. Well-formed strings are normal sentences, both semantically and syntactically meaningful. Anomalous strings are semantically disrupted but maintain syntactic sense. An example of an anomalous string used in the above two studies is "An airplane chops the wood." Ill-ordered strings are neither syntactically nor semantically meaningful. Words of a normal sentence are scrambled: "Baby his calls the mother." These investigators also used three sentence lengths of 3-, 5-, and 7-words. The increasing sentence length served to check for the memory span limit of the children. The authors felt that the point at which subjects began to omit words during the repetition of ill-ordered strings was the limit of their memory span for verbal items. According to Miller (1956), the average mean length of memory span for most individuals has been seven items, plus or minus two, for verbal sentential utterances. Templin (1957) determined it to be 6.1 words with a deviation of 0.9 words. According to the omission errors which occurred on 7-word ill-ordered sequences in the studies by Beasley and Acker (1971) and Beasley and Smith (1972) and the error rates on six-word sentences in Schuckers' study (1973), the use of 7-word ill-ordered sequences appears adequate to test the limit of short-term memory.

In order to test a child's language competence on an imitation task of the type described above, the use of the above control method would appear to be satisfactory. If a subject failed to repeat all the words in a 7-word ill-ordered sequence but performed efficiently when repeating 7-word well-formed and/or anomalous sequences, the investigator could assume that the child was relying on skills other than his short-term memory recall ability. That is, it may be assumed that the child was employing his knowledge of the rules of syntax and semantics which govern the word-order and meaning of his language.

Repetition tasks have been employed by psycholinguists, speech and language pathologists, and speech scientists to investigate aspects of language acquisition (Brown and Fraser, 1964; Menyuk, 1963; Slobin and Welsh, 1967; Scholes, 1969; Shriner and Daniloff, 1969; Schuckers et al., 1973; Beasley and Acker, 1971; and Beasley and Smith, 1972). Menyuk (1963) and Slobin and Welsh (1967) have reported that a child's ability to repeat various linguistic structures appears to be independent of length. Data from the study by Schuckers et al. (1973) showed that when active sentences exceed the limits of auditory memory span, the children delete the last half of the sentence. Children can, however, repeat utterances which are longer and more complex than one they spontaneously produce (Menyuk, 1963; Slobin and Welsh, 1967; and Lackner, 1968). Such findings indicate that when children are able to detect structure through particular linguistic rules or other strategies, they can increase the limits of auditory memory for later encoding of the stimulus items (Schuckers <u>et al</u>., 1973). Scholes (1970) reported that children's attempts to repeat word strings was affected by stimulus length, contrary to the findings by Menyuk (1963) and Slobin and Welsh (1967). Scholes feels that a child may fail to try to repeat a string if it appears to be too long for him.

A mneumonic technique employed by adults to retain stimuli which normally exceed the memory span has been described by Miller (1956) as 'chunking'. One or more contiguous words are grouped or chunked together as a single unit for recall of sentences. The chunking of items has been observed predominantly in the memorization of digital items rather than verbal items, however. Chunking words together in a sentence may disrupt the major constituent connections (Schuckers <u>et al</u>., 1973). For example, if the phrase "the bad little boy who took the toy" was chunked as "the bad little boy" "who took the toy," the relationship between 'boy' and 'who' is broken. Schuckers <u>et al</u>. (1973) do not feel that children chunk sentences in this fashion. Several researchers have reported that children retain 'key words' (contentives) of phrases such as nouns and verbs and tend to drop modifiers (functors) such as articles when their memory span has been exceeded in a repetition task Scholes, 1970; Martin, 1968; Brown and Bellugi, 1964; Beasley and Acker, 1971; and Beasley and Smith, 1972). Such a strategy does not seem unusual since the structural basis of a sentence lies in the co-existence of the noun and verb (Schuckers _et al_., 1973). The noun-verb combination also signals the deep structure (semantic component) of the phrase. Grammatical recall of sentences would seem to depend on the child's ability to identify the syntactic and/or semantic structure of the sentential string.

Short-term memory recall of items varies not only as a function of sequence length and word type (functors and contentives) but also as a function of type of stimuli presented. If the stimuli are discrete (unrelated) verbal items, the items presented last are remembered best, first items are remembered moderately well, and the middle items are least frequently recalled (Deese and Kaufman, 1957). However, if the stimuli are English contextual material, the recall pattern is different. In this case, the first words are most readily recalled, followed by the middle and final items, respectively (Deese and Kaufman, 1957). In studies using well-formed, anomalous and ill-ordered sentential strings, as those by Beasley and Acker (1971) and Beasley and Smith (1972), the recall pattern was not described. However, one might assume that the well-formed sequences would be recalled like English contextual material, whereas ill-ordered sequences would be recalled like discrete items, once the memory span has been exceeded. Since anomalous sequences do contain syntactic structure, recall of these strings might resemble that of contextual material.

These hypotheses warrant investigation. Beasley and Acker (1971) and Beasley and Smith (1972) did describe the differential recall of one sequence type over another. They found that well-formed sequences were recalled with the fewest number of errors, followed by anomalous and ill-ordered sequences, respectively.

The reason for this differential recall of the three sequence types may be explained by the fact that meaningful verbal material is easier to memorize than nonsense material (Miller, 1958). Miller and Selfridge (1950) studied subjects' recall of statistical approximations to English sentences, first-order through seventh-order sentential approximations, and found that as the word strings became increasingly more like meaningful English sentences, recall improved. They concluded that familiarity with the rules of language governing word sequence in meaningful passages facilitated recall.

Statement of the Problem

Research has indicated in the past that children with misarticulations typically have associated language problems (Schneiderman, 1955; Williams and McFarland, 1937; Davis, 1937; Spriestersbach et al., 1958; Morris, 1962; Menyuk, 1964; Vandemark and Mann, 1965; and Shriner et al., 1969). Shriner et al. (1969) investigated the relationship of articulation to syntax development in misarticulating children. Based on their results, the authors suggested that the development of the phonological and syntactical aspects of language may be closely related, if not causally related. Further investigation was recommended to contribute information in support of this hypothetical relationship.

Studies of auditory discrimination have shown that children under nine years of age with severe articulatory disorders exhibit auditory discrimination problems (Weiner, 1967). Further investigation was recommended which would replicate in form any earlier studies in order to establish the specific relationship between auditory discrimination skills and articulation. Shriner _et al_. (1969) noted that auditory discrimination problems may cause auditory perceptual problems which, simultaneous with disturbances of proprioceptive-kinesthetic feedback, may contribute to phonologic and syntactic language disorders. Therefore, the presence of auditory discrimination problems in children with articulatory disorders should be determined, the relationship between articulation and auditory discrimination clarified, and research must attempt to reveal any associated language disorders in children with discrimination and articulation problems. The presence of such a combination of problems would warrant the development of new therapeutic techniques as well as diagnostic approaches for thorough evaluations in a clinical setting.

Further research is necessary to determine whether misarticulating children have associated language problems, i.e., syntax deficits, along with auditory discrimination problems. Shriner _et al_. (1969) suggested that misarticulating children may do less well than normal speaking children on meaningful material, since their syntax development appears to be inferior. Beasley *et al*. (1973) demonstrated that normal speaking children resynthesized meaningful CVCs better than misarticulating children. Beasley and Acker (1971) and Beasley and Smith (1972) investigated the effect of sentence type, sentence length, word type, and stress upon the recall abilities of normal speaking children. Research employing the well-formed and anomalous sentences of Beasley and Smith's study (1972) would determine whether misarticulating children do less well than normal speaking children on the recall of meaningful material. If the syntax development of misarticulating children is indeed inferior to that of normal speaking children, the performance of the two groups should differ on both sentence types since syntactic structure is present in both. The ill-ordered sequences would test for children's recall of discrete items, thereby controlling for short-term memory abilities.

In summary, the relationship between the areas of auditory discrimination, articulation, and syntax should be clarified through further research. The purposes of the present investigation were to (1) evaluate the auditory discrimination abilities of articulatory-impaired and normal speaking first grade children and (2) compare their responses to an imitation task involving, simultaneously, the factors of sequence type (well-formed, anomalous, ill-ordered), sequence length (three, five, and seven words), and word type (functors versus contentives). Specifically, the following questions were investigated:

1. Do the auditory discrimination abilities of first grade articulatory-impaired and normal speaking children differ?
2. Does the recall accuracy of first grade articulatory-impaired and normal speaking children differ for three-, five-, and seven-word sequences?
3. Does the recall accuracy of first grade articulatory-impaired and normal speaking children differ for well-formed, anomalous, and ill-ordered verbal sequences?
4. Does the recall accuracy of first grade articulatory-impaired and normal speaking children differ for contentive and functor word types?
5. Do the types and frequency of recall errors for the factors of sentence type and sentence length differ for articulatory-impaired and normal speaking children?

CHAPTER III

EXPERIMENTAL PROCEDURES

Information concerning subjects, instrumentation, stimuli, and experimental procedures are presented in this chapter.

Subjects

The subjects were 40 first-grade middle-class children selected from the Ingham Intermediate school district. The experimental group consisted of 20 children, 13 boys and 7 girls, with normal hearing and intelligence, who exhibited three or more articulation errors on McDonald's Screening Deep Test of Articulation. The same experimenter tested all children on an individual basis. All children selected were attending speech therapy classes at that time. The mean age of the experimental group was 6.3 years. The control group of subjects consisted of 20 children with normal speech, hearing, and intelligence, 13 boys and 7 girls, with a mean age of 6.3 years. Each control subject matched a particular experimental subject by sex and age (within a few months), and had been taken from the same classroom as the matched experimental subject.

The Wepman Auditory Discrimination Test was administered live-voice to each subject at the beginning of the testing session. Wepman's test had been selected in order to allow for comparison of the present study's results to that of Prins (1963).

Design and Stimuli

The experimental stimulus materials were taken from two previous studies by Beasley and Acker (1971) and Beasley and Smith (1972), consisting of eighteen 3-, 5-, and 7-word sequences. Six of each set of eighteen sequences were well-formed sentences, six were anomalous, and six were ill-ordered in nature (see Appendix A). These sentences were recorded by an experienced speaker on an Ampex AG 44-4 tape recorder (frequency response of 50 to 15000 Hz) using a normal speaking pattern (normal prosodic features which accompany the speech production of sentences).

Presentation Procedures

The procedures followed were those described by Beasley and Smith (1972). The sentences were presented in a randomized order (see Appendix B) via sound-field using a Sony TC-106A tape recorder. The subjects, tested individually, were asked to repeat exactly what they heard. Each subject was situated approximately twenty-six inches directly in front of the Sony speaker. The intensity level for stimulus presentation was 70 to 75 dB SPL (re: .0002 dynes/cm^2) as determined by a Bruel and Kjaer type 2204 sound level meter with a type 4145 sound field condensor microphone. This instrument was also used to determine the ambient noise level in test rooms to check for adequate signal-to-noise ratios. Although different schools and, therefore, different test rooms were used, the ambient noise level in the test rooms was measured at 55 to 60 dB SPL. This noise level was low enough to permit a subject to complete the listening task.

At the time of testing, subjects were read a set of standardized instructions (see Appendix C). Three practice items were introduced at the beginning of the experimental tape (see Appendix D), one practice item for each sentence type. If the subject missed any practice item, he was given another opportunity to hear it and respond. If the subject missed any practice item a second time, he was replaced. During the experimental session, fifteen seconds of response time were allotted between stimulus items. In order to control for the effect of fatigue on scores, the order of presentation of the randomized stimulus items was counterbalanced. The first 20 subjects, 10 experimental and 10 control, heard sentences in the original order 1-54, as listed in Appendix D; the second 20, also 10 experimental and 10 control subjects, heard sentences 27-54, then 1-26.

All responses were recorded on tape as well as transcribed during the test session by the experimenter on a standard answer sheet (Appendix D). The transcriptions were compared to the tape recording to determine accuracy of transcription.

Analysis

A split-plot experimental design with repeated measurements using the factors of sentence length, sentence type, word type, and articulation was employed. Errors of omission, substitution, addition, and word order reversals were noted and are defined as follows:

1. Omission - A stimulus word is missing in the subject's verbal repetition.
2. Substitution - A stimulus word is replaced by a new word of the same grammatical class in the subject's verbal repetition, e.g., blue/black.
3. Addition - A new word is added to the original stimulus in a subject's verbal repetition.
4. Reversal - Words in the original stimulus sequence are found in new positions in the subject's verbal repetition. Two error categories were established to analyze this error type.

A correct response contained all the words of the stimulus sequence in the order presented. The articulatory errors noted by the experimenter during the initial articulation testing of the experimental subjects were not considered as errors when observed in their responses to the task. The data were analyzed by a multifactor analysis of variance (ANOVA) routine.

CHAPTER IV

RESULTS

The study was designed to determine the effects of sentence length, sentence type, word type, and articulation on the imitation behavior of first grade children. Results revealed that mean error scores for the misarticulating children were consistently higher than those of normal speaking children for the main factors and their interactions. The present chapter presents the results of the auditory discrimination evaluation, followed by sections on the error types observed with respect to the main factors under investigation.

1. Auditory Discrimination

The Wepman Test of Auditory Discrimination was administered to each subject at the beginning of the testing session according to test directions. The subjects' responses were recorded and, based on Wepman's scale of adequacy, each subject was determined to have adequate or inadequate discrimination. The results are shown in Table 2.

In the Wepman test, there are 13 discrimination pairs in error type categories I and II (initial and

Table 2. Results of Wepman Auditory Discrimination Test Administered to Normal Speaking (N.S.) and Articulatory-Impaired (A.I.) Subjects.

	Subjects	
	N.S.	A.I.
Number of Subjects	20	20
Inadequate Discrimination	6 (30%)	12 (60%)
Total Number of Errors	78	164
Error Types:		
I. Initial Sounds Differed	17 (6.5%)	41 (16%)
II. Final Sounds Differed	38 (15%)	87 (33%)
III. Vowel Sounds Differed	18 (22%)	32 (40%)
IV. Word Pairs Identical	5 (2.5%)	4 (2%)

final sounds, respectively, differed), 4 in type III (vowel sounds differed), and 10 in type IV (word pairs identical). Percentages were determined on errors made out of the total possible, and the pattern of errors was found to be similar for both articulation groups. The articulatory-impaired children made twice as many errors as normal speaking children in the categories I, II, and III, as shown in Table 2. Subjects made few errors for category IV. Twice as many children with articulatory problems were found to have inadequate auditory discrimination ability based on the results of the Wepman Auditory Discrimination Test.

Subjects' responses to the main stimulus material, the 54-sentence repetition task, were analyzed according to errors of omission (functor and contentive), substitution (functor and contentive), addition (functor and contentive), and reversal of word position. The main factors of articulation, word type, sentence type, and sentence length will be discussed with respect to these error types in the order listed above, emphasizing how the main factors and interactions related to the observance of the errors.

2. Functor Omissions

In the 54 stimulus sentences there were a total of 90 functor words which could be omitted in a subject's repetition. Error scores were translated into percentages of error from the total possible. Functor omissions were analyzed with respect to the main factors of articulation, sentence type, and sentence length. Table 3 presents the results of the ANOVA performed on the data. Table 4 shows the raw data for the main factors and their interactions. All scores are mean percentages of error.

Table 3. Results of the ANOVA for Functor Omission Errors.

Source	df	Mean Square	Significance*
Articulation (A)	38	1245.44	$p < 0.0005$
Sentence Type (ST)	2	10997.23	$p < 0.0005$
Sentence Length (SL)	2	12508.02	$p < 0.0005$
A x ST	2	417.29	n.s.
A x SL	2	557.83	$p = 0.018$
ST x SL	4	3177.35	$p < 0.0005$
A x ST x SL	4	340.53	$p = 0.043$

n.s.: not significant

The three main effects were significant, indicating that articulation ability, sentence type, and sentence length each affected the occurrence of functor omissions. All interactions were significant except A x ST, which indicates both articulation groups' responses were affected similarly by the sentence type factor. The significant main effects and interactions will be discussed individually, and the effects will be related to the error type of functor omissions.

Table 4. Mean Percent Error Scores for Functor Omissions for the Factors of Sentence Type (well-formed: WF, anomalous: A, ill-ordered: IO),Sentence Length (three-word: 3W, five-word: 5W, seven-word: 7W), and Articulation (normal speaking: N.S., articulatory-impaired: A.I.).

Articulation x Sentence Type: not significant

	WF	A	IO	Overall Mean
N.S.	3.6	9.0	24,9	12.5
A.I.	23.9	31.9	40.4	32.1
Overall Mean	13.7	20.5	32.6	

Articulation x Sentence Length: significant

	3W	5W	7W	Overall Mean
N.S.	3.9	11.8	21.8	12.5
A.I.	19.0	35.5	41.7	32.1
Overall Mean	11.4	23.7	31.7	

Sentence Type x Sentence Length: significant

	3W	5W	7W	Overall Mean
WF	9.2	14.8	17.3	13.7
A	10.8	26.0	24.6	20.5
IO	14.4	30.2	53.3	32.6
Overall Mean	11.4	23.7	31.7	

Articulation x Sentence Type x Sentence Length: signif.

	3W		5W		7W		Overall Mean	
	N.S.	A.I.	N.S.	A.I.	N.S.	A.I.	N.S.	A.I.
WF	1.7	16.7	3.3	26.2	5.8	28.7	3.6	23.9
A	2.5	19.2	14.2	37.9	10.4	38.7	9.0	31.9
IO	7.5	21.2	17.9	42.5	49.2	57.5	24.9	40.4
Overall Mean	3.9	19.0	11.8	35.5	21.8	41.7		

Articulation

Briefly, there was a significant main effect for articulation ($p < 0.0005$) which indicated that the two articulation groups' performance of the task significantly differed with respect to the number of functor omissions observed in their stimulus repetitions. As can be seen on Table 4, the overall means for articulation differ, whereby the A.I. subjects have a significantly higher percentage of functor omissions.

Sentence Type

Sentence Type means for the two articulation groups differed, as would be expected from the significant main effect of articulation. The overall means for sentence type, 13.7, 20.5, and 32.6 percent, were subjected to post hoc testing using Tukey procedures (Kirk, p. 88-90, 1968). All three means differed significantly from one another: the well-formed (WF) mean was significantly lower than the anomalous (A) mean, and the latter was significantly lower than the ill-ordered (IO) mean. Ill-ordered sequences, therefore, were most difficult to recall for all subjects, followed by anomalous and well-formed sentences. Figure 2 displays the sentence type and articulation main effect means.

Articulation x Sentence Length

There was a significant articulation x sentence length interaction ($p = 0.018$) (see Table 4). Post hoc testing was conducted on these means to determine

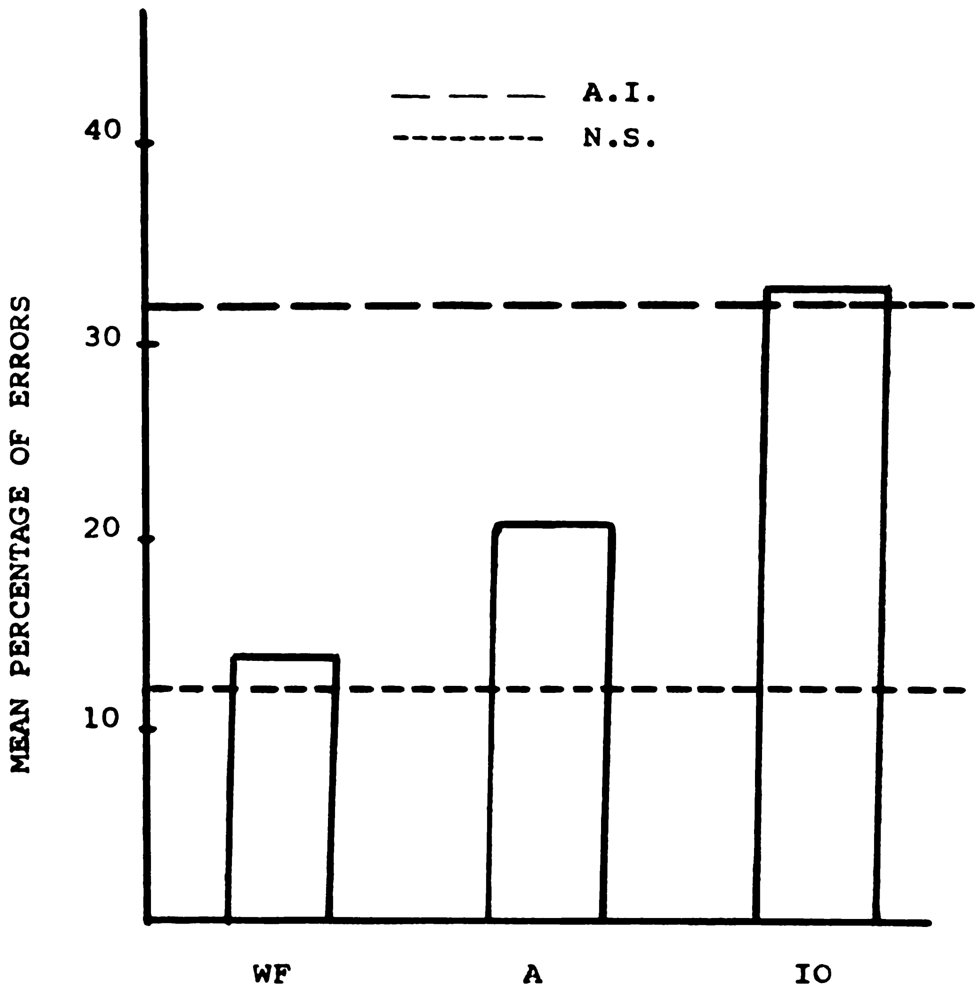


Figure 2. Functor Omission Mean Percentage Error Scores for Sentence Type (well-formed: WF, anomalous; A, ill-ordered: IO) and Articulation (normal speaking: N.S., articulatory-impaired: A.I.).

(1) which means for sentence length within an articulation group significantly differed and (2) which means at each length between the articulation groups differed. These results can be found in Table 5 and Figure 3.

Within each articulation group, the three sentence length mean error scores differed significantly from one another and the mean errors significantly increased as sentence length increased. The A.I. children were more affected by a stimulus increase from 3 to 5 words than the N.S. children as demonstrated by the dramatic increase in mean error score. However, all changes in error were significant for both articulation groups, a finding which means that every increase in length caused a significant increase in errors observed.

Between-group mean comparisons showed that the means for A.I. and N.S. subjects differed significantly at every sentence length. That is, articulatory-impaired children made significantly more functor omissions than the normal speaking subjects at every sentence length.

Sentence Type x Sentence Length

The results of this significant interaction (Table 4) are shown in Table 6 and Figures 4 and 5.

Three-word sentences of all types had the lowest error means and did not differ significantly from one another. Five-word sentences had higher error means than the three-word strings for every sentence type. Seven-word sentences were repeated with the highest

Table 5. Post Hoc Testing Results for Functor Omission Mean Error Comparisons: Articulation (normal speaking: N.S., articulatory-impaired: A.I.) by Sentence Length (three-word: 3W, five-word: 5W, seven-word: 7W).

Mean Comparisons	Significance*	
Within Group Means	N.S.	A.I.
3W vs. 5W	**	**
5W vs. 7W	**	*
3W vs. 7W	**	**
Between Group Means	N.S. vs. A.I.	
3W Means	*	
5W Means	**	
7W Means	**	

* p = 0.05
** p = 0.01

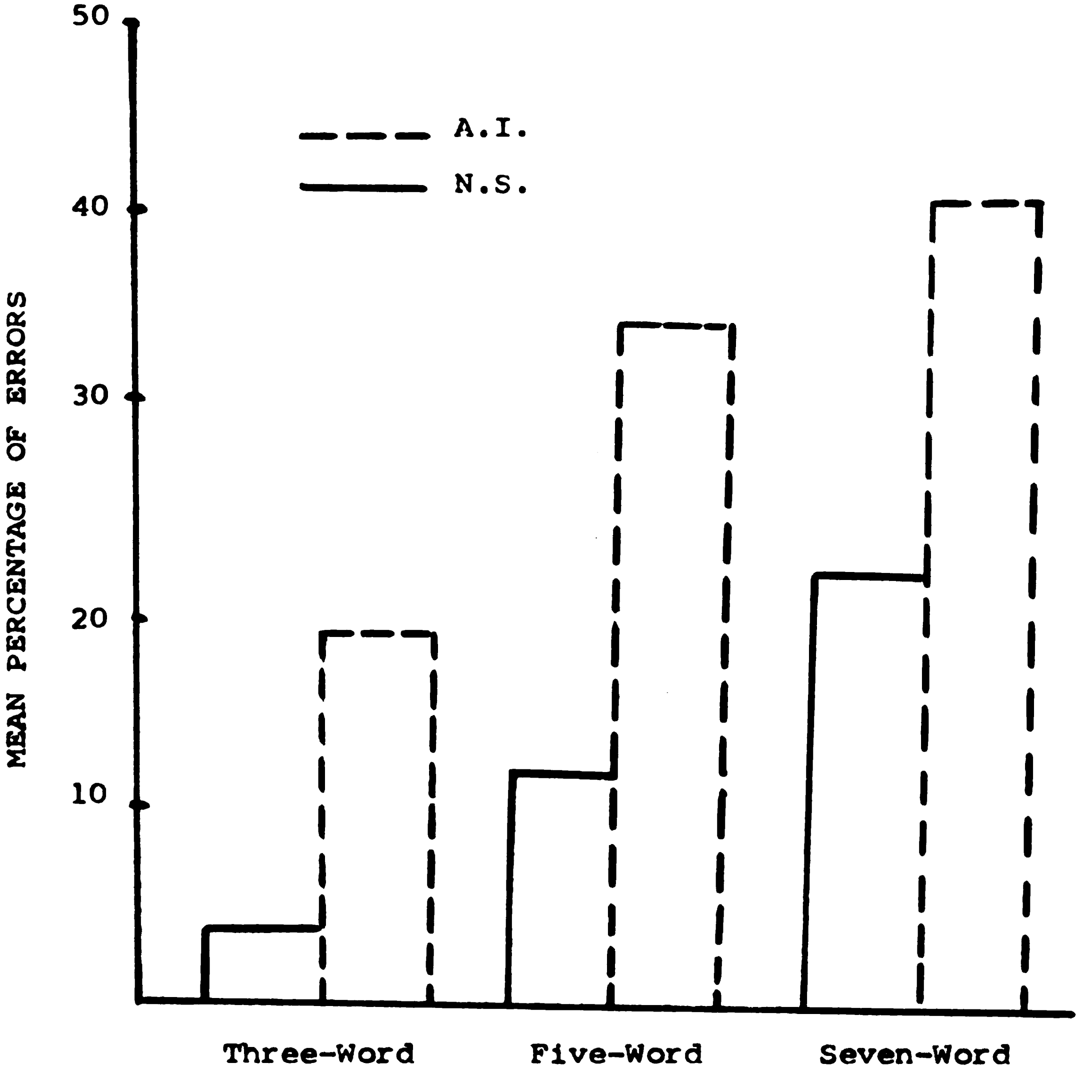


Figure 3. Functor Omission Mean Percentage Error Scores: Sentence Length (three-word, five-word, seven-word) by Articulation (normal speaking: N.S., articulatory-impaired: A.I.).

Table 6. Post Hoc Testing Results for Functor Omission Mean Error Comparisons: Sentence Type (well-formed: WF, anomalous: A, ill-ordered: IO) by Sentence Length (three-word: 3W, five-word: 5W, seven-word: 7W).

Within Sentence Type	3W vs. 5W	5W vs. 7W	3W vs. 7W
Well-Formed	n.s.	n.s.	**
Anomalous	**	n.s.	**
Ill-Ordered	**	**	**
Within Sentence Length	**WF vs. A**	**A vs. IO**	**WF vs. IO**
Three-Word	n.s.	n.s.	n.s.
Five-Word	**	n.s.	**
Seven-Word	n.s.	**	**

n.s.: not significant
** p = 0.01

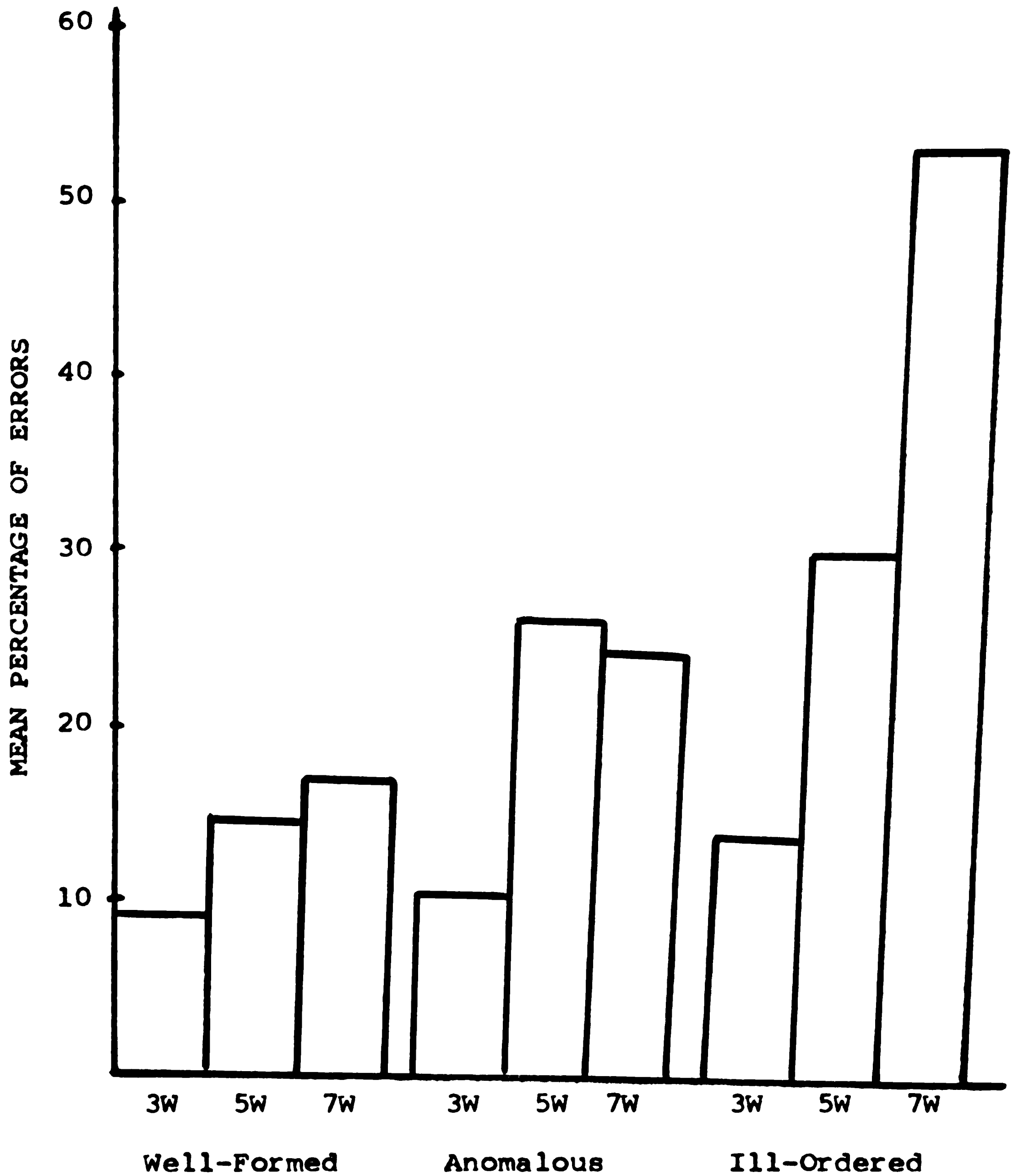


Figure 4. Functor Omission Mean Percentage Error Scores: Sentence Length (three-word: 3W, five-word: 5W, seven-word: 7W) by Sentence Type (well-formed, anomalous, ill-ordered).

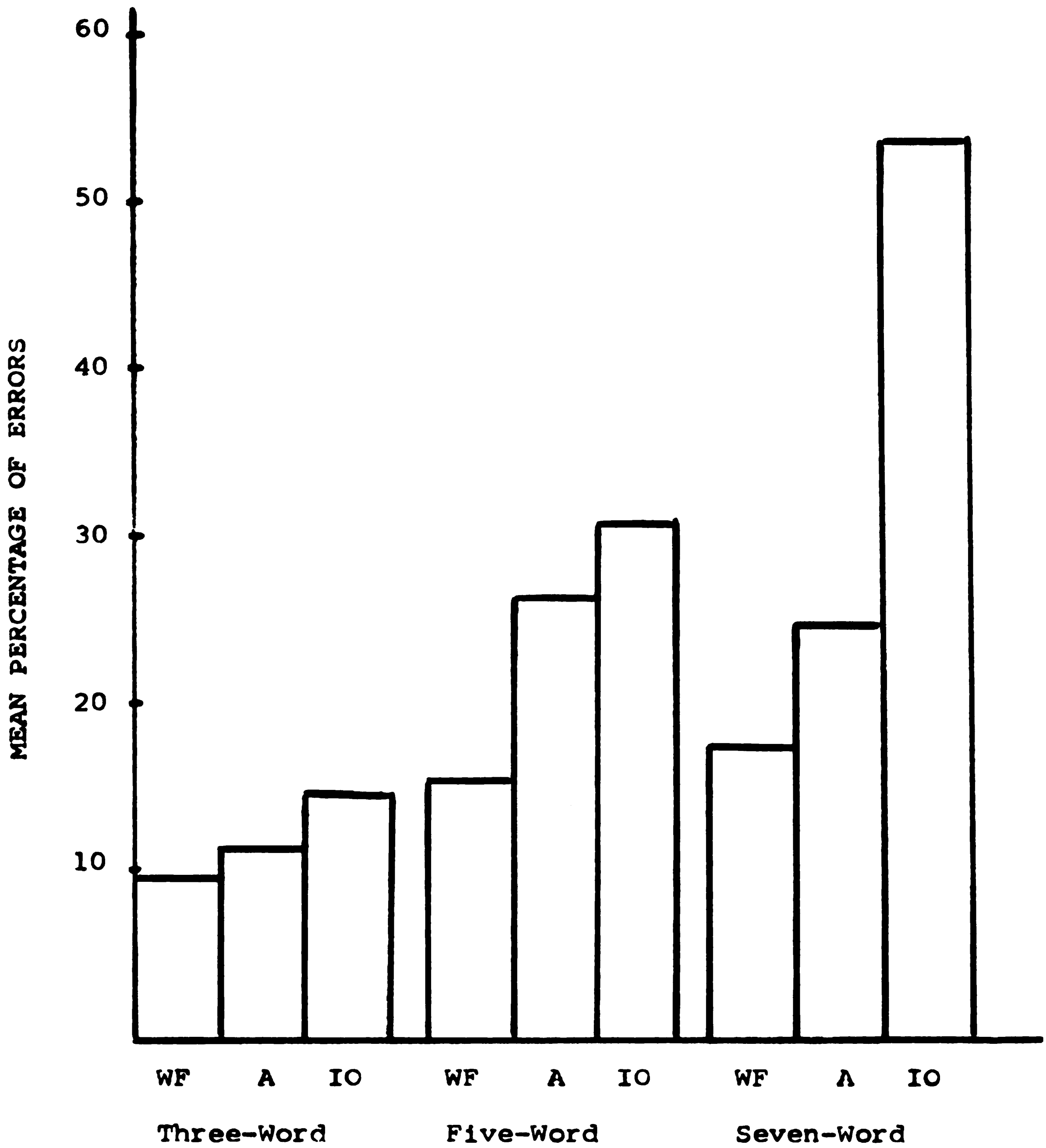


Figure 5. Functor Omission Mean Percentage Error Scores: Sentence Type (well-formed: WF, anomalous: A, ill-ordered: IO) by Sentence Length (three-word, five-word, seven-word).

number of functor omissions.

Within the WF sentence type, means were lowest for 3W strings, followed by 5W and 7W strings, although the means for the latter two did not significantly differ and only the 7W mean was significantly higher than the 3W mean. Within the anomalous sentence type, 3W strings showed the fewest number of functor omissions, followed by the errors on the 7W and 5W conditions. The 7W and 5W error means did not differ significantly from each other, but both were significantly higher than the 3W mean. Within the IO sentence type, error means significantly increased as length increased. Length, therefore, played a major role in the IO sentence type for functor omissions. As length increased from 3 to 5 words, mean percent error rose 16%; a change from 5 to 7 words brought another 23% increase in error rate. Over half of the functor words (53%) were omitted from the 7W-IO sequences. Figure 4 displays these error patterns, whereby it may be observed that within each sentence type errors increased with an increase in sentence length. However, within the WF and A sentence types, approximately equal errors occurred for 5- and 7-word strings.

Figure 5 shows the pattern of errors for sentence types within a sentence length. Maintaining sentence length as a constant, errors increased as sentence type changed from WF to A to IO. This increase was not statistically significant for 3W strings. The 5W-WF errors were significantly lower than 5W-A and 5W-IO means, which did not statistically differ from one another. The 7W-WF and 7W-A means did not statistically differ but were significantly lower than the 7W-IO mean. Briefly, summarized, when stimuli were 3 words in length, sentence type did not affect the number of functor omissions observed; all means were equally low. If a stimulus was 5 words in length, sentence type did affect the number of errors observed. Thus, loss of semantics alone, as in anomalous sequences, caused a significant increase in number of functor omissions. Loss of both semantics and syntax, as in the ill-ordered sequences, did not produce a corresponding increase in errors observed, a finding which suggests that the additional loss of syntax did not affect the subjects' recall of functor words as much as semantics. Sentence type again affected the number of errors observed when a stimulus was 7 words in length. The mean for 7-word well-formed sentences was as low as that for 3- and 5-word well-formed sentences. Loss of semantics, as in the anomalous sequences, once more caused a significant increase in functor omissions. Loss of semantics and syntax, as in the 7-word ill-ordered sequences, produced a significant increase in functor omissions, a finding which is in contrast to the pattern observed for 5-word sequences. In fact, the 7-word ill-ordered sequences were repeated by subjects with 53% of the functor words omitted.

Sentence Type x Sentence Length x Articulation

Post hoc testing was conducted on the significant three-way interaction (see Table 4) to determine (1) within each sentence type, which means for sentence lengths significantly differed in an articulation group; (2) within each sentence length, which means for sentence types differed significantly in an articulation group; and (3) between articulation groups, which means of the same type and length differed significantly. The results are shown in Table 7 and Figures 6 and 7.

Figure 7 illustrates the performance of the two groups of subjects, N.S. and A.I., with their error means for sentence lengths nested within the sentence type categories. Mean errors were low for the N.S. children for WF sentences of every length and, as shown in Table 7-A, did not statistically differ from one another. The A.I. group had higher mean errors in WF sentences, but these values were not significantly different from those of the N.S. children (Table 7). However, the A.I. group means differed from each other. The 3W-WF mean differed significantly from both 5W- and 7W-WF means, the latter two being higher but not differing from each other. This suggests that A.I. subjects have more difficulty repeating WF sentences in their entirety than N.S. children. Articulatory-impaired children made more errors as sentence length increased, whereas length did not significantly affect the responses of normal speakers to WF stimuli.

Table 7. Post Hoc Testing Results for Functor Omission Mean Error Comparisons: Sentence Type (well-formed: WF, anomalous: A, ill-ordered: IO) by Sentence Length (three-word: 3W, five-word: 5W, seven-word: 7W) by Articulation (normal speaking: N.S., articulatory-impaired: A.I.).

Within Sentence Type	3W vs. 5W		5W vs. 7W		3W vs. 7W	
	N.S.	A.I.	N.S.	A.I.	N.S.	A.I.
Well-Formed	n.s.	*	n.s.	n.s.	n.s.	**
Anomalous	**	**	n.s.	n.s.	n.s.	**
Ill-Ordered	*	**	**	**	**	**

Within Sentence Length	WF vs. A		A vs. IO		WF vs. IO	
	N.S.	A.I.	N.S.	A.I.	N.S.	A.I.
Three-Word	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Five-Word	n.s.	*	n.s.	n.s.	**	**
Seven-Word	n.s.	n.s.	**	**	**	**

Between Articulation Groups

Three-Word Well-Formed Means:	n.s.
Three-Word Anomalous Means:	n.s.
Three-Word Ill-Ordered Means:	n.s.
Five-Word Well-Formed Means:	*
Five-Word Anomalous Means:	*
Five-Word Ill-Ordered Means:	*
Seven-Word Well-Formed Means:	*
Seven-Word Anomalous Means:	*
Seven-Word Ill-Ordered Means:	n.s.

n.s.: not significant
* p = 0.05
** p = 0.01

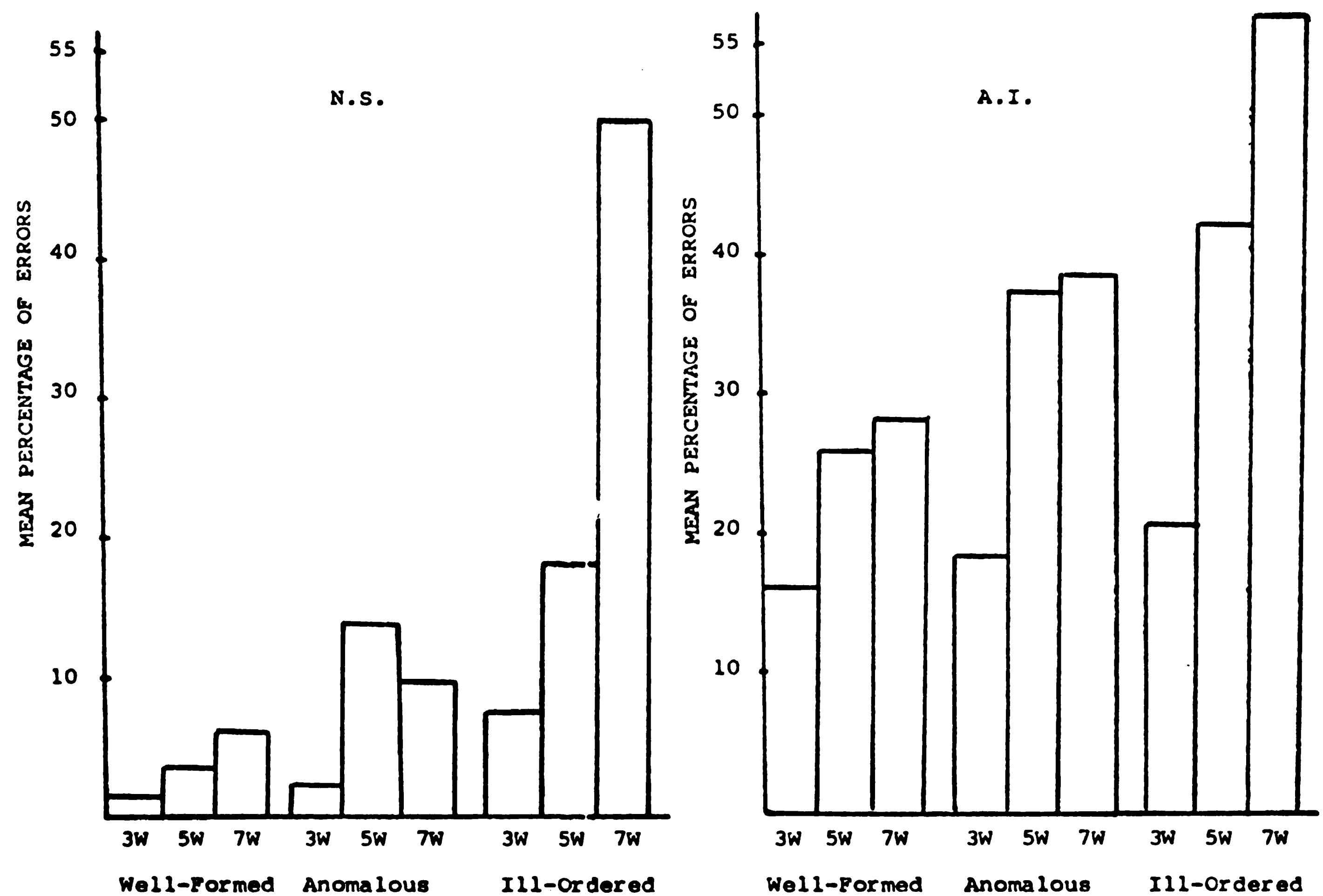


Figure 6. Functor Omission Mean Percentage Error Scores: Sentence Length (three-word: 3W, five-word: 5W, seven-word: 7W) by Sentence Type (well-formed, anomalous, ill-ordered) by Articulation (normal speaking: N.S., articulatory-impaired: A.I.).

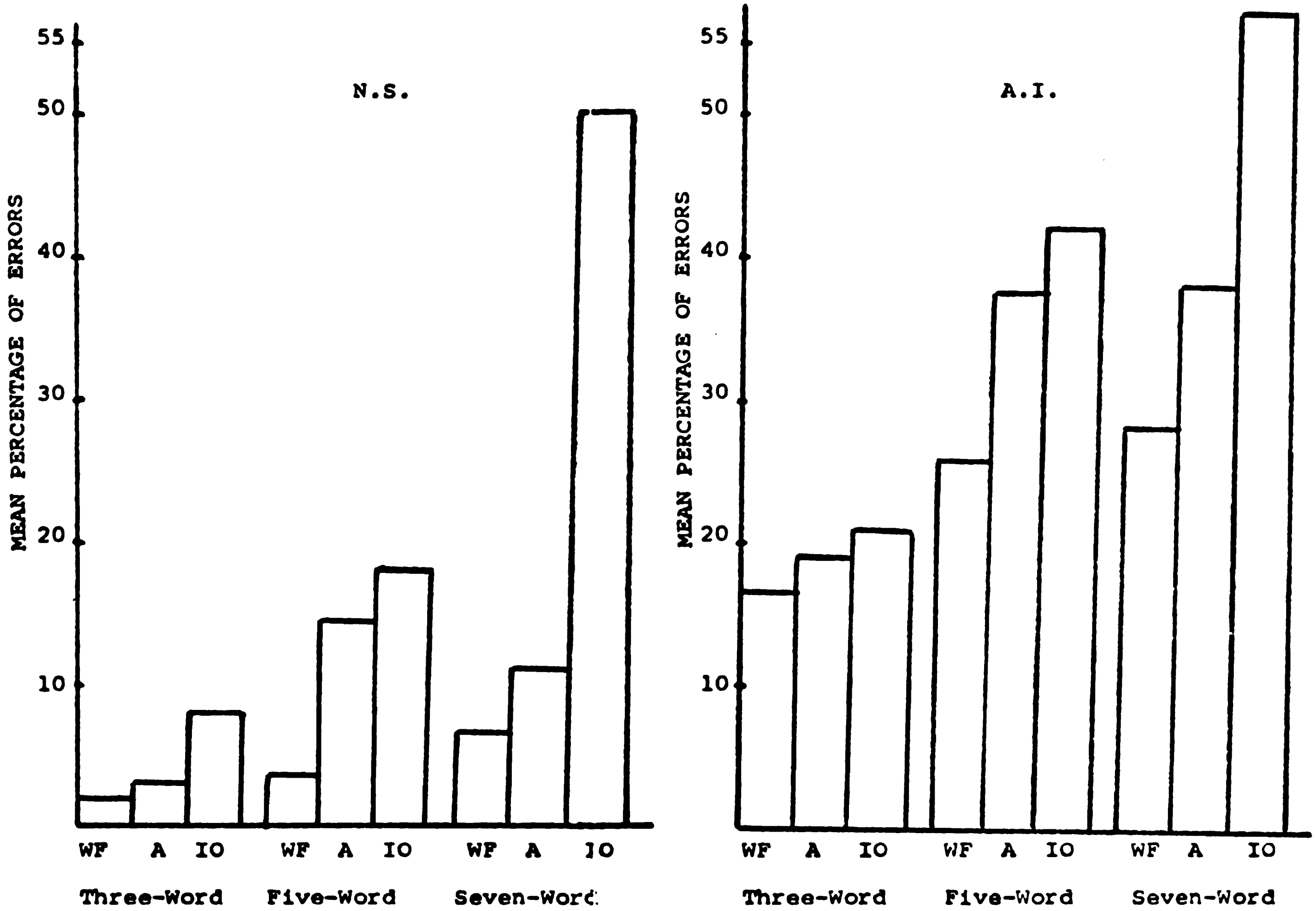


Figure 7. Functor Omission Mean Percent Error Scores: Sentence Type (well-formed: WF, anomalous: A, ill-ordered: IO) by Sentence Length (three-word, five-word, seven-word) by Articulation (normal speaking: N.S., articulatory-impaired: A.I.).

In the anomalous sentence category, 3W strings again showed the lowest mean percent error for both groups of subjects. For the two articulation groups, a significant increase in functor omissions occurred when length increased to 5 words. However, means for 5W and 7W anomalous sentences did not significantly differ; that is, a further increase in length from 5 to 7 words did not cause a corresponding increase in functor omissions. The A.I. children made significantly more functor omissions than N.S. children at each sentence length in the anomalous category, a finding which suggests that their use of such syntactic cues was less effective.

The IO sentence category provided a different error pattern. Means for each articulation group increased significantly as sentence length increased. The A.I. children made significantly more functor omissions than the N.S. children for 3W- and 5W-IO strings. However, mean error scores for 7W-IO repetitions were the highest for both groups and did not significantly differ from one another. Both means approached or crossed the 50% omission point. Therefore, both articulation groups had equal difficulty recalling functor words when the stimulus was 7 items in length and ill-ordered in sentence type.

Figure 7 presents the error means grouped by sentence types within sentence length. Table 7 explains which means were found to be statistically different.

In both the N.S. and A.I. groups, no means of sentence types within the 3W length differed significantly. Of the

5W strings, the two groups again showed similar error patterns. Errors increased as the type changed from WF to A to IO, and again, the N.S. group had lower error means than the A.I. group. In the N.S. group, the 5W-WF mean was significantly different only from the 5W-IO mean. For the A.I. group, the 5W-WF mean differed significantly from both the 5W-A and -IO means. For the A.I. group at the 5W level, removal of semantic structure caused a shift in errors; removal of syntax had a lesser impact since the means for A and IO strings did not significantly differ in either articulation group. Since the N.S. group's mean for 5W-WF and 5W-A did not significantly differ even though an increase in error scores was observed, it is possible that normal speakers used the remaining syntactic cues in the anomalous sentences to better advantage than the A.I. group, whose means for 5W-WF and A did differ.

The 7W-string error pattern was similar for both articulation groups. Mean percentage of errors increased as sentence type changed from WF to A to IO. In both groups, the 7W-WF mean did not differ from the 7W-A mean.

Finally, the two groups' means were compared for each of the nine sentence type x sentence length categories using the Tukey test. The results are shown on Table 7. The values of these means can be found on Table 4. The means for 3W sentence types did not significantly differ even though the A.I. subjects' means were higher. All means for 5W sentences of each type were found to differ at $p = 0.05$. The means for

7W-WF and 7W-A of the two groups also differed at $p = 0.05$. The 7W-IO means, however, were not significantly different. Thus, both groups found 7W-IO strings equally difficult to repeat, a finding which supports the assumption of equal memory spans among the subjects used in the study, regardless of articulation proficiency. Therefore, whatever recall processing strategy(ies) was used by the normal speaking children which helped them perform significantly better than the articulatory-impaired children was something other than automatic memory span ability. The language structure cues present in the other sentence type categories deserve consideration.

The fact that N.S. and A.I. children made similar numbers of errors on 3W- and 7W-IO sequences but made significantly different numbers of errors on 5W-IO sequences further indicates a difference in the two groups' processing strategies. This difference in processing of verbal material again reflects, as suggested above, an existing language problem in articulatory-impaired children.

3. <u>Contentive Omissions</u>

The analysis of variance table for this dependent variable's relationship to articulation, sentence type and sentence length factors is summarized in Table 8.

All main effects were significant, indicating that articulation proficiency, sentence type, and sentence length had an effect on the occurrence of contentive

Table 8. Results of ANOVA for Contentive Omission Errors.

Source	df	Mean Square	Significance*
Articulation (A)	38	130.224	$p = 0.004$
Sentence Type (ST)	2	4961.229	$p < 0.0005$
Sentence Length (SL)	2	8790.389	$p < 0.0005$
A x ST	2	156.342	n.s.
A x SL	2	431.012	$p = 0.001$
ST x SL	4	3849.038	$p < 0.0005$
A x ST x SL	4	88.778	n.s.

n.s.: not significant

omissions. The interactions of Articulation by Sentence Length and Sentence Type by Sentence Length were significant and will be discussed below; Articulation by Sentence Type and Articulation by Sentence Type by Sentence Length were not found to be significant interactions. Table 9 contains the mean values for contentive omission errors for the various interactions.

Articulation x Sentence Length

The articulation groups differed in their responses to the three sentence lengths. Viewing the mean error values from the second section of Table 9, one can see that contentive omissions were less frequent for both articulation groups for 3- and 5-word sentences but increased for 7-word sentences. The A.I. group has higher means overall, but their error mean increased to

Table 9. Mean Percent Error Scores for Contentive Omissions for the Factors of Sentence Type (well-formed: WF, anomalous: A, ill-ordered: IO), Sentence Length (three-word: 3W, five-word: 5W, seven-word: 7W), and Articulation (normal speaking: N.S., articulatory-impaired: A.I.).

Articulation x Sentence Type: not significant

	WF	A	IO	Overall Mean
N.S.	2.8	2.4	12.3	5.9
A.I.	3.9	6.8	17.8	9.5
Overall Mean	3.3	4.6	15.1	

Articulation x Sentence Length: significant

	3W	5W	7W	Overall Mean
N.S.	2.1	1.9	13.5	5.9
A.I.	3.5	3.4	21.5	9.5
Overall Mean	2.8	2.7	17.5	

Sentence Type x Sentence Length: significant

	3W	5W	7W	Overall Mean
WF	3.5	1.4	5.1	3.3
A	2.5	1.5	9.8	4.6
IO	2.3	5.1	37.7	15.1
Overall Mean	2.8	2.7	17.5	

Articulation x Sentence Type x Sentence Length: not sign.

	3W		5W		7W		Overall Mean	
	N.S.	A.I.	N.S.	A.I.	N.S.	A.I.	N.S.	A.I.
WF	3.7	3.3	0.8	1.9	3.8	6.3	2.8	3.9
A	1.7	3.3	0.0	3.1	5.7	14.0	2.4	6.8
IO	0.8	3.7	5.0	5.3	31.2	44.3	12.3	17.8
Overall Mean	2.1	3.5	1.9	3.4	13.5	21.5		

a greater extent than the N.S. group for the 7W sentences (see Figure 8).

Post hoc testing was conducted on these means for within- and between-group mean comparisons. Results are presented in Table 10.

Error means for 3W and 5W sentences did not significantly differ within or between articulation groups. Both groups made significantly more contentive omissions in 7W-string repetitions. The 7W-error mean for the A.I. children was significantly higher than the 7W-mean error score of the N.S. children.

This error pattern differs from the way in which sentence length affected functor omissions, where both groups' mean scores increased significantly as length increased and the means differed significantly at each sentence length. Both groups recall contentives better than functors at every sentence length. As was the case for functor omissions, most errors occurred for both articulation groups for 7W strings, indicating again that the 7W-item stimulus affected the retention abilities of both articulation groups.

<u>Sentence Type x Sentence Length</u>

This was significant at $p < 0.0005$ and the means are shown on Table 9. Figure 9 displays the subjects' error means for each sentence type within a sentence length, and Figure 10 shows means for sentence lengths within a sentence type. Post hoc testing of the means provided

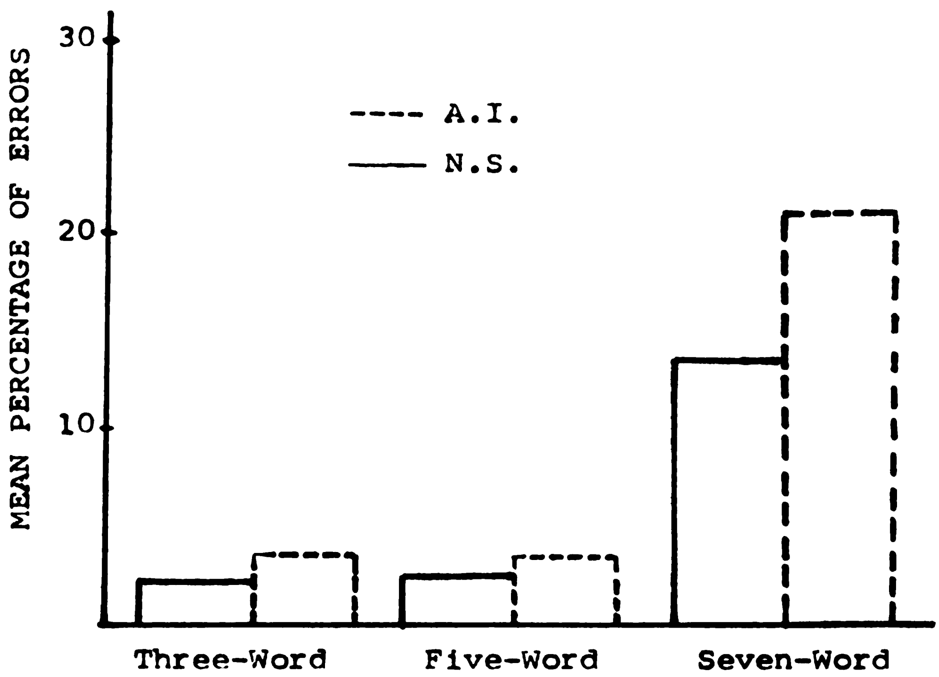


Figure 8. Contentive Omission Mean Percent Error Scores: Sentence Length (three-word, five-word, seven-word) by Articulation (normal speaking: N.S., articulatory-impaired: A.I.).

Table 10. Post Hoc Testing Results for Contentive Omission Mean Error Comparisons: Sentence Length (three-word, five-word, seven-word) by Articulation (normal speaking: N.S., articulatory-impaired: A.I.).

Mean Pairs Within Articulation Groups	N.S.	A.I.
3W vs. 5W	n.s.	n.s.
5W vs. 7W	**	**
3W vs. 7W	**	**
Mean Pairs Across Articulation Groups	**N.S. vs. A.I.**	
3W Means	n.s.	
5W Means	n.s.	
7W Means	**	

n.s.: not significant
** p = 0.01

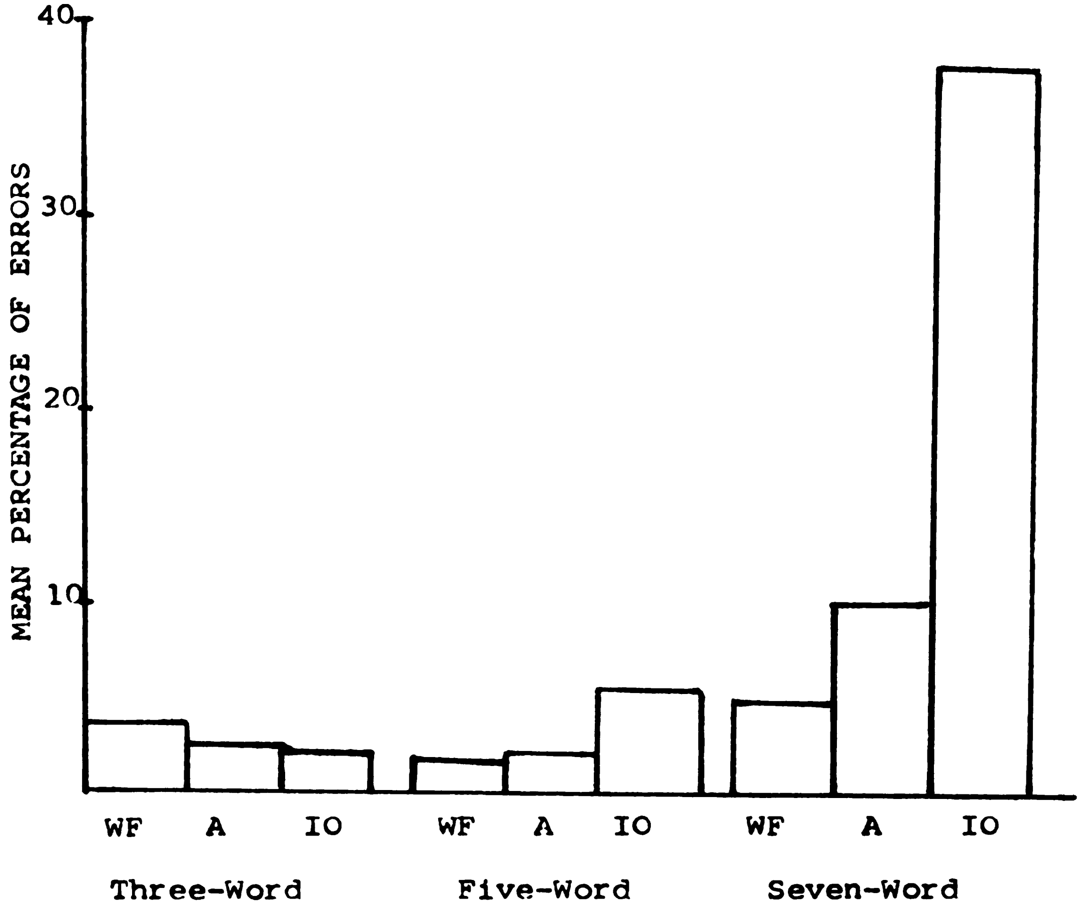


Figure 9. Contentive Omission Mean Percent Error Scores: Sentence Type (well-formed: WF, anomalous: A, ill-ordered: IO) by Sentence Length (three-word, five-word, seven-word).

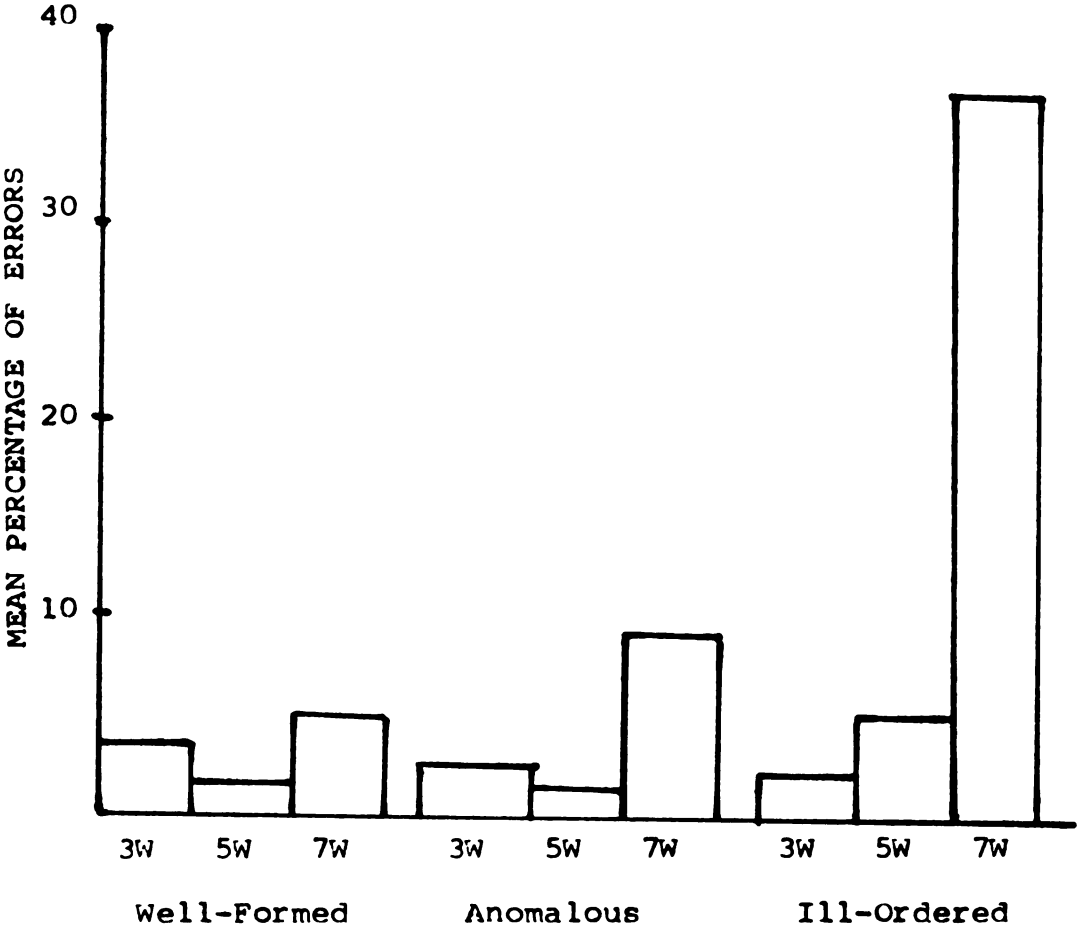


Figure 10. Contentive Omission Mean Percent Error Scores: Sentence Length (three-word: 3W, five-word: 5W, seven-word: 7W) by Sentence Type (well-formed, anomalous, ill-ordered).

the results in Table 11.

The means of all sentence types within the 3W and 5W sentence length categories did not differ significantly from one another; all error means were low. In contrast, the means of all sentence types in the 7W category differed significantly from one another. Therefore, when children had to repeat sentences of 7 words in length, the factor of sentence type became important. Well-formed sentences were easiest to recall, followed by anomalous and ill-ordered sentences. In other words, as language information was gradually removed, repetitions became less complete for all subjects, regardless of their articulation proficiency.

As shown in Table 11 and Figure 10, the length of the stimulus sequence did not have any effect on well-formed sequences. For the anomalous and ill-ordered sentence types, 3W and 5W sentences were repeated with relatively few contentive omission errors. However, 7W-A and 7W-IO sequences were repeated with significantly more contentive omissions. Length, therefore, affected the responses for these two sentence types. The combination of the loss of semantic and syntactic structure plus the increase in stimulus length to 7 items brought about a 40% loss of the contentive words in ill-ordered sequences.

4. Functor Substitutions

Substitutions occurred less often than omissions. A summary of the analysis of variance table for the

Table 11. Post Hoc Testing Results for Contentive Omission Mean Error Comparisons: Sentence Type (well-formed: WF, anomalous: A, ill-ordered: IO) by Sentence Length (three-word: 3W, five-word: 5W, seven-word: 7W).

Sentence Type Means	3W	5W	7W
WF vs. A	n.s.	n.s.	*
A vs. IO	n.s.	n.s.	**
WF vs. IO	n.s.	n.s.	**
Sentence Length Means	**WF**	**A**	**IO**
3W vs. 5W	n.s.	n.s.	n.s.
5W vs. 7W	n.s.	**	**
3W vs. 7W	n.s.	**	**

n.s.: not significant
* $p = 0.05$
** $p = 0.01$

dependent variable is shown in Table 12. Mean values for this error type are shown in Table 13.

Table 12. Results of the ANOVA for Functor Substitutions.

Source of Variance	df	Mean Square	Significance*
Articulation (A)	38	314.778	$p < 0.0005$
Sentence Type (ST)	2	715.542	$p < 0.0005$
Sentence Length (SL)	2	1313.705	$p < 0.0005$
A x ST	2	217.779	$p = 0.035$
A x SL	2	186.588	$p = 0.049$
ST x SL	4	449.619	$p < 0.0005$
A x ST x SL	4	134.718	n.s.

n.s.: not significant

All main effects and two-way interactions were significant; the one three-way interaction was not significant. Again, by discussing the interactions which were significant, it will be possible to determine how the main factors affected the subjects' performance with respect to functor substitutions.

Articulation x Sentence Type

The two articulation groups' performance varied with respect to the factor of sentence type. The mean error scores for the subject groups are shown in Table 13 and Figure 11. Table 14 shows the results of the post hoc testing.

Table 13. Mean Percent Error Scores for Functor Substitutions for the Factors of Sentence Type (well-formed: WF, anomalous: A, ill-ordered: IO), Sentence Length (three-word: 3W, five-word: 5W, seven-word: 7W), and Articulation (normal speaking: N.S., articulatory-impaired: A.I.).

Articulation x Sentence Type: significant

	WF	A	IO	Overall Mean
N.S.	1.7	6.5	5.1	4.4
A.I.	11.5	15.9	10.1	12.5
Overall Mean	6.6	11.2	7.6	

Articulation x Sentence Length: significant

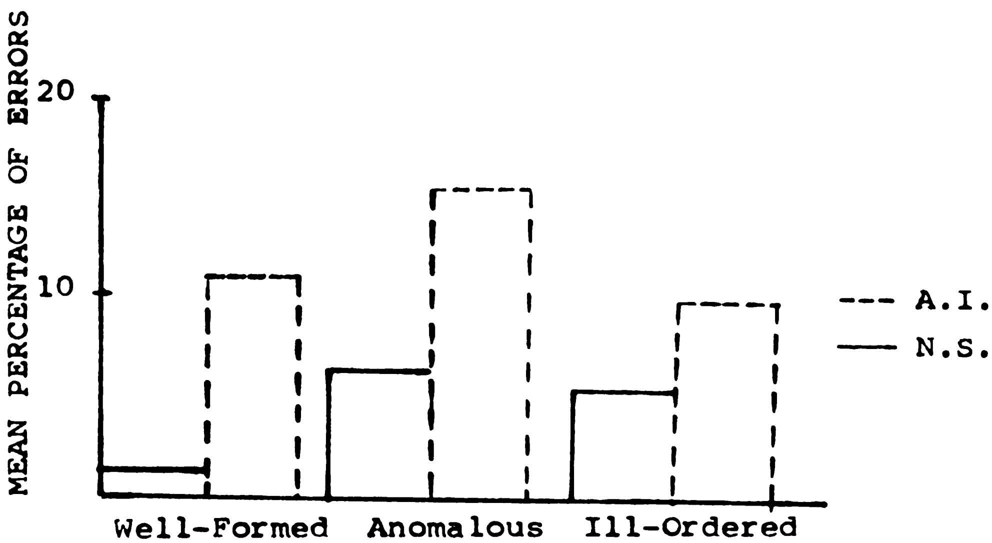
	3W	5W	7W	Overall Mean
N.S.	0.8	6.9	5.5	4.4
A.I.	9.9	16.9	10.8	12.5
Overall Mean	5.3	11.9	8.2	

Sentence Type x Sentence Length: significant

	3W	5W	7W	Overall Mean
WF	4.6	8.5	6.7	6.6
A	4.6	18.7	10.4	11.2
IO	6.9	8.5	7.5	7.6
Overall Mean	5.3	11.9	8.2	

Articulation x Sentence Type x Sentence Length: not sign.

	3W		5W		7W		Overall Mean	
	N.S.	A.I.	N.S.	A.I.	N.S.	A.I.	N.S.	A.I.
WF	0.8	8.3	2.5	14.6	1.7	11.7	1.7	11.5
A	0.0	9.2	12.5	25.0	7.1	13.7	6.5	15.9
IO	1.7	12.1	5.8	11.2	7.9	7.1	5.1	10.1
Overall Mean	0.8	9.9	6.9	16.9	5.5	10.8		



Fiqure 11. Functor Substitution Mean Percent Error Scores: Sentence Type (well-formed, anomalous, ill-ordered) by Articulation (normal speaking: N.S., articulatory-impaired: A.I.).

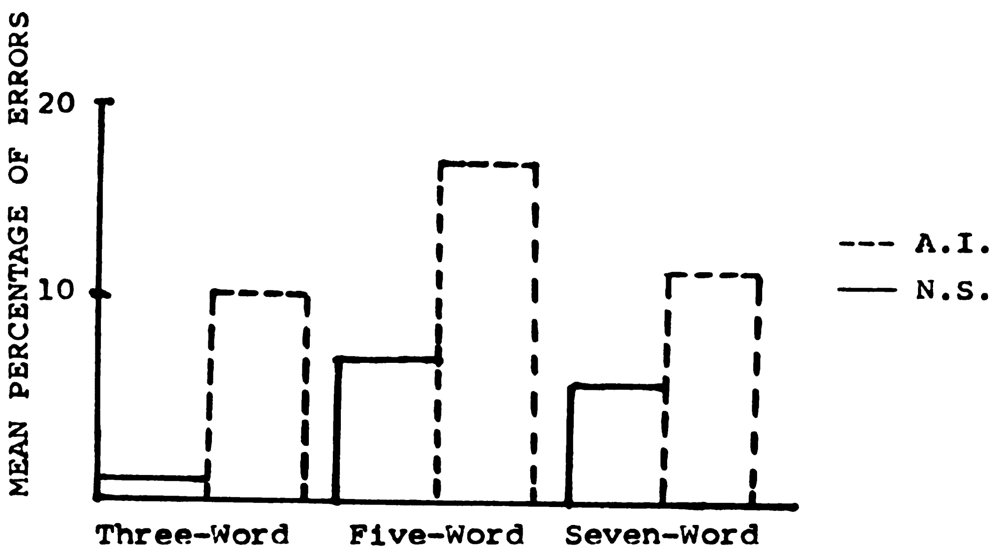


Figure 12. Functor Substitution Mean Percent Error Scores: Sentence Length (three-word, five-word, seven-word) by Articulation (normal speaking: N.S., articulatory-impaired: A.I.).

Table 14. Post Hoc Testing Results for Functor Substitution Mean Error Comparisons: Sentence Type (well-formed: WF, anomalous: A, ill-ordered: IO) by Articulation (normal speaking: N.S., articulatory-impaired: A.I.).

Sentence Types	N.S.	A.I.*
WF vs. A	**	**
A vs. IO	n.s.	**
WF vs. IO	*	n.s.
	N.S. vs. A.I.	
WF Means	**	
A Means	**	
IO Means	n.s.	

* p = 0.05
** p = 0.01
n.s.: not significant

The anomalous sentence type contained the most functor substitutions for both the N.S. and A.I. subjects, as can be seen in Figure 11. The anomalous mean for the A.I. children was significantly higher than the WF and IO means, whereas the WF and IO means did not differ from one another. In contrast, the N.S. subjects' means for A and IO sentences did not significantly differ.

For both groups of subjects, loss of semantic sense caused an increase in functor substitutions. Loss of sentence structure and semantic sense together brought the mean percentage of error back down to the WF level for the A.I. children. Therefore, the A.I. children treated IO sentences differently from the A sentences and, perhaps, processed IO sequences in a manner similar to WF sentences. Since errors were similar for WF and IO sequences, A.I. children demonstrated poorer language processing abilities than the N.S. children.

The following are some examples of functor substitutions that were observed:

1) Stimulus: Her big brother sings his black shoe.
   Response: My brother wears some shoes (and what)?
2) Stimulus: Her bike eats an apple.
   Response: Her bike eats up apple.
3) Stimulus: His sister bakes a book.
   Response: Her sister bakes a book.

Other substitutions included: a/an, a/the, his/the, his/her, and a/her. In 1) above, the repetition changed the type of sentence from anomalous to well-formed. The first possessive pronoun was simply changed to another possessive pronoun. The second substitution, some/his, changed a possessive pronoun to an adjective. The change is not readily explained; it may be due, in part, to the change in verb from sings to wears. In 2) above, up/an was possibly due to an effect of coarticulation. The /n/ in an might not have been perceived and the vowel in an became mixed with the vowel in apple. The p of apple helped form the word up. In 3) above, her/his occurred. This was a common substitution as well as his/her. It is possible that, for these children, such pronouns may be interchangeable. It is also possible that these substitutions were made more often by one sex than another, i.e., more male subjects than female subjects. This should be investigated in future research.

Referring again to Table 14, the two subject groups showed significantly different means for WF and A sentences but not for IO strings. In other words, sentences in which some language structure was present, either semantic or syntactic, were repeated by the N.S. children with significantly fewer functor substitutions than were observed in the responses of A.I. subjects. Ill-ordered sentences, however, were repeated by all subjects with a similar number of functor substitutions.

Articulation x Sentence Length

The two subject groups performed differently with respect to the factor of sentence length. Actual mean error values are shown on Table 13 and Figure 12. Post hoc testing was conducted on these scores and results are given in Table 15. Both articulation groups produced the most functor substitutions in 5W sentences, followed by 7W sentences. The fewest number of errors occurred in 3W sentences, although for A.I. subjects, the difference between the 3W and 7W means was not statistically different. The N.S. group produced similar numbers of substitutions for 5W and 7W sentences. The A.I. subjects produced significantly more functor substitutions than N.S. subjects for 3W and 5W sentences. Seven-word sentences were repeated by the subject groups with

Table 15. Post Hoc Testing Results for Functor Substitution Mean Error Comparisons: Sentence Length (three-word: 3W, five-word: 5W, seven-word: 7W) by Articulation (normal speaking: N.S., articulatory-impaired: A.I.).

Sentence Lengths	N.S.	A.I.*
3W vs. 5W	**	**
5W vs. 7W	n.s.	**
3W vs. 7W	**	n.s.
	N.S. vs. A.I.	
3W Mean Pairs	**	
5W Mean Pairs	**	
7W Mean Pairs	n.s.	

n.s.: not significant
** p = 0.01

relatively equal numbers of errors.

Sentence Type x Sentence Length

Figures 13 and 14 group the subjects' error means according to sentence type and sentence length, respectively. Figure 13 shows that most functor substitutions occurred in 5W anomalous sentences, followed by 7W anomalous sentences. The other means were fairly close with the fewest number of errors occurring in 3W anomalous sequences. Table 16 shows the post hoc testing results.

No error means differed significantly in WF and IO sentences of all lengths. Functor substitutions occurred most often in 5W and 7W anomalous sentences. All anomalous means differed significantly from one another.

In terms of length as a factor, the means for 3W sentences and 7W sentences of all types were not significantly different. Five-word sentences had the highest means for every sentence type. Five-word WF and IO means did not differ; both were significantly lower than the 5W anomalous mean.

5. Contentive Substitutions

The ANOVA table for this error type is shown in Table 17. The main factors of articulation and sentence length were significant, whereas sentence type was not. Therefore, articulation groups varied with respect to contentive substitutions for the 3 sentence lengths. Since the factor of sentence type was not significant, the type of stimulus had little independent effect on the retention of

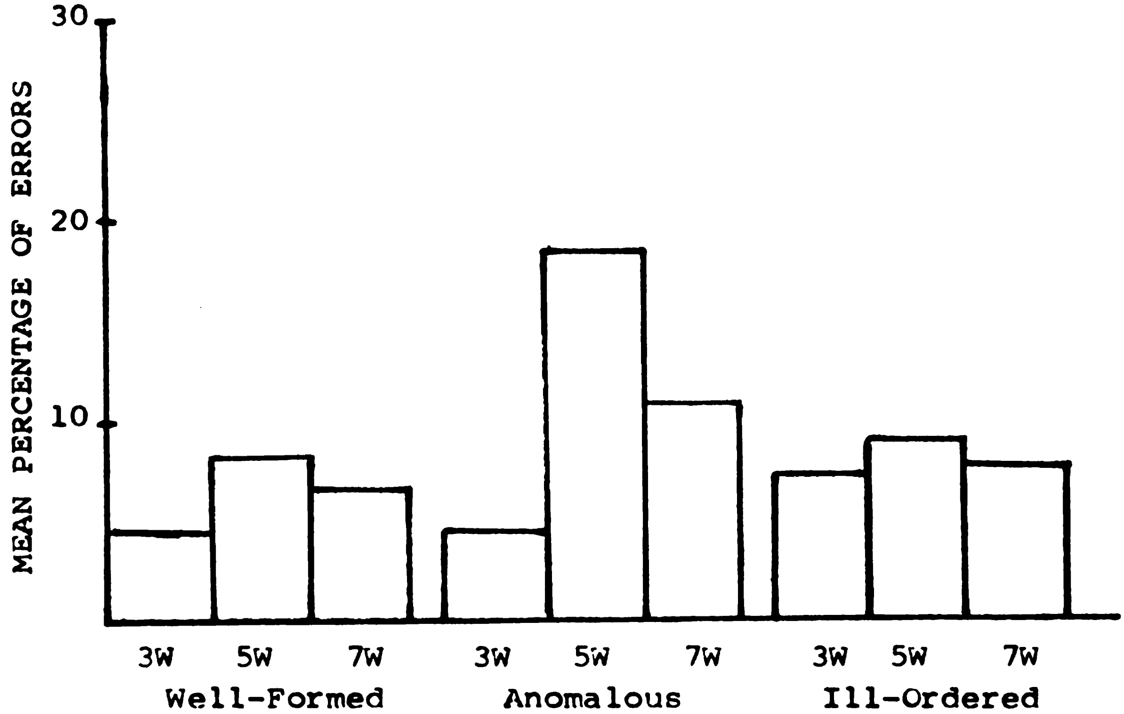


Figure 13. Functor Substitution Mean Percent Error Scores: Sentence Length (three-word: 3W, five-word: 5W, seven-word: 7W) by Sentence Type (well-formed, anomalous, ill-ordered).

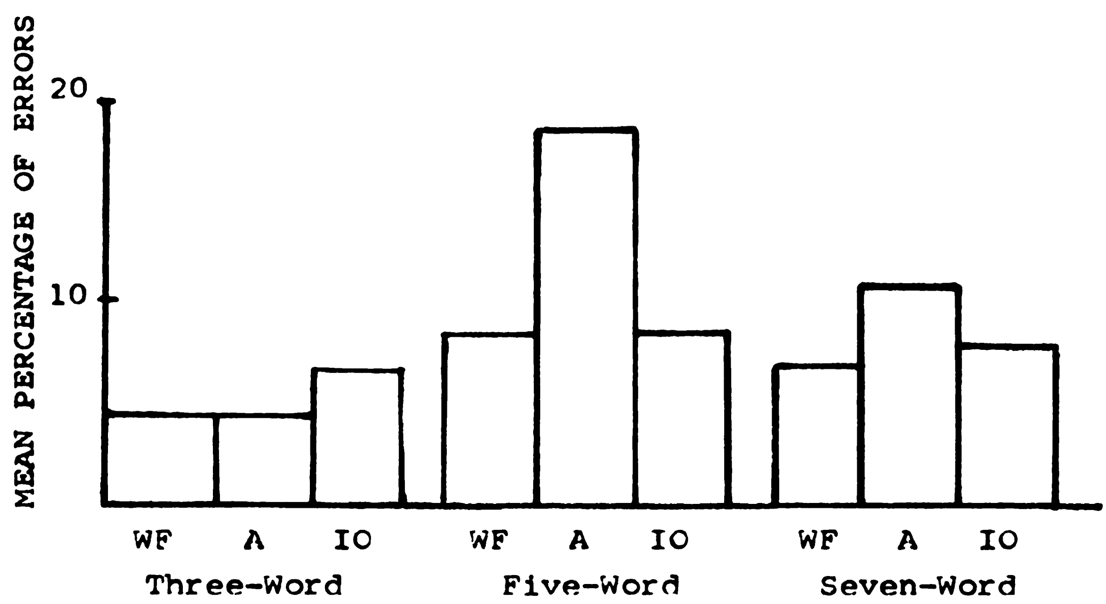


Figure 14. Functor Substitution Mean Percent Error Scores: Sentence Type (well-formed: WF, anomalous: A, ill-ordered: IO) by Sentence Length (three-word, five-word, seven-word).

Table 16. Post Hoc Testing Results for Functor Substitution Mean Error Comparisons: Sentence Length (three-word, five-word, seven-word) by Sentence Type (well-formed, anomalous, ill-ordered).

Within Sentence Type	Means Tested*		
	3W vs. 5W	5W vs. 7W	3W vs. 7W
1. Well-Formed	n.s.	n.s.	n.s.
2. Anomalous	**	**	**
3. Ill-Ordered	n.s.	n.s.	n.s.

Within Sentence Length	Means Tested		
	WF vs. A	A vs. IO	WF vs. IO
1. Three-Word	n.s.	n.s.	n.s.
2. Five-Word	**	**	n.s.
3. Seven-Word	n.s.	n.s.	n.s.

n.s.: not significant
** $p = 0.01$

Table 17. Results of the ANOVA for Contentive Substitutions.

Source of Variance	df	Mean Square	Significance*
Articulation (A)	38	16.647	$p = 0.05$
Sentence Type (ST)	2	3.963	n.s.
Sentence Length (SL)	2	95.569	$p < 0.0005$
A x ST	2	4.683	n.s.
A x SL	2	17.685	n.s.
ST x SL	4	90.189	$p < 0.0005$
A x ST x SL	4	17.692	n.s.

n.s.: not significant

the original contentive words. The significant interaction will be discussed. Mean error scores are provided on Table 18.

Articulation

Articulation was a significant main factor, indicating that the two groups of subjects differed in performance with respect to contentive substitutions. The articulation means, 1.7% and 2.6%, were found to be significantly different, with the articulatory-impaired children making more contentive substitution errors.

Sentence Length

The main effect means for sentence length were tested for significant differences. The means for 3W and 5W sentences, 1.9% and 1.3% respectively, were significantly

Table 18. Mean Percent Error Scores for Contentive Substitutions for the Factors of Sentence Type (well-formed: WF, anomalous: A, ill-ordered: IO), Sentence Length (three-word: 3W, five-word: 5W, seven-word: 7W), and Articulation (normal speaking: N.S., articulatory-impaired: A.I.).

Articulation x Sentence Type: not significant

	WF	A	IO	Overall Mean
N.S.	1.6	1.7	1.8	1.7
A.I.	2.5	2.9	2.2	2.6
Overall Mean	2.0	2.3	2.0	

Articulation x Sentence Length: not significant

	3W	5W	7W	Overall Mean
N.S.	1.9	0.8	2.4	1.7
A.I.	1.9	1.9	3.8	2.6
Overall Mean	1.9	1.3	3.1	

Sentence Type x Sentence Length: significant

	3W	5W	7W	Overall Mean
WF	3.3	0.7	2.1	2.0
A	1.4	0.8	4.7	2.3
IO	1.0	2.5	2.5	2.0
Overall Mean	1.9	1.3	3.1	

Articulation x Sentence Type x Sentence Length: not sign.

	3W		5W		7W		Overall Mean	
	N.S.	A.I.	N.S.	A.I.	N.S.	A.I.	N.S.	A.I.
WF	3.7	2.9	0.0	1.4	0.9	3.2	1.6	2.5
A	1.7	1.2	0.0	1.7	3.5	5.9	1.7	2.9
IO	0.4	1.7	2.3	2.8	2.7	2.3	1.8	2.2
Overall Mean	1.9	1.9	0.8	1.9	2.4	3.8		

lower than the mean for 7W sequences (3.1%). Percentage error scores for contentive substitutions were low; however, the A.I. group produced more errors on the average, and all subjects tended to produce more contentive substitutions when the stimulus was 7 items in length.

Sentence Type x Sentence Length

Post hoc testing was performed to compare means of sentence types and sentence lengths. Results of the testing are shown on Table 19.

Most contentive substitutions occurred in 7W anomalous sentences, followed by 3W well-formed and 5W anomalous. As may be recalled, functor substitutions occurred primarily in 5W anomalous sentences. It can be stated with some confidence, therefore, that substitutions were brought out by the anomalous sentence type when the stimulus was 5 or more words in length.

6. Reversals

A reversal is a change of word position during the repetition of a stimulus. For example, if the stimulus sentence was "A girl pulled the pretty toy," and the subject's repetition was "The pretty girl pulled a toy," reversals have occurred. For analysis of reversal errors, two categories were established: 1-2 word reversals (category I) or 3+ (category II), wherein 3 or more words have changed position. An arbitrary weight of 1.5 was given to category I and 3.5 given to category II. The number of times either category was observed in a

Table 19. Post Hoc Testing Results for Contentive Substitution Mean Error Comparisons: Sentence Type (well-formed: WF, anomalous: A, ill-ordered: IO) by Sentence Length (three-word: 3W, five-word: 5W, seven-word: 7W).

Within Sentence Type	Means Tested* 3W vs. 5W	5W vs. 7W	3W vs. 7W
1. Well-Formed	**	n.s.	n.s.
2. Anomalous	n.s.	**	**
3. Ill-Ordered	n.s.	n.s.	n.s.

Within Sentence Length	Means Tested WF vs. A	A vs. IO	WF vs. IO
1. Three-Word	n.s.	n.s.	*
2. Five-Word	n.s.	n.s.	n.s.
3. Seven-Word	**	*	n.s.

n.s.: not significant
* p = 0.05
** p = 0.01

subject's responses was then multiplied by the appropriate weight value; the scores were added to obtain a final reversal error score, or index of error. For example, if a subject made 5 reversals of category I and 3 reversals of category II, his score would be:

$$(1.5 \times 5) + (3.5 \times 3) = 18$$

Mean scores were then obtained by adding all index of error scores and dividing by the total number of subjects.

The ANOVA for this error type is presented in Table 20. Mean index scores for the factors and interactions are presented on Table 21.

Table 20. Results of the ANOVA for Reversals.

Source of Variance	df	Mean Square	Significance
Articulation (A)	38	212.408	n.s.
Sentence Type (ST)	2	3810.210	$p \leq 0.0005$
Sentence Length (SL)	2	4608.958	$p \leq 0.0005$
A x ST	2	200.069	n.s.
A x SL	2	325.069	n.s.
ST x SL	4	2862.291	$p \leq 0.0005$
A x ST x SL	4	116.736	n.s.

n.s.: not significant

Articulation, in this instance, was not a significant main factor, nor were any interactions in which it was a part. That indicates that all subjects performed with similar error patterns. Main factors of sentence type

Table 21. Mean Index of Error Scores for Reversals for the Factors of Sentence Type (well-formed: WF, anomalous: A, ill-ordered: IO), Sentence Length (three-word: 3W, five-word: 5W, seven-word: 7W) and Articulation (normal speaking: N.S., articulatory-impaired: A.I.).

Articulation x Sentence Type: not significant

	WF	A	IO	Overall Mean
N.S.	1.0	2.2	18.0	7.1
A.I.	2.5	3.2	23.7	9.8
Overall Mean	1.8	2.7	20.8	

Articulation x Sentence Length: not significant

	3W	5W	7W	Overall Mean
N.S.	1.3	7.7	12.3	7.1
A.I.	1.5	14.1	13.8	9.8
Overall Mean	1.4	10.9	13.1	

Sentence Type x Sentence Length: significant

	3W	5W	7W	Overall Mean
WF	1.2	1.1	3.0	1.8
A	0.4	1.9	6.0	2.8
IO	2.6	29.6	30.2	20.8
Overall Mean	1.4	10.9	13.1	

Articulation x Sentence Type x Sentence Length: not sign.

	3W		5W		7W		Overall Mean	
	N.S.	A.I.	N.S.	A.I.	N.S.	A.I.	N.S.	A.I.
WF	1.7	0.7	0.0	2.2	1.5	4.5	1.1	2.5
A	0.0	0.7	0.0	3.7	6.7	5.2	2.2	3.2
IO	2.2	3.0	23.0	36.2	28.7	31.7	18.0	23.7
Overall Mean	1.3	1.5	7.7	14.1	12.3	13.8		

and sentence length were significant, a finding which means both factors were related to the occurrence of reversals.

Sentence Type

The sentence type main effect means, shown on Table 21 as the overall means for WF, a, and IO types, were subjected to post hoc testing. The overall means for WF and A were not significantly different; however, both were significantly lower than the IO overall mean. Ill-ordered strings, therefore, were highly correlated to the occurrence of reversals. In WF and A sentences, in which word order contributes to semantic and/or syntactic structure, reversals were infrequent.

Figure 15 displays mean index scores (overall means) for each sentence type for all subjects and demonstrated the dramatic upturn in reversal errors when the sentence types were ill-ordered.

Sentence Length

The main effect means for sentence length (overall means shown on Table 21) were also tested for significant differences. The mean index of error for 3W sentences was found to be significantly lower than the 5W and 7W index means; the latter two means were not significantly different. Reversals, therefore, occurred primarily in 5W and 7W IO sequences. Figure 16 shows the main effect means for sentence length.

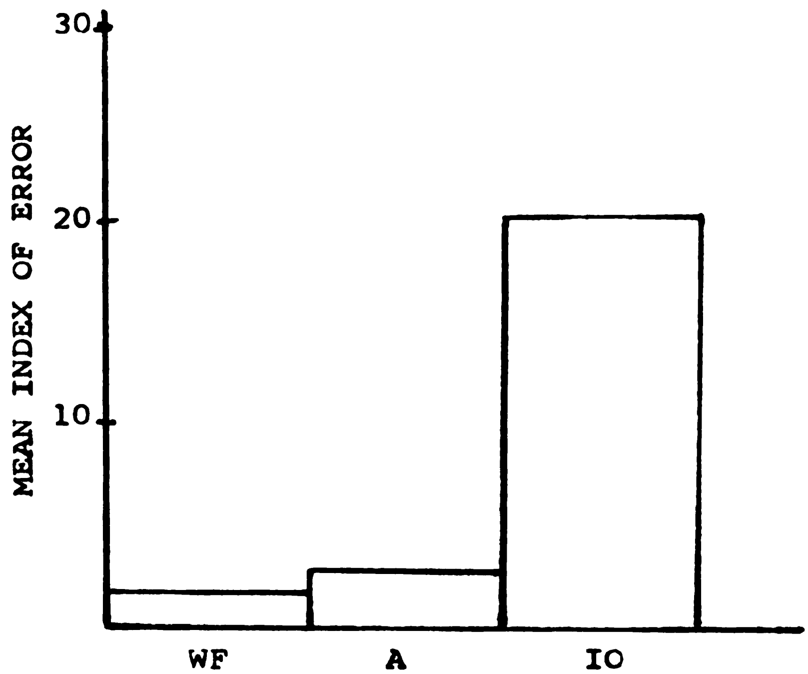


Figure 15. Mean Index of Errors for Reversals for Sentence Types (well-formed: WF, anomalous: A, ill-ordered: IO).

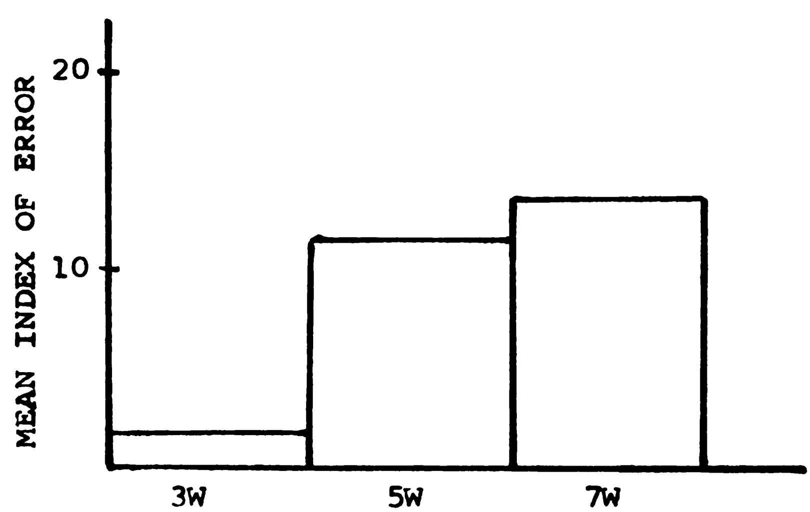


Figure 16. Mean Index of Errors for Reversals for Sentence Lengths (three-word: 3W, five-word: 5W, seven-word: 7W).

Sentence Type x Sentence Length

This was the only significant interaction. Mean index of error values are shown on Table 21. The highest number of reversals occurred in 5W and 7W ill-ordered sequences. Post hoc testing of these means (see Figure 17) showed that the means for IO sentences were affected by the sentence length such that 3W sentences had significantly fewer errors than 5W and 7W sentences.

7. Functor Additions

Additions of words during the repetition of sentence stimuli were observed and analyzed with the other error types. However, it was a very infrequently observed error type. The means are shown on Table 22. Error scores in this case were a simple total number of additions made by the subject. The highest mean obtained for functor additions occurred in 7W-IO sentences. No information can be derived from such a small error sample.

8. Contentive Additions

This error type was the least frequent to occur. Most contentive additions occurred in 7W-IO sequences. Mean values are shown on Table 23.

In the chapter concerning experimental procedures, the method of counterbalancing the order of stimulus presentation was mentioned which, hopefully, would control for the effect of fatigue on subjects' error scores. This method was found to be successful since error scores were equivalent for either order of presentation across subject groups.

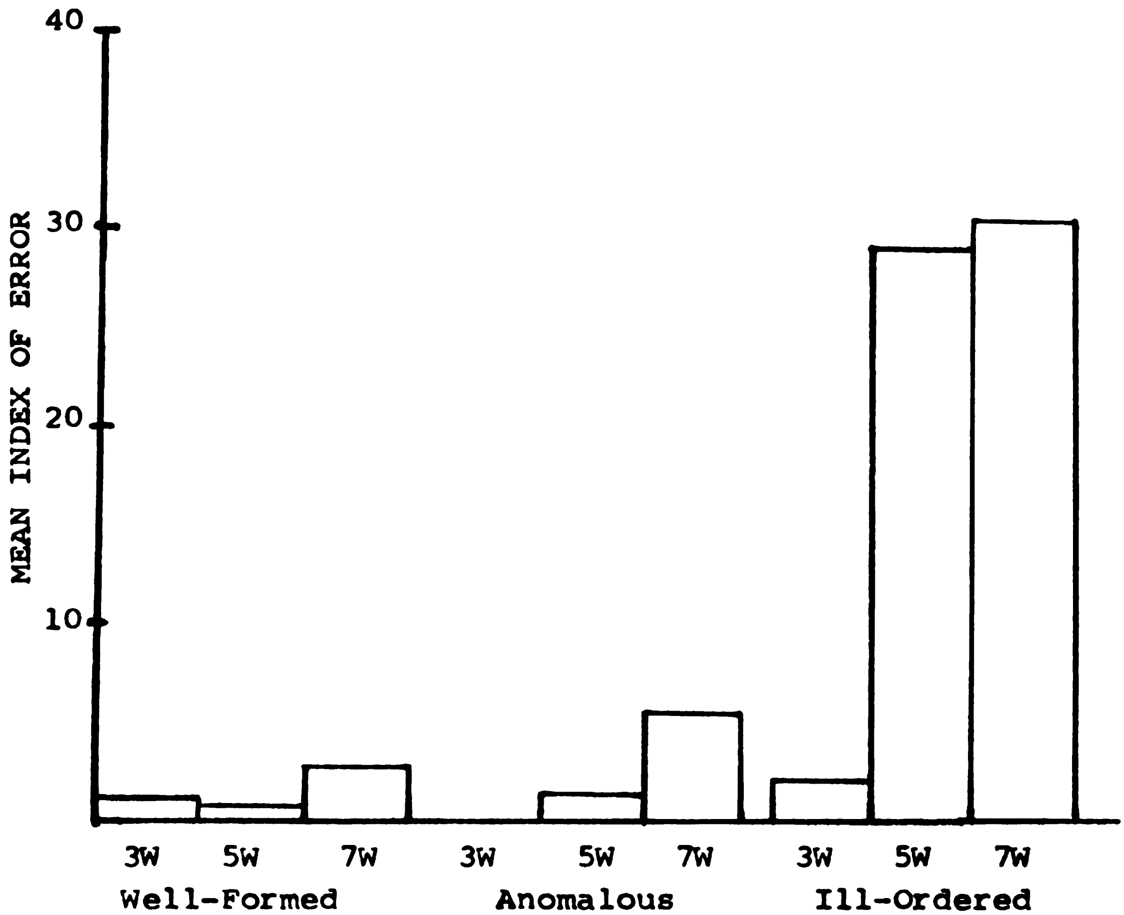


Figure 17. Reversal Error Index Means: Sentence Length (three-word: 3W, five-word: 5W, seven-word: 7W) by Sentence Type (well-formed, anomalous, ill-ordered).

Table 22. Functor Addition Mean Error Scores for the Factors of Sentence Type (well-formed: WF, anomalous: A, ill-ordered: IO), Sentence Length (three-word: 3W, five-word: 5W, seven-word: 7W) and Articulation (normal speaking: N.S., articulatory-impaired: A.I.).

Articulation x Sentence Type

	WF	A	IO	Overall Mean
N.S.	0.07	0.13	0.93	0.38
A.I.	0.20	0.27	1.52	0.66
Overall Mean	0.13	0.20	1.22	

Articulation x Sentence Length

	3W	5W	7W	Overall Mean
N.S.	0.22	0.35	0.57	0.38
A.I.	0.43	0.53	1.02	0.66
Overall Mean	0.32	0.44	0.79	

Sentence Type x Sentence Length

	3W	5W	7W	Overall Mean
WF	0.17	0.05	0.17	0.13
A	0.07	0.00	0.52	0.20
IO	0.72	1.27	1.67	1.22
Overall Mean	0.32	0.44	0.79	

Articulation x Sentence Type x Sentence Length

	3W		5W		7W		Overall Mean	
	N.S.	A.I.	N.S.	A.I.	N.S.	A.I.	N.S.	A.I.
WF	0.10	0.25	0.00	0.10	0.10	0.25	0.07	0.20
A	0.05	0.10	0.00	0.00	0.35	0.70	0.13	0.27
IO	0.50	0.95	1.05	1.50	1.25	2.10	0.93	1.52
Overall Mean	0.22	0.43	0.35	0.53	0.57	1.02		

Table 23. Contentive Addition Mean Error Scores for the Factors of Sentence Type (well-formed: WF, anomalous: A, ill-ordered: IO), Sentence Length (three-word: 3W, five-word: 5W, seven-word: 7W) and Articulation (normal speaking: N.S., articulatory-impaired: A.I.).

Articulation x Sentence Type

	WF	A	IO	Overall Mean
N.S.	0.05	0.02	0.47	0.18
A.I.	0.08	0.17	1.12	0.45
Overall Mean	0.07	0.09	0.79	

Articulation x Sentence Length

	3W	5W	7W	Overall Mean
N.S.	0.00	0.07	0.47	0.18
A.I.	0.03	0.30	1.03	0.45
Overall Mean	0.02	0.18	0.75	

Sentence Type x Sentence Length

	3W	5W	7W	Overall Mean
WF	0.00	0.02	0.17	0.07
A	0.02	0.02	0.22	0.09
IO	0.02	0.50	1.85	0.79
Overall Mean	0.02	0.18	0.75	

Articulation x Sentence Type x Sentence Length

	3W		5W		7W		Overall Mean	
	N.S.	A.I.	N.S.	A.I.	N.S.	A.I.	N.S.	A.I.
WF	0.00	0.00	0.00	0.05	0.15	0.20	0.05	0.08
A	0.00	0.05	0.00	0.05	0.05	0.40	0.02	0.17
IO	0.00	0.05	0.20	0.80	1.20	2.50	0.47	1.12
Overall Mean	0.00	0.03	0.07	0.30	0.47	1.03		

CHAPTER V

DISCUSSION

Results of the study will be discussed in the following sections with respect to auditory discrimination and the main experiment factors of sentence length, sentence type, word type, and articulation. Suggestions for future research conclude this chapter.

Auditory Discrimination

Twice as many A.I. as N.S. children were found to have inadequate auditory discrimination on the Wepman Auditory Discrimination Test. Errors on the test ranged from 7 to 15 for the A.I. children and 7 to 8 for N.S. children. These results support previous studies which found a positive relationship between articulation defects and poor auditory discrimination. Weiner (1967) had questioned the reliability of these earlier studies, however, because of the variety of test instruments used and the differences in number of articulatory errors exhibited by the subjects selected. He recommended that replications of earlier studies be performed. The present study did not replicate the study by Prins (1963) entirely, but it did make use of his subject selection criteria of 3 or more misarticulations and the same auditory discrimination test. Prins was interested in what types of phonological errors were related to auditory discrimination problems and determined that children whose error sounds were close to the target sounds had the most difficulty with the Wepman test compared to children who exhibited more random articulation errors. The experimental children in the present study exhibited misarticulations which were close to the target sounds, e.g., [t/s, t/tʃ, s/ʃ , s/θ, t/k] . Sixty percent of these children had poor performances on the Wepman test. Therefore, support for Prins' contention was evident.

Prins also suggested that auditory discrimination was related to the total language processes. He believed that language processes were involved in the kind of discrimination required to distinguish the difference in Wepman's word-pairs wherein acoustic variations are phonemic, signalling a change in linguistic meaning. If a child's language processing system is intact, he should detect the symbolic differences in the words. If the relationship between language and auditory discrimination is valid, then poor performance on the Wepman test indicates a disturbance in the language system of the testee. Since N.S. children performed better than A.I. children on the Wepman test, one could then conclude that the language systems of the two groups differ. Also, since the two groups differ only by the factor of articulatory proficiency, one could infer that inadequate articulatory development also relates to poor auditory discrimination and a depressed language processing system.

Marquardt and Saxman (1970) had found that kindergarten children with numerous misarticulations performed poorly on Wepman's test and on the Carrow Auditory Test for Language Comprehension. The authors held that language competence and auditory discrimination were significantly correlated within the articulatory-impaired group, although not within the normal speaking group. The present study tended to support the theory that articulation proficiency was related to auditory discrimination skills and certain language performance skills.

The Wepman test assesses the auditory perception of speech units, linguistic units which are paired but not actually meaningfully related and do not occur in ongoing speech contexts. In order to discriminate the word-pair stimuli, it is necessary to perceive the phonemic and/or semantic differences of the language units. The hearing mechanisms, that is, the peripheral auditory systems, were intact for all subjects. Therefore, poor auditory discrimination of such word pairs indicated a failure to perceive and process accurately either the phonemic and/or semantic characteristics of the stimuli. The subjects' test papers were reviewed to investigate these factors.

Upon reviewing the test forms, the following observations were made. The control subjects had made errors on 16 of the 30 'different' word pairs on the Wepman test for a total of 75 discrimination errors. The experimental subjects had made a total of 148 discrimination errors on 26 of the 30 word pairs. Since a majority of the 'different' word pairs were missed at one time or another by all subjects tested, it is possible that the words within the pairs were not readily semantically recognized by the subjects. In other words, the test words were foreign to the spoken and receptive vocabularies of the subjects and did not signal linguistically different information. Further examination of the word pairs more commonly missed supported this hypothesis. The most commonly missed word pairs for both groups were: clothe-clove, sheaf-sheath, fie-thigh, and vow-thou. These words are probably not used nor often heard by the children. They are also phonemically difficult to distinquish since the phonemes involved are [ð , v, f, and θ]. Voiced and unvoiced fricative sounds of this kind are difficult to detect without the aid of visual cues, i.e., viewing the speaker. Therefore, these words may be difficult to perceive semantically and phonemically for both subject groups. Other word pairs in the Wepman test are similarly hard to distinguish on a semantic level (lath-lash, shack-sack, shoal-shawl, muff-muss), but some are more readily distinguished phonemically (pork-cork, din-bin, coast-toast).

If one can assume that the children from both articulation groups generally hear and use similar vocabulary words and that a variety of the words of the Wepman list were unfamiliar to all of the children, then the factor of phonemic differentiation becomes more important than the semantic variable in distinguishing the performance of the two articulation groups. When the words themselves are not readily distinguished on a semantic basis, the listener must rely on the detection of phonemic variations. On this basis, the normal speakers performed better than the experimental subjects. In order to determine whether a relationship existed between the articulation problems of the experimental subjects and the errors made on the Wepman test, further analysis of the test papers of the misarticulating children was conducted.

Of the 148 errors observed, 52 occurred on words differentiated by unvoiced fricatives, 26 on words differentiated by unvoiced stop plosives, and 22 on words differentiated by voiced fricatives. The remaining errors occurred for words differentiated by vowels, voiced plosives, and nasals. It is interesting to note that these children had articulation errors primarily for unvoiced fricative sounds: [s, ʃ, tʃ, θ, f]. The distinctive feature theory could explain the relationship between their articulation errors and their subsequent discrimination errors by noting that the children did not have the distinctive features in their articulation system necessary for accurate perceptual discrimination. The motor theory of speech perception, on the other hand, would suggest that the discrimination errors occurred because these particular phonemes were referred to incorrect motor patterns of articulation in the perceptual systems of the children. In either case, the discrimination errors observed do correlate with the children's articulation errors.

Sentence Length

The results of this study agreed with those of previous studies (Beasley and Smith, 1972; Aaronson, 1967; Miller, 1956; and Schuckers, Shriner, and Daniloff, 1971) in that error rate tended to increase as stimulus length increased.

This tendency was clearly observed for all subjects with respect to functor omission errors. However, the articulatory-impaired children made significantly more functor omissions than normal speaking children at every sentence length. Since three-word stimuli should be within the short-term memory ability of the subjects, it was interesting to obtain significantly different error scores for the two articulation groups at the three-word length. It is possible that the responses reflect more than simply automatic recall of stimuli, rather, that the responses reflect the subjects' level of language competence. Menyuk and Looney (1972) believed that repetitions reflect children's level of grammatical competence if they are developing language normally. If repetitions also reflect the level of grammatical competence in misarticulating children and this level is below that of normal speaking children, poorer performance on even three-word stimuli would be expected to be observed.

Contentive omissions did not generally occur until the stimulus item was seven words in length (see Figure 10). The error rate for seven-word sequences for both articulation groups for functor and contentive omissions indicated that the short-term memory spans of the subjects had been exceeded. Seven items in a stimulus were found to exceed subjects' memory spans in previous studies (Beasley and Smith, 1972; Miller, 1956; Templin, 1957; Beasley and Acker, 1971; and Schuckers et al., 1973).

Functor substitutions were infrequent and, in this case, most errors occurred on five-word anomalous sequences. After reviewing subjects' responses to these sequences, a main factor was found to contribute to the high error mean. Of 61 functor substitution errors made by experimental subjects and 28 made by control subjects, 28 and 24 of these, respectively, were made on the functor word an in the five-word anomalous sequences "her bike eats an apple" and "an airplane chops the wood". The word an was usually replaced by the or a or was omitted (contributing to omission error scores). The word an did not occur in any of the other 52 sentences used as stimuli. It is probable that an was not used in the expressive vocabulary of the first grade children of this study. Also, the word an was an unstressed word in these anomalous sequences, a fact which might have interfered with accurate perception. A more exact explanation for the effect of the word an on subjects' performances would have been possible had it occurred in other sentence types in the stimulus sentences.

Other functor substitutions which commonly occurred and helped to contribute to the high error mean for 5-word anomalous sequences also occurred in other sentence types. Generally, the most common functor substitutions observed were the following: a/the, her/his, his/her, the/his, or the/her. The substitution a/the was considered an error if the subject had produced the word the at other times during the test session. If a subject consistently produced a/the and had shown articulation problems including the [ð] sound, then a/the was not an error for that subject. This substitution was common, however, even for normal speakers. Therefore, the error may be due to their acoustic similarity, particularly when the word the is unstressed in a stimulus item.

The his/her and her/his substitutions suggested that the subjects may not have his and her clearly distinguished in a linguistic sense. At times, recall accuracy may have been affected by sentence context. For example, her/his frequently occurred in the repetitions of the sequence "his sister bakes a book." Two explanations appear feasible. The feminine noun, sister, may have brought about the change from a masculine possessive pronoun to a feminine possessive pronoun such that his was replaced by her to agree with a feminine image created by the sequence. The second explanation is that the coarticulation of 'his sister' caused the perception of her as the /h/ in his is perceived in close conjunction with the /ɚ/ in sister.

The the/his and the/her substitutions may also have occurred due to the sentence context, although not in every instance. When the/his and the/her occurred in the 5-word anomalous sequences "the dog purrs his bone" and "the lady walks her coat," the occurred in the sequence, was recalled for its position, and was substituted for the words his and her. Therefore, the was recalled for both functor positions. However, when the/his occurred in "his sister bakes a book," the change is less readily explained. It is hypothesized that when a stimulus taxes a subject's recall, as an anomalous sentence can, less frequently used possessive pronouns such as his or her may be replaced by a common, useful functor word such as the. Since the anomalous sentence type may appear to be nonsense to the child, the change from his to the or her to the may not appear to affect the basic structure of the sentence and, indeed, it does not. If the sentence were meaningful, such as "his dog is chasing her dog," in which his and her have significant roles to play on a semantic level, substitution of the for possessive pronouns would make a major semantic difference. Briefly, the can be used to substitute for other functor words and the anomalous sentence remains anomalous. The word the appears to be easier to recall than the possessive pronouns, particularly when the was already present elsewhere in the stimulus sequence.

Sentence length affected subjects' performances in approximately the same fashion with respect to the remaining error types: contentive substitutions, additions, and reversals. Errors were highest on seven-word strings.

Sentence Type

Error rate was highest for ill-ordered strings, followed by anomalous and well-formed sequences, except in the case of substitutions, which has been discussed. This error pattern was observed in previous studies (Beasley and Acker, 1971; Beasley and Smith, 1972; Brown and Bellugi, 1964; and Scholes, 1970).

All subjects, regardless of articulation proficiency, made more functor and contentive omissions on ill-ordered sequences, followed by anomalous and well-formed sequences. Experimental subjects made significantly more functor omissions for every sentence type and more contentive omissions on ill-ordered sequences than control subjects.

Sentence type appeared to have a greater effect on subject performance than sentence length. For example, for functor omission errors, the mean error for 3-word ill-ordered sequences was higher than the mean error for 5-word well-formed sequences in normal speaking subjects' responses. For experimental subjects, the mean error for functor omissions was higher for 5-word anomalous than for 7-word well-formed sequences. In other words, although a stimulus may contain more words, the sentence type had more to do with the number of functor omissions which occurred, not the additional words. A longer but well-formed sentence was easier for subjects to recall than a shorter, ill-ordered one.

In general, subjects showed better recall of well-formed and anomalous sequences than ill-ordered sequences. This suggests that the language structure (semantic and/or syntactic) present in well-formed and anomalous sentence types contributed toward recall processing, especially when the stimulus length increased to seven words. All subjects showed better recall of seven-word well-formed and anomalous sequences than seven-word ill-ordered sequences. However, the normal speaking children performed with fewer errors than the articulatory-impaired children in their repetitions of well-formed and anomalous sequences. This may mean that language structure was of more assistance to the normal speaking children than to the articulatory-impaired. Since syntactic structure is present in both well-formed and anomalous sequences and since scores were better for these types than for ill-ordered sequences, it appears that syntax played an important function in the task of recall. At the same time, therefore, syntax was of greater value as a language cue to the normal speaking children than to the articulatory-impaired. This, in turn, implies that the syntax development of the two articulation groups is somehow different, with articulatory-impaired children having less well-developed syntax. This is, of course, speculation based upon the results of the study; and more definite comments with respect to differences in syntax development cannot be made. However, a difference does exist between the recall skills of the articulation groups for the various language stimuli which cannot be explained simply by differences in short-term memory skills.

The short-term memory skills of the two articulation groups would appear to be comparable. In one instance (functor omissions), normal speaking children performed better than the articulatory-impaired children in the recall of every sentence type and sentence length stimuli except for 7-word ill-ordered sequences. Even the means for 5-word ill-ordered sequences were significantly different, suggesting that articulatory-impaired children have poorer automatic memory recall for 5-word stimuli. However, scores for the other error types (substitutions, additions, reversals, contentive omissions) did not show this difference at the 5-word level. Also, the groups generally showed equal difficulty repeating 7-word ill-ordered sequences across the error types. Therefore, all subjects' memory spans were exceeded by seven-word ill-ordered stimuli; and thus, it can be concluded that memory spans of the two groups were not significantly different. This would support the hypothesis that the performance differences observed on well-formed and anomalous sequences were due to factors other than short-term memory abilities of the separate articulation groups. Language structure, and how it was used by the children as a cue for recall, appeared to differentiate the two groups of subjects.

Returning to the factor of sentence type and its relationship to error types observed, reversals provided interesting data. Reversals occurred infrequently in well-formed and anomalous sequence repetitions. However, many reversals occurred for ill-ordered sequences. Word position in well-formed and anomalous sequences is important to the semantic and/or syntactic structure of language units. Therefore, reversals, or changes in word position, would change the meaning and structure of the original stimulus. Ill-ordered stimuli, on the other hand, are semantically and syntactically meaningless. Words in such a sequence cannot easily be chunked according to semantic association or bound together by a perceived grammatical structure. As stimulus length increases, words may be chunked together for memorization, but the order may change as short-term memory loses efficiency.

It was interesting to find that, in the repetitions of 5- and 7-word ill-ordered stimuli, reversals actually introduced semantic and/or syntactic structure, such that the sentence type was changed. In other words, ill-ordered stimuli were repeated as anomalous or well-formed sequences. The experimental subjects changed the sentence type of 48 of the ill-ordered sequences. Some examples are shown below.

Ill-Ordered Stimulus	Subjects' Responses
1. Carrot the bunny eats the	1. The carrots eat the /dʌ/
	A bunny eats a carrot the
2. Kitten chases my her dog	2. My big kitten chases her big dog
	A kitty chases a dog
	My kitten chases her dog
3. Baby his calls the mother	3. His baby calls the mother
	Baby calls his mother
4. Covers blanket baby the yellow the bed	4. Blanket the baby with her yellow bed

Since the above ill-ordered stimuli were frequently repeated with reversals such as those listed, some factor common to these sequences must have triggered the response behavior. After studying these sequences, it was noted that a portion within each stimulus is actually in sentential order: (1) "the bunny eats the", (2) "kitten chases", (3) "calls the mother", (4) "the yellow" or "the bed". It is possible that the listeners recognized these particular portions of the ill-ordered sequences as somewhat similar to a real sentence and consequently restructured the string to attempt to give meaning to the stimulus as a whole.

Normal speaking subjects made 28 reversals which introduced some syntactic and/or semantic structure into the ill-ordered stimuli. A few of the more commonly observed responses follow.

Ill-Ordered Stimulus	Subjects' Responses
1. Baby his calls the mother	1. The baby calls his mother
	Baby calls his mother
	His baby calls his mother
2. Carrot the bunny eats the	2. The carrot eats the bunny, too
	The carrot eats the bunny
3. Sister my the spills water	3. Sister my spills the water
	The sister my spills the water
4. Washes a the man big green car	4. Washes the big man's green car
	A man washes a car
	Black man washes big dirty car

Ill-Ordered Stimulus (cont.)	Subjects' Responses
5. Girl red cow silly draws the a	5. The red cow draws the silly the
	The girl draws the silly cow the
6. Covers blanket baby the yellow the bed	6. Yellow blanket covers the baby yellow bed

Again, the stimuli contain a portion which resembles or forms part of a sentence. Normal speaking children may have reacted to the stimuli in the same fashion as the experimental children, that is, they recognized this meaningful portion and reassembled the remaining words to give meaning to the stimulus as a whole.

To this point, differences in subjects' performances have been discussed relative to errors observed. "Better" performance on the part of normal speaking children can also be shown by tabulating totally correct responses of the articulation groups, as shown in Table 24. The table illustrates that the greatest differences between the N.S. and A.I. subjects occurred for 7-word well-formed and anomalous sequences, and for 5-word well-formed and anomalous sequences. Experimental subjects had fewer totally correct repetitions. Seven-word ill-ordered sequences were least often correctly repeated by either articulation group. The fact that normal speaking children were better able to correctly repeat 7-word and 5-word well-formed and anomalous sequences further supports the hypothesis that a difference does exist in the two groups' abilities to process the linguistic information present in these sentence

Table 24. Number of Totally Correct Responses by Normal Speaking (N.S.) and Articulatory-Impaired (A.I.) Children for the Nine Sentence Type by Sentence Length Categories.

Sequence Type	Total Number of Correct Responses Out of 120 Possible		
	N.S.	Difference	A.I.
3-Word Well-Formed	107	+13	94
5-Word Well-Formed	114	+39	75
7-Word Well-Formed	95	+42	53
3-Word Anomalous	113	+22	91
5-Word Anomalous	88	+45	43
7-Word Anomalous	72	+45	27
3-Word Ill-Ordered	98	+25	73
5-Word Ill-Ordered	53	+34	19
7-Word Ill-Ordered	10	+ 7	3

types.

Recall Patterns for Sentence Types

Recall patterns were analyzed in order to compare results of the present study to the patterns described by Deese and Kaufman (1957). Deese and Kaufman described the recall patterns of normal adult speakers for English contextual material and discrete items. The well-formed sentences of the present study were considered to be comparable to the English contextual material. Ill-ordered sequences were considered similar to discrete items. Anomalous sentences were considered to be more like contextual material than discrete items since the words of an anomalous sequence are bound together by syntactic structure.

Results did not follow the predicted patterns, however. Table 25 describes the patterns observed by Deese and Kaufman (1957) and those of the present study.

Briefly, the recall pattern described by Deese and Kaufman for English contextual material was observed for ill-ordered sequences of the present study. The recall pattern described by Deese and Kaufman for discrete items was similar to the pattern observed for well-formed and anomalous sequences in the present study. This difference in recall patterns observed may be due to the use of different material, despite similarity in linguistic structure or non-structure, or due to the difference in ages of the subjects studied.

Table 25. Recall Patterns from the Deese and Kaufman (1957) Study and Present Study Results.

Deese and Kaufman	Present Study
<u>English Contextual Material</u>	<u>Well-Formed Sentences</u>
first items recalled best, followed by middle and final items, respectively	final items recalled best, followed by middle and first items, respectively
<u>Discrete Items</u>	<u>Ill-Ordered Sentences</u>
final items recalled best, followed by first items and middle items, respectively	first items recalled best, followed by middle and final items, respectively
	<u>Anomalous Sentences</u>
	same pattern as for well-formed sentences

Word Type

Error means were higher for functor words than for contentive words for both articulation groups with respect to omissions and substitutions. Error means were low for both word types with respect to additions. This trend for functors to be omitted more than contentives as the task becomes more difficult agreed with reports in earlier studies (Scholes, 1970; Martin, 1968; Brown and Bellugi, 1964; Beasley and Acker, 1971; and Beasley and Smith, 1972). Deleted functors in a repetition produces a "telegraphic" form of speech, and this was often observed in the responses of severely misarticulating subjects, i.e., for "The old man takes a long walk," the response was "old man take long walk."

Articulation

The difference in the performances of the two groups of subjects has been discussed within the other topic areas. Briefly, the articulatory-impaired children demonstrated less adequate auditory discrimination skills than the normal speaking children based on the Wepman Auditory Discrimination Test results. This finding was felt to indicate auditory perceptual problems caused by or related to their specific articulation problems. It also may indicate that the articulatory-impaired children do less well than the normal speaking children in distinguishing the word pairs linguistically. However, the word pairs are likely to be difficult for both subject groups to distinguish on a semantic basis, since the words are probably not familiar to them (e.g., as a part of their receptive vocabulary).

The two articulation groups also differed in their ability to recall 5- and 7-word well-formed and anomalous sequences, whereby the articulatory-impaired children had higher error scores. Yet, in the case of 7-word ill-ordered sequences, both groups of subjects made similar numbers of errors.

It was assumed in the present study that if a subject failed to repeat 7-word ill-ordered sequences adequately but performed effectively while repeating 7-word well-formed and/or anomalous sequences, the difference could be attributed to the language structure in the latter two sentence types and particularly to the ability of the subjects to extrapolate such information and use it to help them in the recall task. All subjects did show better recall for well-formed and anomalous sequences than for ill-ordered sequences. However, normal speaking children had the greater ability to repeat the stimuli, indicating more adequate use of the language structure cues. It is possible, therefore, that the poorer performance of the articulatory-impaired children is due to less developed language competence in semantic and/or syntactic areas which may directly relate to their moderate to severe phonological impairments. Since specific syntactic and semantic structures were not tested in this study, it is not possible to assess the specific linguistic strengths or weaknesses of the children. One can only say that the recall abilities of the two groups often significantly differed and that language competence may be a factor contributing to the difference in their performance.

Implications for Future Research

The present study supported previous studies which demonstrated a positive relationship between articulation proficiency and auditory discrimination ability for children below 9 years of age, specifically between 5.11 and 6.9 years. Further research should be done to clarify the role of age in this relationship using subjects from 7-8, 8-9, and 9+ years of age who exhibit 3 or more articulation errors with no associated physical, psychological, or learning problems, and testing them with the Wepman Auditory Discrimination Test. This would help to fulfill the need for replications of studies of this kind as well as to determine the actual relationship between discrimination, articulation, and language proficiency.

The above populations could also be tested using the Wepman Auditory Discrimination Test and one or more other discrimination tests, i.e., the Goldman-Fristoe-Woodcock Auditory Discrimination Test, in order to compare results obtained. Since the Wepman test appears to have some inherent problems, specifically with respect to vocabulary used as stimuli, other tests such as the Goldman-Fristoe Woodcock test may be possible alternatives.

An extension of the auditory discrimination portion of this study would also add to the linguistic information needed to describe the differences in language skills of normal speaking and articulatory-impaired children. An in-depth analysis of (1) what word pairs were missed by the subjects; (2) what phonemes and linguistic units, therefore, were not discriminated; (3) what specific articulation errors were present in each subject tested; and (4) what, then, might be the relationship between undiscriminated speech sounds and the child's own misarticulations. Theories pertaining to the relationship of articulation proficiency, auditory discrimination, and language skills would become more clear and perhaps strengthened by such detailed information.

The main part of the present study analyzed recall performance with respect to error types of omission, substitution, addition, and reversal of word position on a cursory level to indicate which errors were more frequent and compared the two articulation groups on the basis of error occurrence. A future study could be designed to determine error types in depth, attempting to study which particular words are omitted, substituted, added or reversed and to what extent linguistic information is added or subtracted. Substitutions such as his/her and her/his could be investigated with respect to the sex of the subject making these substitutions. A brief study of reversals in the present study indicated that children sometimes added syntactic or semantic (or both) meaning to an ill-ordered sequence. Interesting information on the differing approaches to the words of the stimuli could be gleaned from such a descriptive study.

With modifications, the stimulus material could be presented to other subject populations, i.e., hearing-impaired children or adults, aphasic adults, normal speaking adults, in order to describe their recall as it is affected by the factors of sentence type, sentence length, word type, and particular handicap, if one is present.

The present study could be replicated with the addition of a speech sample taken from each subject prior to or following the taped portion of the study. The experimenter could then determine (1) what kind of sentences are used by the subjects in normal conversation, (2) whether articles such as _the_, _a_, and _an_ are used differentially by the subject, (3) whether such possessive pronouns as _his_ and _her_ are employed, and other relevant facts which would aid the experimenter to more adequately analyze errors observed.

The Beasley and Smith study (1972) included the factor of stress to determine how stress affected a normal speaking child's recall of functor and contentive words. They found that stressing of a word improved the subjects' recall of both functor and contentive word types. In fact, the error rate difference between functor and contentive words was less than the difference between stressed and unstressed words, especially for 7-word sequences and ill-ordered sequences. This meant stress was more important than word type with respect to recall. Therefore, they felt that stress may be used, for example, in a speech therapy language habilitation program or as an aid toward strengthening the short-term memory span. Stress may be an equally important factor affecting the recall abilities of misarticulating children. This could be determined by replicating the present study, adding stress as a factor, and testing children with moderate to severe misarticulations.

Future research, in general, must concentrate on the discrimination problems, recall problems, language problems, and phonological problems of misarticulating children and, insofar as possible, describe how these areas relate to one another. From such information, it should be possible to create effective speech and language habilitation programs which can make a greater difference in their performance skills at an earlier time in their school or preschool years.

CHAPTER VI

SUMMARY AND CONCLUSIONS

There has been increasing interest in the relationship of phonology, syntax, and semantics to each other in the process of normal language development and the added factor of auditory discrimination to each of them. A review of the research indicated that children with moderate to severe articulation errors have associated auditory discrimination problems and/or delayed grammatical development. Shriner et al. (1969) suggested that children may suffer from auditory feedback problems which lead to misarticulations which, in turn, induce syntactic deficits. Short-term memory studies, resynthesis studies, repetition task or sentence-elicited studies have all provided some information on the differential skills of normal speaking and articulatory-impaired children.

This experimenter believed that a study was needed to fulfill three primary research concerns: (1) replicate an earlier study on auditory discrimination in terms of subject selection criteria and testing material in order to verify earlier findings about auditory discrimination skills of articulatory-impaired children, (2) use a repetition task experiment in which the stimuli offered language structure (deep and/or surface structure) as cues for recall yet controlled for short-term memory parrotting effects, and (3) compare the performance of normal speaking and articulatory-impaired children based on an analysis of specific error types observed.

The following questions were investigated: Would there be significant differences in the recall accuracy of first grade articulatory-impaired and normal speaking children for 3-, 5-, and 7-word sequences? Would there be significant differences in the recall accuracy of first grade articulatory-impaired and normal speaking children for well-formed, anomalous, and ill-ordered sequences? Would there be significant differences in the recall accuracy of first grade articulatory-impaired and normal speaking children for contentive and functor word types? What types of errors would occur and with what frequency on the factors of sentence type, sentence length, and word type for articulatory-impaired and normal speaking children?

The experimenter hypothesized that normal speaking children (1) would demonstrate more adequate auditory discrimination than articulatory-impaired children as demonstrated by the results of the Wepman Auditory Discrimination Test, (2) normal speaking children would apply the available language cues in well-formed and anomalous sentences for better recall responses than those of articulatory-impaired children, (3) normal speaking and articulatory-impaired children would demonstrate equivalent short-term memory spans as evidenced by similar error scores on ill-ordered sequences, and (4) word type errors would follow results of previous studies: all subjects would find functor words more difficult to retain than contentive words as the task increased in difficulty.

Forty first grade children with normal hearing and intelligence served as test subjects. Twenty children with normal articulation, 13 boys and 7 girls, mean age 6.3 years, formed the control group. Twenty children, 13 boys and 7 girls, mean age 6.3 years, who had exhibited 3 or more articulatory errors on McDonald's Screening Deep Test of Articulation served as the experimental group.

Each subject was tested individually. Initially, the subject was administered the Wepman Auditory Discrimination Test. The experimenter then read a standardized set of instructions directing each subject to repeat exactly what was heard. The subject listened to a tape of 54 randomized stimulus sentences which varied in length and type. Responses were tape recorded and transcribed on a standard answer sheet. Response errors were classified according to error type: (1) omission--functor or contentive, (2) substitution--functor or contentive, (3) addition--functor or contentive, and (4) reversals of word order. The study was a Split-Plot design with repeated measures, and a multifactor analysis of variance was performed using a computer routine available in the Michigan State University Computer Library. Post hoc analysis was carried out using Tukey's "Honestly Significant Difference" test.

Auditory Discrimination

Results supported the findings of Prins (1963) in that articulatory-impaired children had more difficulty with the Wepman test than normal speaking children. Sixty percent of the experimental group failed the test as compared to 30% of the control group. Results were discussed with respect to possible differences in language skills.

Functor Omissions

The occurrence of functor omission errors was directly related to the factors of sentence type, sentence length, and articulation. More functor words were omitted for ill-ordered sequences, followed by anomalous and well-formed sequences, respectively. Functor omissions increased as sentence length increased. Articulatory-impaired children made significantly more functor omissions than normal speaking children for every sentence type and sentence length except for 7-word ill-ordered sequences. This finding indicated that all subjects appeared to demonstrate equivalent short-term memory spans.

Contentive Omissions

The factors of sentence type, sentence length, and articulation directly related to the occurrence of contentive omissions. Most errors occurred for 7-word ill-ordered sequences; error means were low for the other sentence type and sentence length categories. In this case, articulatory-impaired children made significantly more contentive omissions than normal speaking children for 7-word ill-ordered sequences.

Functor Substitutions

The factors of sentence type, sentence length, and articulation appeared to affect the occurrence of this error type. Functor substitutions occurred primarily in the repetition of 5-word anomalous sequences. However, analysis of subjects' responses indicated that the reasons for the high error rate were factors outside of the sentence type and length of the stimulus. Articulatory-impaired children produced significantly more functor substitutions than normal speaking children in 3- and 5-word sequence repetitions; 7-word sequences had similar error means.

Contentive Substitutions

The factors of articulation and sentence length were found to relate to the occurrence of contentive substitutions. Most errors occurred for 7-word anomalous sequences, followed by 3-word well-formed and 5-word anomalous sequences. Error means, however, were low for all sentence type-sentence length categories.

Reversals

Sentence Type and Sentence Length factors related directly to the occurrence of reversals. Errors occurred primarily in 5- and 7-word ill-ordered sequence repetitions. Few reversals occurred for well-formed and anomalous sequences of any length.

Additions - Functor and Contentive

This error type was least frequent and, although it was analyzed along with the other error types, no meaningful information could be derived from the data. When observed, additions occurred in the repetition of 7-word ill-ordered sequences.

Conclusions

Within the limitations of the present study, the following conclusions seem warranted:

1. Children with moderate to severe articulatory problems reveal less adequate auditory discrimination skills than normal speaking children as determined by the results of the Wepman Auditory Discrimination Test.

2. First grade children, regardless of their articulation proficiency, make more errors on a recall task as the stimulus length increases.

3. First grade children make most errors in the repetition of ill-ordered sequences, followed by anomalous and well-formed sentences, respectively.

4. Errors are greater for the functor word type than for the contentive word type.

5. Articulatory-impaired first grade children reveal poorer recall than normal speakers for well-formed and anomalous sentences of all lengths as well

as for 3- and 5-word ill-ordered sequences. Seven-word ill-ordered sequences are equally difficult for articulatory-impaired and normal speaking first grade children. Short-term memory spans appear to be the same for the subjects tested.

6. Functor omissions occur with greatest frequency of the error types analyzed. Contentive omissions are infrequent until the stimulus is a 7-word ill-ordered sequence. Functor substitutions appear to occur primarily in anomalous sequences for all subjects. Contentive substitutions are infrequent regardless of sentence type or length; error means did not exceed 3%. Reversals occur almost exclusively in 5- and 7-word ill-ordered strings.

LIST OF REFERENCES

Aaronson, D., Temporal factors in perception and short-term memory. Psychol. Bull., 67, 130-144 (1967).

Aungst, L. F., and Frick, J. V., Auditory discrimination ability and consistency of articulation of /r/. J. Speech Hearing Dis., 29, 76-85 (1964).

Beasley, D., and Acker, J., The effect of sentence length, sentence type, word type and stress on four and five year olds. Unpublished Master's thesis, Michigan State University (1971).

Beasley, D., and Beasley, D. C., Auditory reassembly abilities of black and white first- and third-grade children. J. Speech Hearing Res., 16, 213-221 (1973).

Beasley, D., Shriner, T. H., Manning, W. H., and Beasley, D. C., Auditory reassembly of CVCs by children with normal and defective articulation. Unpublished study, Michigan State University (1973).

Beasley, D., and Smith, A., Short-term memory and imitation: effects of sentence length, sentence type, word type, stress and grade. Unpublished Master's thesis, Michigan State University (1972).

Beatty, J., and Borree, J., Effects of word class on the recall of sentences. J. Verb. Lrng. Verb. Behav., 10, 604-607 (1971).

Braine, M. D. S., Ontogeny of English phrase structure: the first phase. Language, 39, 1-13 (1963).

Broadbent, D., A mechanical model for human attention and immediate memory. Psychol. Rev., 64, 205-215 (1957).

Brown, R., and Bellugi, U., Three processes in the child's acquisition of syntax. Harvard Educational Rev., 34, 133-151 (1964).

Brown, R., and Berko, J., Word associations and the acquisition of grammar. Child Develpm., 31, 1-14 (1960).

Brown R., and Fraser, C., The acquisition of syntax. In Ursula Bellugi and R. Brown, The Acquisition of Language, Monogr. of the Society for Research in Child Developm., 29, 43-79. Yellow Springs: Antioch Press (1964).

Carrell, J., The etiology of sound substitution defects. Speech Monogr., 4, 17-37 (1937).

Chomsky, N., Syntactic Structures. Gravenhage, The Netherlands: Mouton (1957).

Chomsky, N., and Halle, M., The Sound Pattern of English. Harper and Row: New York (1968).

Cohen, J. H., and Diehl, C. F., Relation of speech-sound discrimination ability to articulation-type speech defects. J. Speech Hearing Dis., 28, 187-190 (1963).

Daniloff, R., and Moll, K. L., Coarticulation of lip rounding. J. Speech Hearing Res., 11, 707-721 (1968).

Davis, E. A., The Development of Linguistic Skill in Twins, Singletons, Singletons with Siblings, and Only Children from Five to Ten Years. Minneapolis: University of Minnesota Press (1937).

Deese, J., and Kaufman, R. A., Serial effects in recall of unorganized and sequentially organized verbal material. J. Exp. Psychol., 54, 180-187 (1957).

Farquhar, M. S., Prognostic value of imitative and auditory discrimination tests. J. Speech Hearing Dis., 26, 342-347 (1961).

Fontaine, V. E., The auditory memory span of children for vowel sounds. (M.A. thesis, Univ. Wisconsin, 1940); cited by Van Riper, C. and Irwin, J., Voice and Articulation. Englewood, N. J.: Prentice-Hall, Inc. (1958).

Fraser, C., Bellugi, U., and Brown, R., Control of grammar in imitation, comprehension, and production. J. Verb. Lrng. Verb. Behav., 2, 121-135 (1963).

Freedle, R. O., Keeney, T. J., and Smith, N. D., Effects of mean depth and grammaticality on children's imitations of sentences. J. Verb. Lrng. Verb. Behav., 9, 149-154 (1970).

Hall, M., Auditory factors in functional articulatory defects. J. Exp. Educ., 7, 110-132 (1938).

Irwin, R. B., Speech therapy and children's linguistic skills. J. Speech Hearing Res., 5, 377-381 (1962).

Johnson, W., Darley, F. L., and Spriestersbach, D. C., Diagnostic Methods in Speech Pathology. Harper and Row, Publishers: New York (1963).

Kirk, R. E., Experimental Design: Procedures for the Behavioral Sciences. Wadsworth Publishing Company, Inc.: Belmont, California (1968).

Kozhevnikow, V., and Chistovich, L., Speech, Articulation, and Perception. (English transl. fr. Russian) Washington, D. C.: U.S. Dept. Commerce (1965).

Kronvall, E. L., and Diehl, C. F., The relationship of auditory discrimination to articulatory defects of children with no known organic impairment. J. Speech Hearing Dis., 19, 335-338 (1954).

Lackner, J., A developmental study of language behavior in retarded children. Neuropsychologia, 6, 301-320 (1968).

Liberman, A., Harris, K. S., Eimas, P., Lisker, L., and Bastian, J., An effect of learning on speech perception: the discrimination of durations of silence with and without phonemic significance. Lang. Speech, 4, 175-195 (1961).

Liberman, A. M., Harris, K. S., Hoffman, H. S., and Griffith, B. C., The discrimination of speech sounds within and across phoneme boundaries. J. Exp. Psychol., 54, 358-368 (1957).

Lieberman, A. M., Cooper, F. S., Harris, K., and McNeilage, P. M., A motor theory of speech perception. Proceedings of the Speech Communication Seminar, Vol. 11. Stockholm: Speech Transmission Laboratory, Royal Inst. Technol. (1963).

Marks, L. E., and Miller, G. A., The role of semantic and syntactic constraints in the memorization of English sentences. J. Verb. Lrng. Verb. Behav., 3, 1-5 (1964).

Marquardt. T., and Saxman, J., Language Comprehension and Auditory Discrimination in Articulation Deficient Kindergarten Children. J. Speech Hearing Res., 15, 382-389 (1972).

Martin, J. G., Temporal word spacing and the perception of ordinary, anomalous, and scrambled strings. J. Verb. Lrng. Verb. Behav., 7, 154-157 (1968).

Martin, E., and Roberts, K. H., Grammatical factors in sentence retention. J. Verb. Lrng. Verb. Behav., 5, 211-218 (1966).

Mange, C. V., Relationships between selected auditory perceptual factors and articulation ability. J. Speech Hearing Res., 3, 67-74 (1960).

Mase, D. J., Etiology of articulatory speech defects. New York: Teachers College, Columbia University, Bureau of Publications, Contributions to Education, No. 921 (1946).

McCarthy, D. A., The language Development of the Preschool Child. Institute of Child Welfare Monograph Series, No. 4. Minneapolis: Univ. Minn. Press (1930).

McNeill, D., Developmental psycholinguistics. In F. Smith and G. Miller, The Genesis of Language. Cambridge: M.I.T. Press (1966).

Menyuk, P., A preliminary evaluation of grammatical capacity in children. J. Verb. Lrng. Verb. Behav., 2, 429-439 (1963).

Menyuk, P., Syntactic structures in the language of children. J. Child Devel., 34, 407-422 (1963).

Menyuk, P., Comparison of grammar of children with functionally deviant and normal speech. J. Speech Hearing Res., 7, 109-121 (1964).

Metraux, R., Auditory memory span for speech sounds: norms for children. J. Speech Hearing Dis., 9, 31-38 (1944).

Miller, G. A., Free recall of redundant strings of letters. J. Exp. Psychol., 56, 484-491 (1958).

Miller, G. A., The magical number seven, plus or minus two: some limits on our capacity for processing information. Psychol. Rev., 63, 81-97 (1956).

Miller, G. A., and Selfridge, J. A., Verbal context and the recall of meaningful material. Amer. J. Psychol., 63, 176-185 (1950).

Morris, H. D., Common skills of children with cleft lips and palates. J. Speech Hearing Res., 5, 79-90 (1962).

Nurss, J. R., and Day, D. E., Imitation, comprehension, and production of grammatical structures. J. Verb. Lrng. Verb. Behav., 10, 68-74 (1971).

Ohman, S., Numerical model of co-articulation. J. Acoust. Soc. Amer., 41, 310-320 (1967).

Perozzi, J. A., and Kunze, L. H., Relationship between speech sound discrimination skills and language abilities of kindergarten children. J. Speech Hearing Res., 14, 382-390 (1971).

Pollack, I., Message uncertainty and message reception. J. Acoust. Soc. Amer., 31, 1500-1508 (1959).

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

Robbins, D. D., Importance of sensory training in speech therapy. J. Speech Hearing Dis., 7, 183-188 (1942).

Schneiderman, N., A study of the relationship between articulatory ability and language ability. J. Speech Hearing Dis., 20, 359-364 (1955).

Scholes, R., On functors and contentives in children's imitations of word strings. J. Verb. Lrng. Verb. Behav., 9, 167-170 (1970).

Scholes, R., The role of grammaticality in the imitation of word strings by children and adults. J. Verb. Lrng. Verb. Behav., 8, 225-228 (1969).

Schuckers, G., Shriner, T., and Daniloff, R., Auditory Assembly of segmented sentences by children. J. Speech Hearing Res., 16, 116-127 (1973).

Shriner, T. H., A comparison of selected measures with psychological scale values of language development. J. Speech Hearing Res., 10, 828-835 (1967).

Shriner, T. H., and Daniloff, R. G., Reassembly of segmented CVC syllables by children. J. Speech Hearing Res., 13, 537-547 (1970).

Shriner, T. H., Holloway, M. S., and Daniloff, R. G., The relationship between articulatory deficits and syntax in speech defective children. J. Speech Hearing Res., 12, 319-325 (1969).

Slobin, D., and Welsh, C., Elicited imitation as a research tool in developmental psycholinguistics. Readings on Child Language Acquisition, Holt, Rinehart, and Winston, In press: New York (1970).

Smith, C. R., Articulation problems and ability to store and process stimuli. J. Speech Hearing Res., 10, 348-353 (1967).

Sperling, G., A model for visual memory tasks. Human Factors, 5, 19-31 (1963).

Spriestersbach, D. C., and Curtis, J. F., Misarticulation and discrimination os speech sounds. Quart. Speech, 37, 483-491 (1951).

Spriestersbach, D. C., Darley, F. L., and Morris, H. L., Language skills in children with cleft palates. J. Speech Hearing Res., 1, 279-285 (1958).

Templin, M., Certain Language Skills in Children. Institute of Child Welfare Monograph Series, No. 26, Un. of Minneapolis Press: Minneapolis (1957).

Templin, M. C., A study of sound discrimination ability of elementary school pupils. J. Speech Dis., 8, 127-132 (1943).

Vandemark, A. A., and Mann, M. B., Oral language skills of children with defective articulation. J. Speech Hearing Res., 8, 409-414 (1965).

Van Riper, C., and Irwin, J., Voice and Articulation. Englewood Cliffs, N. J. : Prentice-Hall (1958).

Weiner, P. S., Auditory discrimination and articulation. J. Speech Hearing Dis., 32, 19-28 (1967).

Wepman, J. M., Auditory discrimination test (Manual of Directions). Chicago: Language Research Associates (1958).

Williams, H. M., McFarland, M. L., and Little, M. F., Development of language and vocabulary in young children. Univ. Iowa Stud. Child Welfare, 13(2), (1937).

Yedinack, J. G., A study of the linguistic functioning of children with articulation and reading disabilities. J. Genet. Psychol., 74, 23-59 (1949).

APPENDICES

APPENDIX A

SENTENCES LISTED ACCORDING TO SENTENCE TYPE

APPENDIX A

SENTENCES LISTED ACCORDING TO SENTENCE TYPE

Well-Formed

My mother washes the dishes.
My dog runs.
The boy plays.
Her doll cries.
The little boy pulls his red wagon.
His brother climbs a tree.
My black dog likes the new bone.
Her big sister wants a new dress.
The pretty teacher reads a funny story.
The other girl lost her blue ball.
Your father drives a car.
Take the book.
The boy rides a bike.
Wash your face.
My cat drinks the milk.
Throw the ball.
The old man takes a long walk.
The girl wears a hat.

Ill-Ordered

His purrs cat.
Eats bear the fresh honey the brown.
Man dirty nice cleans shoes the his.
Balloon happy the clown carries funny a.
Hits car train the a.
My bring bike.
Milk spills the.
Choose friend a.
Door close the.
Carrot the bunny eats the.
Kitten chases my her dog.
Covers blanket baby the yellow the bed.
Washes a the man big green car.
Spins toy your.
Brings a flower lady the.
Baby his calls the mother.
Sister my the spills water.
Girl red cow silly draws the a.

<u>Anomalous</u>

The tall tree washes the dirty dog.
The chair flies.
My yellow dress cries a large tear.
Her big brother sings his black shoe.
Read a paint.
Drink the table.
An airplane chops the wood.
The dog purrs his bone.
A leaf walks.
Comb your teeth.
A nice man wears his new horse.
Her bike eats an apple.
The happy children drink a green spoon.
The tree hops.
His sister bakes a book.
The pretty picutre colors a little boy.
The chair plays a drum.
The lady walks her coat.

APPENDIX B

RANDOMIZATION OF SENTENCE TYPE, AND SENTENCE LENGTH

APPENDIX B

RANDOMIZATION OF SENTENCE TYPE, AND SENTENCE LENGTH

Sentence Type	No. of the Sentence
Well-Formed	1, 4, 5, 6, 9, 17, 18, 23, 25, 30, 35, 36, 39, 45, 46, 50, 53, 54.
Ill-Ordered	2, 10, 11, 14, 15, 16, 19, 20, 21, 22, 26, 27, 28, 29, 31, 37, 38, 52.
Anomalous	3, 6, 8, 12, 13, 24, 32, 33, 34, 40, 41, 42, 43, 44, 47, 48, 49, 51.

Sentence Length	
Three-Word	2, 4, 6, 7, 9, 13, 16, 19, 20, 21 24, 29, 34, 39, 40, 44, 46, 53.
Five-Word	1, 5, 15, 18, 22, 26, 31, 33, 36, 37, 38, 42, 45, 47, 49, 50, 51.
Seven-Word	3, 8, 10, 11, 12, 14, 17, 23, 25, 27, 28, 30, 35, 41, 43, 48, 52, 54.

APPENDIX C

INSTRUCTIONS GIVEN TO SUBJECTS

APPENDIX C

INSTRUCTIONS GIVEN TO SUBJECTS

I want you to listen to what the man is saying on the tape recorder and then tell me exactly what you heard him say. If you can't remember everything, tell me as much of it as you can. For example, if the man said, "He likes food," what would you say? ________________. Good! Let's try another. If the man said, "Find go him," what would you say? ________________. Good! Let's do one more. If the man said, "The door plays," what would you say? ________________. Fine, let's begin.

APPENDIX D

ANSWER FORM USED TO TRANSCRIBE SUBJECTS' RESPONSES

APPENDIX D

ANSWER FORM USED TO TRANSCRIBE SUBJECTS' RESPONSES

NAME______________ S#__________ GRADE____________ TEACHER________________

AGE_______________

Practice items: That girl eats. (WF) Is big she. (IO) The desk talks. (A)

1. My mother washes the dishes.
2. His purrs cat.
3. The tall tree washes the dirty dog.
4. My dog runs.
5. The girl wears a hat.
6. The chair flies.
7. The boy plays.
8. My yellow dress cries a large tear.
9. Her doll cries.
10. Eats bear the fresh honey the brown.
11. Man dirty nice cleans shoes the his.
12. Her big brother sings his black shoe.
13. Read a paint.
14. Balloon happy the clown carried funny a.
15. Hits car train the a.
16. My bring bike.
17. The little boy pulls his red wagon.
18. His brother climbs a tree.
19. Milk spills the.
20. Choose friend a.
21. Door close the.
22. Carrot the bunny eats the.
23. My black dog likes the new bone.
24. Drink the table.
25. His big sister wants a new dress.
26. Kitten chases my her dog.
27. Covers blanket baby the yellow the bed.
28. Washes a the man big green car.

APPENDIX D (CONT.)

29. Spins toy your.
30. The pretty teacher reads a funny story.
31. Brings a flowers lady the.
32. An airplane chops the wood.
33. The dog purrs his bone.
34. A leaf walks.
35. The other girl lost her blue ball.
36. Your father drives a car.
37. Baby his calls the mother.
38. Sister my the spills water.
39. Take the book.
40. Comb your teeth.
41. A nice man wears his new horse.
42. Her bike eats an apple.
43. The happy children drink a green spoon.
44. The tree hops.
45. The boy rides a bike.
46. Wash your face.
47. His sister bakes a book.
48. The pretty picture colors a little boy.
49. The chair plays a drum.
50. My cat drinks the milk.
51. The lady walks her coat.
52. Girl red cow silly draws the a.
53. Throw the ball.
54. The old man takes a long walk.

APPENDIX E

WEPMAN'S AUDITORY DISCRIMINATION TEST
FORM I

Name: ______________________ Age: ______________ Grade: _________

Date: ______________________

AUDITORY DISCRIMINATION TEST*
FORM I

	X	Y		X	Y
1. tub - tug			21. cat - cap		
2. lack - lack			22. din - bin		
3. web - wed			23. lath - lash		
4. leg - led			24. bum - bomb		
5. chap - chap			25. clothe - clove		
6. gum - dumb			26. moon - noon		
7. bale - gale			27. shack - sack		
8. sought - fought			28. sheaf - sheath		
9. vow - thou			29. king - king		
10. shake - shape			30. badge - badge		
11. zest - zest			31. pork - cork		
12. wretch - wretch			32. fie - thigh		
13. thread - shred			33. shoal - shawl		
14. jam - jam			34. tall - tall		
15. bass - bath			35. par - par		
16. tin - pin			36. pat - pet		
17. pat - pack			37. muff - muss		
18. dim - din			38. pose - pose		
19. coast - toast			39. lease - leash		
20. thimble - symbol			40. pen - pin		

Error Score: X: /30 Y: /10

* Typed copy of original Wepman form in order to accommodate margin size requirements.