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RELATIONS AMONG DEFECTIVE ARTICULATORY PATTERNS AND SELECTED MORPHOLOGIC AND SYNTACTIC PATTERNS IN FIRST GRADE CHILDREN

by

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CHAPTER I

INTRODUCTION

In recent years there has been a growing interest in the study of child language. Attention has been given to all the facets of language including phonology, morphology, syntax and semantics. In order to investigate language more expeditiously, linguists have examined these constituents and analyzed their relationship to other linguistic elements in a sentence.

Phonology is the branch of linguistics that deals with the sound patterns of a language, or, in other words, with the phonemes of a language and the rules for their sequence. Phonology provides a generalized, abstract description of articulation, or of the way speakers produce the phonemes of their language. This investigation focuses on articulatory production, and its relation to grammar.

Berko and Brown (1960) and Ervin and Miller (1963) among others have developed theories of language structure that describe the relations between articulation and grammar. The importance of such interrelationships in the diagnosis and treatment of children with communication disorders needs to be emphasized. The clinician must be aware that a child who displays difficulty in articulatory production may have other language deficits that should be identified before a program of therapy is devised.

It has been shown that children with articulation defects have more and different types of linguistic difficulties than children with normal articulation (Menyuk, 1964a, 1968a, 1971b; Templin, 1969; Whitacre, Luper, and Pollio, 1970). These investigators, however, used gross measures (i.e. counting articulatory errors) and took no account of the type of error produced. There has been, to date, little research examining the qualitative relationships that may exist between certain grammatical functions and defective articulation. This study investigated the specific relationships between some grammatical patterns used by first grade children with various articulatory errors in an attempt to provide this information.

Background

Attempts have been made to quantify and measure articulation. Wood (1946, 1949), for example, developed an articulation index based on the work of Travis (1931) that considered the relative frequency with which different sounds occurred in speech and the different positions in which they occurred in words. His index included 70 consonant sounds: 20 consonants in three different word positions and five consonants in two positions. Each consonant was weighted in relation to its frequency of occurrence. The weighting for each consonant was then divided equally among its three or two positions of occurrence. Since the total weighting equalled 100, the examiner had only to subtract the weightings for the misarticulated sounds to determine the articulation index for the subject. To compute Wood's index, therefore, it was obviously not sufficient for a clinician merely to count misarticulated sounds. The clinician had to examine the types of misarticulations which occurred.

Later, Snow and Milisen (1954) derived an articulation score based upon an assignment of values of 1.0 to 5.0 for each speech sound in every position. A value of 1.0 indicated correct articulation, 2.0 a mildly distorted sound, 3.0 a severely distorted sound, 4.0 a substitution, and 5.0 an omission. The articulation score was the mean of these values for all sounds in all positions.

Templin and Darley (1960) constructed an articulation test which yielded a quantitative measure of articulation proficiency based on number of correct responses.

A more recent technique using what might be considered a qualitative analysis of articulatory errors is based on distinctive features. Jakobson, Fant and Halle (1952) developed a distinctive feature theory of phonology. They defined a distinctive feature as the "smallest" acoustic, articulatory, and perceptual characteristic that determined differences between phonemes (e.g. /p/ is distinguished from /b/ by the feature + voice). Later variants of the theory have followed the original assumptions, but have selected slightly different feature sets. Chomsky and Halle (1968), for example, developed the binary feature system which described each phoneme as having (+/plus), or not having (-/minus), a specific feature. The eleven features from their universal set that Chomsky and Halle (1968) applied to English phonology include: +/- vocalic; +/- consonantal; +/- high; +/- back; +/- low; +/- anterior; +/- coronal; +/- voice; +/- continuant; +/- nasal; and +/- strident. Within this system each phoneme is composed of a different combination of features which describe that phoneme. The phoneme /t/, for example, is described as being -vocalic, +consonantal, -high, -back, -low, +anterior, +coronal, -voice, -continuant, -nasal, and -strident. Several investigators (Cairns, 1969; Compton, 1970; Crocker, 1969; McReynolds and Huston, 1971; Menyuk, 1968a; Pollack and Rees, 1972; Snow, 1964; Winitz, 1969) have suggested that articulatory deviations be considered within the framework of distinctive feature systems. They have proposed that the emphasis be placed on the child's acquisition of phonological rules rather than on his development of motoric skills.

More specifically, McReynolds and Huston (1971), for example, contended that the necessary speech motor skills were usually available to the child before his acquisition of phonology and that what he learned were rules for organizing phonetic elements. Although differing in their approach to distinctive feature analysis, several investigators (Compton, 1970; Crocker, 1969; McReynolds and Huston, 1971) agreed that children with articulation difficulties exhibited phonemic patterns differing from the adult model. Upon closer examination, these deviations could be described by a set of phonological rules providing a consistent description of the articulatory behavior (Winitz, 1969). Hannah (1974) proposed that, in order to locate the features underlying a number of misarticulations, a clinician should analyze the distinctive feature patterns of the child's errors. Although the use of distinctive features as a device in therapy has been strongly criticized by some (e.g. Walsh, 1974), the distinctive feature construct provides a structured approach that (1) reveals patterns of articulatory behavior, and (2) may enable a clinician to determine the underlying rules which seem to govern the surface behavior (Faircloth, 1974; Hannah, 1974). A clinician should be aware, however, that a distinctive feature analysis of a child's misarticulations is merely a measure of articulatory performance, and that these acoustic and articulatory features are no more than a small part of a larger and more complex phonological system (Moskowitz, 1970).

In acquiring language the child must not only learn to articulate the sounds of a language, but he must also discover its system of phonology. He learns to use certain articulatory skills which reflect the differences among phonological entities and so displays the interaction between phonetics and phonology. Moskowitz (1972, p. 240) states that "this interaction is essential to a theory of speech therapy which tries to deal with the child's inaccurate creation of a system, rather than with just the superficial pronunciation problems which may result."

Furthermore, acquisition of the phonology of a language is integrally related to acquisition of its morphology and syntax (Chomsky and Halle, 1968; Menyuk, 1964a, 1964b; Menyuk and Looney, 1972a, 1972b). Not surprisingly, therefore, evidence has been found that various aspects of language usage were significantly poorer in children with articulatory defects than in children with normal articulation. Schneiderman (1955), for example, noted that children retarded in language development often tended to be those who made articulatory errors, and children who made articulatory errors were often delayed in the onset of speech and had difficulty in the usage of other aspects of language. In similar research Menyuk (1964a) has shown that syntax was intimately related to articulation. In 1969, Templin found that those children from 3 to 7 years who showed the greatest knowledge of morphological rules also articulated most accurately, thus underlining the relationship between grammar and articulatory behavior. Whitacre, Luper, and Pollio (1970) noted that children with defective articulation produced significantly fewer paradigmatic responses, experienced more difficulty in discriminating possible from impossible phoneme sequences in English, and repeated fewer sentences correctly than children with normal articulation. In addition, Marquardt and Saxman (1972) found that scores on tests of language comprehension and sound discrimination were depressed in relation to the number of articulation errors made by the individual children. That is, children with more articulatory errors received lower scores on language comprehension and sound discrimination tasks than children with fewer errors. Speech-sound identification ability was also found to be lower in speech-defective subjects in a more recent study by Monnin and Huntington (1974).

These previous findings suggest that articulation disturbances are related to other aspects of linguistic functioning. It is appropriate, therefore, to view defective articulation as a potential sign of larger language disorders (Whitacre, Luper, and Pollio, 1970). Since language development involves the simultaneous learning of a set of interrelated systems - phonology, morphology, syntax, and semantics (Berko and Brown, 1960; Ervin and Miller, 1963), a description of a child's articulation patterns should provide a systematic basis for understanding his errors and their possible relationship to deviant patterns in other areas of linguistic performance.

Purpose of the Study

The significant interaction among the articulatory, morphologic, and syntactic aspects of language has already been mentioned. However, past research neglected to provide sufficient information about each aspect to allow for a valid exploration of the relations among these factors. For example, previous researchers classified their subjects as "articulatory defective" or "delayed" because of quantitative scores on an articulation test. The investigators failed to identify the misarticulated sounds or sound patterns used by the subjects and made no attempt to describe the articulatory patterns beyond "defective." The investigators then noted the kinds and number of morphologic and syntactic errors the subjects produced. These other linguistic behaviors were usually assessed using structured tests and repetition tasks which provided very limited observations of linguistic performance.

In general, investigators (Menyuk, 1964a; Menyuk and Looney, 1972a, 1972b; Shriner, Holloway, and Daniloff, 1969) have been concerned with the broad question of whether children with articulatory defects performed better or worse on linguistic tasks than children with normal articulation. Little information concerning the precise relations between articulatory production and other aspects of linguistic performance has been provided. Consequently, the nature and degree of relations between articulation and other language functions is still little understood.

Therefore, objective evidence concerning specific relations between articulatory errors and other language abilities in children is still needed. The present study was designed to provide information to meet this need by investigating the relationship among articulatory, morphologic, and syntactic patterns in first grade children exhibiting defective articulation. Specifically, its purpose was to provide information concerning the relations between types of distinctive feature errors and performance on certain measures of morphology and syntax. Three approaches, not used in previous studies, were taken:

1. The investigator examined in detail the types of articulatory errors produced by the subjects using the Chomsky-Halle (1968) distinctive feature system. Since each misarticulation is the result of an alteration of feature patterns, the investigator attempted to locate the features which accounted for the misarticulations. By computing the percentage of times the features were used incorrectly in all the misarticulated phonemes, it was possible to discover the patterns of features responsible for the production errors. The percentage-correct usage of the Chomsky-Halle features provided, therefore, a detailed profile of articulatory behavior for each subject.

2. The investigator used samples of spontaneous speech to evaluate morphologic and syntactic skills rather than the structured tests and repetition tasks utilized in previous studies. The use of more natural speech samples tapped a broader spectrum of performance skills than specific test items.

3. The examiner used a multi-dimensional scaling procedure (MD-SCAL) to determine the relations that

existed among the available articulatory, morphologic, and syntactic data. This statistical procedure provided a basis for inferring the relations among specific articulatory, morphologic, and syntactic items by discovering how they grouped, or clustered, in behavior.

Definition of Terms

Articulation. The performance aspect of phonological competence resulting from the operation of a set of context-sensitive rules on the underlying phonological category (Chomsky and Halle, 1968).

Defective Articulation. Articulation patterns were described as defective if the child produced incorrectly any of the standard speech sounds as presented in the picture section of the Fisher-Logemann Test of Articulation Competence (1971).

Distinctive Features. Those aspects of the process of articulation and their acoustic consequences that serve to contrast one phoneme from another (Berko and Brown, 1960, pp. 525-526).

Free-Speech Sample. A corpus of utterances elicited from a child in conversation with the examiner using stimulus materials, pictures, and toys in which the child was interested.

Morphology. Morphology includes the 14 grammatical morphemes as described by Brown (1973).

Multi-Dimensional Scaling Procedure (MD-SCAL). A nonmetric scaling procedure that generates a picture or spatial representation of the relationship among a set of data objects O_1, O_2,...,O_n. Nonmetric multi-dimensional scaling determines: (1) the number of factors or dimensions necessary to account for the similarities; and (2) the projections or coordinates of each object on each dimension, from which a spatial representation of the *n* objects can be constructed (Kruskal, 1964a, 1964b; Shepard, 1972a, 1972b).

Sentence. An utterance that has at least a noun and a verb in a subject-predicate relation is termed a sentence.

Syntax. Syntax includes the specific syntactic forms as described by Lee (1974).

CHAPTER II

REVIEW OF THE LITERATURE

This chapter presents an overview of research pertinent to the problem of this study. Investigations of articulatory, morphologic and syntactic development in children, and reports describing other language deficits in children with defective articulation are included. This review will not attempt an exhaustive discussion of all available literature. It will indicate, however, the major areas of investigation and their relation to the present study.

Articulatory Development of Children

The chronological development of speech sounds has been of concern to researchers (Poole, 1934; Templin, 1957; Wellman et al., 1931) for many years. Infant vocalizations have been studied in attempts to describe the process by which the child acquires the articulatory system of his language. Several empirical studies (Ferguson, 1968; Leopold, 1947; Velten, 1943; Weir, 1962) reported in detail the development of speech sounds in individual children. Some researchers, such as Templin (1957), Poole (1934), and Wellman et al. (1931) surveyed large groups of children to determine the average age at which various sounds were mastered. They suggested that some sounds were learned before others, but that most sounds were learned by the time the child was 5- to 7-years-old.

Such research resulted in volumes of recorded data and has been interpreted to bear on the development of phonemes (Slobin, 1967). However, the data failed to reveal when each sound achieved phonemic status in the language of the child such that it could serve to distinguish minimal pairs. Presumably research in sound acquisition should consider the appearance and use of those factors which make such distinctions, (i.e. distinctive features).

In 1941 the study of articulatory acquisition made a great step forward with the publication of Jakobson's Child Language, Aphasia, and Phonological Universals. This work integrated studies of sound acquisition, sound change, and aphasia based on distinctive features rather than phoneme units. He described distinctive features as articulatory and acoustic aspects of speech (cf. Jakobson, Fant and Halle, 1952), and argued that the child who had acquired the full set of features used in his language and the rules for their combination, had thereby acquired the phonemes of his language. In general, Jakobson stated that sounds were acquired in a systematic and orderly fashion and that phonemes with subtle and numerous distinctions were acquired after phonemes which had less subtle and fewer distinctions.

If articulatory development proceeds from maximal contrasts to smaller, more stratified and differentiated contrasts, the number of distinctive features in the phoneme can be said to increase by degrees in child language. The child, therefore, does not learn phonemes as bundles of distinctive features but rather learns specific features which gradually differentiate his initial general phonemes (Jakobson, 1941; McNeill, 1970; McReynolds and Huston, 1971). For example, the feature "nasality" serves to distinguish the phonemes /m/ and /b/, /n/ and /d/, /ŋ/ and /g/. Thus, the child who has already acquired /b,d,g/ and subsequently develops the feature, nasality, adds three phonemes to his repertoire as a result of acquiring a single distinctive feature. The acquisition of distinctive features seems to depend principally on the clarity of the contrast and the ease with which it is heard and produced, regardless of the specific language spoken.

In his discussion of articulatory acquisition, Jakobson (1941) described the development of the child's consonantal and vocalic systems as governed by irreversible and universal laws. Jakobson's schema, later adapted by Jakobson and Halle (1956) for the development of phoneme contrasts, was derived from several major observations about phonemic distinctions in a number of natural languages. One such observation was that the acquisition of phonemes was related not only to the difficulty of production but also to frequency of occurrence in the languages of the world. Nasal consonants, for example, were found to exist in all languages and were among the earliest acquisitions of the child. Liquids, on the other hand, were comparatively rare and were among the last speech sounds acquired (Jakobson and Halle, 1956). Jakobson's contention was supported in a study by Ruke-Dravina (1965) in which the author studied the process of acquisition of the apical Czech /r/, one of the rarest phonemes, in the speech of two Czech and two Latvian children. In all four cases the apical /r/ was the last sound to appear. Jakobson also observed a dependent relation of contrasts. Back consonants, he found, did not occur unless front consonants were present, but front consonants occurred without the presence of back ones. Jakobson described this growth of phoneme contrasts by examining the speech patterns of children from varying linguistic backgrounds and using acoustic and physiological data to supplement his analysis.

Although subsequent research has shown that some of Jakobson's proposals concerning the order of acquisition of distinctive features were inaccurate or overly broad (Moskowitz, 1970), Jakobson had nonetheless provided a new framework for the discussion of articulatory acquisition.

Elaborating Jakobsonian feature theory, Chomsky and Halle (1968) and Postal (1968) suggested that the concept of "markedness" be considered in describing phonological theory. Markedness theory was originally devised by Trubetzkoy (1929) and later developed by Cairns (1969).

It described a method by which phonemic complexity could be analyzed. Trubetzkoy had described several phonological oppositions as a basis for his theory. The presence of a certain phonetic quality in a sound was referred to as the "marked" member of the opposition and the absence of that quality as the unmarked member. The concept of "markedness" characterized the total complexity of each phoneme by assigning the "marked" (M) or "unmarked" (U) values to certain features. The features included consonantal, vocalic, anterior, coronal, continuant, strident, voiced, and lateral. The basis for the marked and unmarked values reflects relative articulatory and perceptual complexity and frequency of occurrence in the languages of the world. The relative complexity of phonemes are determined, therefore, by the number of M assignments ascribed to that phoneme. For example, the phoneme /f/ is described as being Unmarked for vocalic, anterior, coronal, voiced, and lateral, and Marked for continuant and strident.

In addition to the feature system by Jakobson, Fant, and Halle (1952), several individuals (Graham and House, 1971; Miller and Nicely, 1955; Peters, 1963; Singh and Becker, 1972; Wickelgren, 1966) have proposed other sets of features based upon configurations observed in perceptual and short-term memory studies. Yet other researchers (Fant, 1971; Singh, 1971) have questioned the existence of a one-to-one relationship between the physical production of features and their articulatory descriptions.

They stated that previous feature systems had not considered the different contexts and environments in which the sound was produced nor the physiological differences among speakers (McReynolds and Engmann, 1975). Fant and Singh, therefore, chose to describe their features as abstractions.

These feature systems, whether they identified the physical properties of phoneme production or proposed abstract categories, did not contribute significantly to a general theory of language (McReynolds and Engmann, 1975).

In 1968 Chomsky and Halle proposed a different system of distinctive features concerned with a theory of generative grammar. It defined distinctive features in the context of syntactic components since phonetic variations were said to occur as a function of syntactic rules. The system of distinctive features proposed by Chomsky and Halle (1968) is basically a competence model which describes phonemes within a system of grammar.

Many of the distinctive features proposed in these varying systems overlap, despite the fact that they were determined by different linguistic, perceptual or physiological criteria. This commonality among the features of different systems indicates that investigators agree on certain features as basic to the English language (McReynolds and Engmann, 1975).

Since distinctive feature systems contained some common items, investigators (Compton, 1970; Crocker, 1969;

Menyuk, 1968a; Oller, 1973) selected different systems to analyze articulatory behavior. This widespread use of varying feature systems in analysis of articulatory errors, reflected an increased acceptance of this method in research.

Several individuals (Crocker, 1969; Leonard, 1973; Menyuk, 1968a; Messer, 1967; Pollack and Rees, 1972) used a form of the Jakobson, Fant, and Halle (1952) feature system to analyze children's articulatory errors. Others (McReynolds and Bennett, 1972; Oller, 1973) employed the features described by Chomsky and Halle (1968). Crocker (1969) used the feature systems of both Jakobson, Fant, and Halle and Chomsky and Halle to develop yet another model of phonological competence. This model was later used by Leonard (1973) to examine deviant articulatory behavior. In addition, the more traditional features of manner, place, and voicing were selected by several investigators (Compton, 1970; Singh and Frank, 1972) as an appropriate system for analysis since it was not binary and allowed for more variation in the description of the misarticulations. Finally, Cairns, Cairns and Williams (1974) and McReynolds, Engmann and Dimmitt (1974) applied the system of markedness to the defective articulatory patterns of children.

As a result of their research, the investigators agreed that distinctive feature systems were a valid approach to the analysis of misarticulations. Analysis of deviant articulatory behavior demonstrated that children's errors were highly consistent and systematic (Cairns, Cairns and Williams, 1974; McReynolds and Bennett, 1972; Messer, 1967; Oller, 1968). Leonard (1973), however, suggested that articulatory systems must be closely examined to distinguish between those that simply reflect delayed development and those that reflect deviation from the hypothesized developmental sequence. Errors of 70% of the subjects were described by Leonard as developmental and could be accounted for by Crocker's (1969) model; but 30% of the subjects produced "deviant" errors that did not follow the normal sequence of articulatory development.

Investigators (Compton, 1970; Crocker, 1969; McReynolds and Bennett, 1972; Menyuk, 1968; Oller, 1968; Pollack and Rees, 1972; Singh and Frank, 1972) also found that the patterns of the misarticulations stemmed from a relatively small number of underlying phonological principles that produced a large number of deviant phonetic forms. By attempting to identify the phonological rules underlying the articulatory errors, the distinctive feature analysis also provided important diagnostic information to the clinician (Crocker, 1969; McReynolds and Bennett, 1972; Pollack and Rees, 1972).

By examining the substitutions used by children with articulatory errors, investigators (Cairns, Cairns and Williams, 1974; Crocker, 1969; Singh and Frank, 1972) found that a target sound was usually substituted by a sound drawn from a developmentally earlier feature set. Therefore, phonemes which were usually acquired last were most often the targets for substitutions and the substituted phonemes were most often those learned earliest. Although Cairns, Cairns, and Williams (1974) demonstrated that markedness theory could predict that substituted sounds would be less complex than target sounds, McReynolds and Dimmitt (1974) later found that their subjects did not consistently substitute phonemes requiring less effort than the target phoneme. In fact, 47% of the substitutions did not show this change, but resulted in phonemes that required equal or more effort than the target sound.

Observation of the feature errors of sound substitutions revealed that (1) if children made substitutions, they generally used a sound which was one distinctive feature removed from the original sound (Cairns, Cairns, and Williams, 1972; Menyuk, 1968a; Messer, 1967); and (2) some of the later appearing features were less well maintained by children with articulation problems than were earlier appearing features (Compton, 1970; Crocker, 1969; Jakobson, Fant, and Halle, 1956; Menyuk, 1968a; Singh and Frank, 1972). Specifically, the children would maintain an earlier feature, such as nasality, in their substitutions more often than a feature such as stridency which is acquired later.

Children with articulatory deficiencies have been found to maintain all features significantly less than children who develop language normally (Menyuk, 1968). The only exception to this was the feature "nasal" where no significant difference was found. Menyuk found that +voice, +nasality, and +grave were among the best maintained features occurring in the substitutions and that +diffuse, +continuant, and +strident were the least maintained. There appeared to be, therefore, a direct correlation between feature maintenance and the order of appearance of that feature. Features which were acquired early were maintained more often than features which were acquired later. As a result of these data, Menyuk (1968a) proposed that a hierarchy of feature distinction may be a linguistic universal depending on the developing perceptive and productive capacities of the child.

Several descriptive studies (Compton, 1970; Crocker, 1969; McReynolds and Bennett, 1972; Oller, 1968) have demonstrated that it is feasible to use distinctive feature systems to examine deviant articulatory behavior. In general, these studies revealed that children's articulatory errors were not random and that feature error patterns across phonemes could be identified. These findings underline the contention that distinctive features are a potentially powerful tool in describing articulation errors (McReynolds and Huston, 1971; Singh and Palen, 1972; Winitz, 1969).

Morphologic Development of Children

The study of morphology has attempted to determine at what point a child knows how to use a given form and when to use it. The available data have been gathered from free-speech samples as well as from structured test items. Several investigators (Brown and Fraser, 1963; Leopold, 1947; Miller and Ervin, 1964) have provided information relevant to the developmental patterns of certain morphemes in 2-year-old children. They found that the morphemes "the," "a" and the plural suffix "-s" were the most common noun markers used by their subjects. Their data also indicated that the progressive verb form "-ing" was used earlier than the auxiliary, (i.e. subjects used the item "walking" before "is walking"). In addition, Leopold's data have indicated that his subject appropriately used the past irregular and possessive forms in her free speech patterns (Brown, 1973). Brown and Fraser (1963) used imitation rather than free-speech samples to determine the presence of certain morphemes among their subjects. The children, aged 2 years 1 month to 2 years 11 months, imitated sentences to determine their ability to use certain morphemes including: "a," "the," progressive, plural, "in," past regular, third person irregular, third person regular, contractible copula, (e.g. I'm sick), and contractible auxiliary, (e.g. I'm going). Performance improved with age. In fact, the youngest child did not reproduce any sentence correctly, whereas the oldest child correctly reproduced 10 out of 13 sentences. Brown and Fraser also noted that the children were more likely to omit functors (i.e. inflections, auxiliaries, prepositions, articles, and the copula) than to omit the contentive aspects, (i.e. nouns, verbs, and adjectives), of the sentences. They concluded, therefore, that preservation of morphemes is negatively correlated with time of acquisition.

In addition to these studies which observed the presence of certain morphological items among subjects of a particular age group, several researchers (Brown, 1973; Cazden, 1968; Menyuk, 1969) presented data relevant to the general order of morpheme acquisition across several age groups. The results of these studies indicated that, although rate of acquisition for the items differed, the order of acquisition remained the same. This supported the findings of previous research (Brown and Fraser, 1963; Miller and Ervin, 1964; Newfield and Schlanger, 1968). Menyuk (1969) had observed a large cross-sectional sample of nursery school, kindergarten and first grade children. She, as well as Cazden (1968), noted that the verb developed in the same order as described by earlier investigations (Brown and Fraser, 1963; Leopold, 1949; Miller and Ervin, 1964) of very young children. This order included first the generic form of the verb, next, the progressive "-ing", then the past "-ed," and finally, the auxiliary "be."

Menyuk (1969) also considered the development of several other morphemes. Because of the varying ages of her subjects, she was able to determine the developmental appearance of these morphologic items as follows: possessive, plural (regular), articles, and the third person form of the verb "-s".

This sequence differed somewhat from the work of Cazden (1968) who observed that plurals appeared before possessives. Interestingly, Cazden found that each of these items appeared first in a particular linguistic context. In all, Cazden described the acquisition of five noun and verb inflections by three children over a five year period. She defined the point of acquisition for a morpheme as "...the first speech sample of three, such that in all three the inflection is supplied in at least 90% of the contexts in which it is clearly required" (Cazden, 1968, p. 435). She did not indicate, however, the length of each sample. Cazden examined only those inflections which occurred in obligatory contexts and computed the percentage of time each child correctly used such inflections. An obligatory context can be regarded as a verbal instance in an individual's sentence structure which obliges him to use a particular morphologic item. For example, if the child is referring to quantity and uses the item "two," he is obliged to add the plural morpheme "-s" to the following noun, (i.e. two dog<u>s</u>). By introducing the notion of obligatory context and establishing certain specific criteria for the child's use of particular inflections (Cazden, 1968, p. 435), Cazden made a significant contribution to research involving morpheme usage in free speech.

Two recent publications (Brown, 1973; de Villiers and de Villiers, 1973) have significantly increased our information about morpheme development. Brown (1973) has described longitudinal data on the acquisition of 14 morphemes including a discussion of the semantic and grammatical role of each. The morphemes examined included: present progressive, "in," "on," plural, past irregular, articles "a" and "the," third person regular (verb), third person irregular (verb), possessive, uncontractible copula, contractible copula, uncontractible auxiliary, contractible auxiliary, and past regular (verb).

In addition, Brown described, critically evaluated, and compared the findings of numerous studies in an attempt to bring together the available data and describe their importance to the understanding of language acquisition. Brown's acquisition material was based on the spontaneous speech samples of three children recorded over several years. In order to inject more control into his research, Brown, like Cazden, examined the frequency of morpheme usage only in obligatory contexts. Brown described in detail the constraints of his obligations. These constraints included:

1. Linguistic context, the child's own utterance. Thus That book pronounced with an intonation that makes that a demonstrative pronoun calls for a third

> person copula and an article.
>
> 2. Nonlinguistic context. If the child points as he speaks then the copula should be in the present tense rather than the past or future, and if he points at a single book the copula should be singular rather than plural. In the sentence in question it could be either uncontracted (That is) or contracted (That's).
>
> 3. Linguistic prior context, from child or others. If this is the first mention anyone has made of the book then the article ought to be the indefinite a. Had the noun been one that began with a vowel, such as eraser, then the obligatory indefinite would be an.
>
> 4. Linguistic subsequent context. The mother may confirm and expand the child's utterance as: Yes, that's a book. Occasionally the child himself expands his own utterance in this way. Coding for obligatory morphemes is a good deal easier than it is likely to seem when constraints are considered in the abstract. For the most part the several constraints converge on a single form, and the adult native speaker can tell at a glance what that form is (Brown, 1973, p. 255).

From the free-speech samples, Brown tallied the number of times each child correctly used the morpheme in an obligatory context. He then determined the order of acquisition of the 14 morphemes for each of the three children. Brown described this acquisition using his five stages and mean length of utterance (MLU) as guidelines. Each of Brown's stages I through V was identified by a significant grammatical development that occurred in that interval, e.g. Stage I was entitled "Semantic Roles and Syntactic Relations" and Stage II "Grammatical Morphemes and the Modulation of Meaning." In addition, Brown has used mean length of utterance (MLU) as a device in describing grammatical complexity and further identifying these stages. Stage I, for example, begins when the MLU rises above one word (1.0) and ends at two-word utterances (2.0). The upper and lower MLU bounds for the other four stages include the following: Stage II (2.25 to 7); Stage III (2.75 to 9); Stage IV (3.50 to 11); and Stage V (4.0 to 13.0).

Brown defined acquisition points using Cazden's 90% criterion. By examining the three acquisition patterns, Brown found that the developmental order of the morphemes remained constant across the three subjects. This finding, Brown remarked, was significant since the source of performance was free speech, which could not control for frequency and allomorph usage. Therefore, the data confirmed the notion that there is a consistent and orderly development of linguistic performances as demonstrated by the individual morphemes.

Brown, in evaluating the acquisition of morphemes, also noted that there was an appreciable time span between the first time a morpheme appeared and when it reached the 90% criterion. Since morpheme acquisition was not sudden, the notion that a child would always apply a grammatical rule once it was learned was not supported.

Finally, Brown concluded from his research that MLU was a good index of morpheme acquisition at least until MLU equalled four. He did find, however, that, although age could not accurately predict this development, age and MLU together was a better predictor than MLU alone.

Using Brown's 14 morphemes, de Villiers and de Villiers (1973) analyzed free-speech samples of 21 children aged 16- to 40-months. The number of utterances in these samples ranged from 200 to 900. The de Villiers' determined the presence or absence of each of Brown's 14 grammatical morphemes in linguistic and nonlinguistic obligatory contexts. In addition, the authors used two procedures to determine the order of acquisition of these items. First, they rank-ordered the morphemes using the 90% criterion of occurrence at the lowest MLU sample. Secondly, they averaged the percentage of occurrence for each morpheme across the children and ranked these scores. They found their data correlated very highly with those of Brown (1973). The only discrepancy was found in the contractible over uncontractible forms of the copula and auxiliary "be." Like Brown, the de Villiers' found that MLU was a much better predictor of morpheme acquisition than age. Having proposed the order of morpheme acquisition, the de Villiers' examined the possible determinants for this order. One possibility considered was frequency of the morpheme in the speech of the parents to the child. However, they found no significant relationship between the rank ordering of morpheme frequency in parents and the mean order of morpheme acquisition by children (R = 0.26). Next, the de Villiers' investigated the role of semantic and grammatical complexity as predictors of morpheme acquisition. Both complexity elements were found to be important predictors of the morphemes, but the de Villiers' noted that it was impossible to separate out the specific contribution of each since they made the same predictions.

This research by de Villiers' has been described as the most ambitious analysis of morphology to date using free speech (Brown, 1973).

Besides the research based on morpheme usage in spontaneous speech, data have also been collected from controlled studies. One such study was conducted by Jean Berko (1958), using a procedure whereby the construction rules of morphology could be sequenced and evaluated. Berko used nonsense syllables to separate imitative responses from rule-formed responses. For example, in testing the plural allomorph /-z/ the child would be shown a birdlike figure and told, "This is a wug, now there is another one. There are two of them. There are two ____." If the child responded with the appropriate /wʌgz/, it indicated that he had an "...internalized working system of the plural allomorphs in English, and was able to generalize to new cases and select the right form" (Berko, 1958, p. 359).

The results of Berko's research indicated that the children's ability to use appropriate morphological markers increased with age. First grade children performed better than preschoolers. The features of English morphology most commonly represented in the language of the first grader were found to be: (1) the plural and the two possessives of the noun; (2) the third person singular of the verb; (3) the progressive and the past tense; and (4) the comparative and superlative of the adjective (Berko, 1958; Berry, 1969).

Berko's test of morphology was later administered by several investigators (Dever and Gardner, 1970; Newfield and Schlanger, 1968) to groups of educable mentally retarded children and groups of normal children. The studies resulted in the hypothesis that the retarded children were deficient in their ability to construct the systematic morphemic forms of English when compared with normal subjects. The order of acquisition of morphology by the retarded children, however, paralleled that of the normal children.

A criticism of the construction of Berko's test was her use of "nonsense" items. Several investigators (Bryant and Anisfeld, 1969; Dever and Gardner, 1970; Miller and Ervin, 1964) have examined the difference in children's ability to inflect real and nonsense words. In general, the authors found that inflecting nonsense words was a more difficult task for the subjects than inflecting real words. Furthermore, Dever and Gardner (1970) contended that the nonsense items were a confusion factor for some subjects since their scores were consistently better for the "real" word stimuli than they were for the nonsense syllables: Item analyses of children's scores on the Berko test usually resulted in more correct responses on the English items than on the nonsense items. It seemed, therefore, that data from studies using nonsense items should not be used as a basis for describing morpheme usage in English, since the results of these studies reflected a very low level of success as compared with other studies (Brown, 1973; de Villiers and de Villiers, 1973) which used spontaneous speech.

The literature available on morphology included data from spontaneous speech as well as controlled test items. It is important to emphasize that the findings of Brown (1973), Cazden (1968), Miller and Ervin (1964), and Brown and Fraser (1963) relevant to morphology were based on the verbal behavior of a very small number of children. Their conclusions, therefore, are limited by this condition. In spite of the limited number of subjects, however, these data do provide some important information about how a child develops and uses some of the morphologic forms of his language.

Syntactic Development of Children

Syntax is concerned with the order and relations of linguistic items in an utterance. Noam Chomsky (1968) describing the importance of syntax in language development, proposed the existence of an innate set of universal rules that enabled a child to understand, formulate, and use a functional grammar.

Since then, researchers (Bloom, 1970; Braine, 1963; Lee, 1974; McNeill, 1970; Miller and Ervin, 1964) have examined the development of syntax in the free speech of young children. Most of their results, however, described only the form of the utterances used by the children, with very little experimental data concerning the child's understanding of various syntactic structures at different ages. The studies were usually longitudinal, carried out over a period of months or years, and included only a few children.

McNeill (1970) and Brown (1973) indicated that the most active period for learning base syntax was between 18 months and 4 years. At about 18 months children have begun combining two words in their utterances (Brown and Bellugi, 1964a, 1964b). These early sentences, however, displayed the same basic syntactic constructions, individuality, and sentence-types as adult sentences.

Descriptive analysis of two-word utterances has been provided by Braine (1963). Braine proposed that a child had a large "open" class set of words made up of nouns and verbs. In addition, each child also had a smaller, more limited group of words which he called "pivots." Upon careful observation, Braine discovered that the "pivot" words usually preceded the "open" types and were combined in terms of a set of rules. Braine termed these beginning utterances "pivotal constructions" because it seemed that the "pivot" word operated on the "open" word in the child's grammar.

Another use of distributional analysis was proposed by Brown and Fraser (1963) and Brown, Fraser, and Bellugi (1964). These authors described utterances of up to three words in length using a subscript number to denote word classes. In this way they isolated parts of speech and described the rules that operated on them. Not only did this approach appropriately evaluate past utterances, but it accurately predicted many of the utterances which the child would produce in the near future (Brown, Fraser, and Bellugi, 1964). However, Brown (1973) and Bloom (1970) have recently concluded that distributional analysis of two word utterances has been ineffective since it failed to account for semantic relations and described only a small number of a child's utterances.

Several researchers chose to investigate selected syntactic processes. For example, Klima and Bellugi (1966) and Bloom (1970) studied the development of negatives; Klima and Bellugi (1966) also directed their attention to the development of questions; and Brown (1968) investigated "wh-" questions. As in previous studies, these researchers collected free-speech samples of children at different points in time and examined the development of certain syntactic structures.

Some evaluation of syntax has been limited to picture identification and repetition of sentences. Fraser, Bellugi, and Brown (1963) used both techniques in their research. Picture stimuli, however, had one obvious drawback: the structures to be tested were limited to what one could indicate by a drawing. On the other hand, a researcher using repetition, has the advantage that he can shape a sentence to measure a number of elements including length, syntax, semantics, and phonology. By using this technique Menyuk (1971a) found that a child's repetition of a "well-formed" utterance was affected by its underlying structure rather than its surface structure.

Carol Chomsky (1969) used a slightly different technique to examine the comprehension of syntactic structures used by 40 children, aged 5- to 10-years. She presented the children with toy objects and materials and gave them preliminary directions making sure they understood the task. Then she listed their comprehension of certain syntactic structures by asking them to answer questions, give instructions, and move objects. Chomsky found that, contrary to previous beliefs, syntactic acquisition was occurring up to age 9 years and sometimes beyond. In addition, each child displayed the (1) orderly sequence of acquisition and (2) considerable variation in rate of acquisition found by investigators (Bloom, 1970; Brown and Bellugi, 1964b) working with younger children.

One of the most recent methods for writing a children's grammar was proposed by Bloom (1970). Bloom tape-recorded observations of approximately 8 hours of activity for three children aged 19 months, 19 months, and 21 months. These corpora not only provided surface constructions, but included contextual information to aid in semantic interpretation. She accomplished this by including not only the child's utterance, but also what the child was doing and what the adult was saying to the child at the time. The inclusion of semantics especially at the very early stages of language development has been supported by other linguists (Brown, 1973). Brown contended that the use of semantic relations (i.e. cases of possession, location, agent, etc.) was a much more realistic approach to syntactic analysis than distribution of items.

In addition to research describing normal syntactic development, investigators (Morehead and Ingram, 1973) have also examined the syntax of linguistically deviant children. The authors compared the syntax of children with deviant language to the syntactic patterns of young children. They found that the children with deviant linguistic behavior developed linguistic systems similar to children developing syntax normally. The only difference between the two groups was that of onset and acquisition time which, as might be expected, was delayed for the linguistically deviant children. The authors also found that the children with deviant syntax did not use their syntactic systems as creatively as the normal children to produce a variety of utterances.

Clinical procedures for estimating syntactic development in children's spontaneous speech have been developed. One method, Developmental Sentence Scoring (DSS) by Lee and Canter (1971), is based upon a developmental scale of language acquisition and gives weighted scores to a developmental order of syntactic items (e.g. pronouns, verbs, negatives, conjunctions, etc.). This procedure was used to examine the syntax of 160 normally developing children aged 3- to 6-years and 11 months, and resulted in percentile scores for the varying syntactic behaviors.

Lee (1974) later revised the DSS procedure and included the speech samples of 40 additional children, aged 2- to 2-years 11 months. She then subjected all 200 collections of data from 1971 and 1974 to statistical analysis, and, using reciprocal averages, determined a developmental order for the structures. Reciprocal averaging is a statistical procedure that takes data calculated from an ordinal scale of weighted scores and reweights it to approach certain interval scale requirements (Lee, 1974). This procedure was used by Lee to strengthen the internal consistency of the scoring system and the item-total correlations. She asserted that these statistics were important in assessing the reliability and appropriateness of the measurement device. This new procedure resulted in the reweighting of many of the items and, since development across categories was now considered, it provided a more complete model of the development of grammatical items (Lee, 1974). The reweighted scores for the DSS can be found in Appendix A. Lee's work, although limited to particular syntactic items, provided important information relevant to the development and assessment of syntactic skills.

Although much of the research cited above involved the development of specific structures of syntax in very young children, there have also been studies (Menyuk, 1964b; O'Donnell, Griffin, and Norris, 1967) examining older subjects' abilities to derive and apply the rules of syntax in free speech.

For example, the development of transformational rules used by children from approximately 3- to 7-years has been described by Menyuk (1964b). She found that the children produced both completely grammatical sentences and sentences that demonstrated incorrect use of transformational rules at each age level. There were, however, differences in the number of children using the various transformational structures and in the types of deviant structures used.

Menyuk (1971a) found that her subjects, aged 2- to 3-years, used most of the transformational structures that involved operations on a single underlying string. The exceptions noted included the reflexive, passive, adverb preposing, "there" insertion, and participle movement. An increase was noted in the number of children using these structures from nursery school to first grade. All first grade children, however, did not use these structures in their utterances. From these data Menyuk concluded that "permutation" (passive, adverb preposing, "there" insertion, and participle movement) was a transformational operation used by fewer of the younger children and more of the older children, but still not used by all the children at the end of the age range. Menyuk also found that, although the number of children using utterances reflecting operations on a single underlying string did not significantly increase over the age range, there was a significant increase over the age range in the number of children who used structures that involved operations on two or more underlying strings. Only 61% of the first grade children were using "if," "so," and "or" conjunctions, whereas 100% of these children used "and." Menyuk concluded that although conjunctions may appear similar in their operation, they were dissimilar in terms of the semantic relationships they exhibited.

In addition to the total number of rules required for the generation of sentences, O'Donnell, Griffin, and Norris (1967) observed the types of rules used by children in grades 1, 2, 3, 5, and 7. The data resulted in some interesting trends. As previously noted by Menyuk (1964b), utterances using the conjunction "and" occurred frequently throughout the age range. In addition, structures that involved embedding, such as the relative clause, relative clause reduction, participial complements, etc., were used much less frequently. It was also found that kindergarten children used more relative clause structures but less participial complements than children in the seventh grade.

Nursery school and first grade have been described as time periods when rapid changes occurred in syntactic competence resulting in more complex utterances, whereas the kindergarten period was a time when little change occurred (Menyuk, 1964b; O'Donnell, Griffin, and Norris, 1967). In addition, it has been found that there was a decrease in the number of deviant structures used by kindergarten children, but an increase in these structures in the nursery school and first graders (Menyuk, 1964b). During this development period from 3- to 7-years, children no longer just added one sentence on to another for purposes of conjunction, but rather began observing the restrictions that were imposed by operations. Specifically, the first grade child has been described as having a sentence length of 6.5 words. Although he has command of every form of sentence structure (Berry, 1969), he has begun to use more declarative and fewer imperative and interrogative sentences. In addition, this child demonstrated skill in subordination and coordination, and so used complex and compound sentences in 10- to 15% of his utterances (Templin, 1957).

Other Linguistic Deficits of Children With Defective Articulation

Winitz (1969) stated that defective articulation is merely one of several responses that indicates a more general language impairment. Therefore, any delay in articulatory development may be accompanied by a delay in other linguistic areas. This section reports the findings of a number of studies, which has as their aim, empirical assessment of the relationship between phonetic accuracy and syntactic and lexical development.

The nature and degree of relations between articulation and other language functions is still little understood. Results of past studies are inconclusive and often contradictory. As early as 1937 Davis (1937) and Williams (1937a, 1937b) sought to correlate linguistic skills and articulation. Davis found that 5-year-old children achieved significantly lower scores than children with "perfect" articulation in mean length of responses, number of different words, number of spontaneous remarks, and time required to elicit the responses. In the same year Williams related articulation and language performance of 38 children, aged 3- to 4-years, who were examined on a 98-item articulation test. He found significant correlations among articulatory skills and number of grammatical words, mean length of response, number of complete sentences, and sentence complexity. Nonsignificant, however, was the correlation between articulation skills and performance on two separate vocabulary tests. Like Williams, Yedinak (1949), Wellman et al. (1931) and Carrell and Pendergast (1954) found no relationship between articulatory performance and vocabulary.

Several studies (Carrell and Pendergast, 1954; Darley and Winitz, 1961) have investigated the relationship of a specific aspect of language to articulation proficiency. Darley and Winitz (1961), for example, found no evidence to indicate that age of the first word can predict severity of articulatory defectiveness at some later date. In addition, Carrell and Pendergast (1954) investigated spelling ability in relation to articulation proficiency in children. The authors compared children with deviant articulation with controls on spelling ability and type of spelling error. They found no underlying phonetic disability.

In comparison to the few studies showing no significant correlations between articulation and certain language skills there have been many studies (Menyuk, 1964a; Schneiderman, 1955; Shriner, Holloway, and Daniloff, 1969; Van Demark and Mann, 1965; Winitz, 1959) which established definite relationships between these functions. Schneiderman (1955) examined the relationship between articulation and a combined language score obtained from three language measures: spoken vocabulary, sentence length, and teacher's rating of language ability. Each language measure was equally weighted and the subjects, aged 6- to 7-years, were assigned to one of three language groups according to their level of language ability, (i.e. high, medium, and low). Among the three groups the author noted that the number of articulatory errors increased as the combined language scores decreased.

Winitz (1959) correlated articulation of kindergarten children with several other language measures.

Nonsignificant correlations were obtained for length of response and number of different words used. Significant correlations, however, were obtained for: structural complexity, vocabulary, naming, and rime ability. Furthermore, Templin (1957) attempted to determine the correlation of articulation and language measures, not just for one age group, but for each of 8 age levels (3- to 8-years). She found that significant correlations occurred in the younger children, but tended to decrease with age.

In addition to research with younger children, Van Demark and Mann (1965) observed the relationships between articulation scores obtained on the Templin Darley Screening Test and several oral language measures in children aged 8- to 13-years. Nonsignificant relationships were found for mean length of response, standard deviation of mean length, number of one word responses, number of different words, and type-token ratio. The only oral language measure which had a significant relationship with articulation was the grammatical complexity of the utterances.

Some research (Bloom, 1970; Shriner, Holloway, and Daniloff, 1969; Whitacre, Luper, and Pollio, 1972) has been directed towards establishing relations between articulation and syntax. Bloom (1970) stated that the syntactic component specifies the surface structure of the sentence. In doing so it provides information to the phonological component so that it can determine the sequence of phonetic signals for the produced sentence.

The grammar of children, aged 3- to 5-years, diagnosed as using infantile speech has been compared with the grammar of children using normal speech (Menyuk, 1964a; Menyuk and Looney, 1972a, 1972b; Shriner, Holloway, and Daniloff, 1969; Templin, 1969). The grammatical usage of the two groups differed in that the children with normal speech used more transformations and the children with deviant speech used more restricted forms and used them much more frequently (Menyuk, 1964a).

In examining the effects of sentence length and structure on the accuracy of sentence repetition, examiners (Menyuk and Looney, 1972a) found that children with deviant speech had much greater difficulty than the normal speaking children in repeating all sentence types. The repetition of sentences by children with normal speech seemed dependent on the structure of the sentence, and for them non-repetition was not significantly correlated with sentence length (Menyuk, 1964a). In addition, the children with deviant speech repeated with omissions or just repeated the last words of sentences. Non-repetition by this group was significantly correlated with sentence length. In use and repetition of syntactic structures the children with deviant speech, in the terms of the model of grammar used for analysis, formulated their sentences with the most general rules whereas children with normal speech used increasingly differentiated rules to generate syntactic structures. As a result, it has been hypothesized that the differences found between the children with normal and deviant articulation might be due to differences in how the coding processes for perception and production of language were used.

Subjects with articulatory errors have also been found to produce significantly fewer paradigmatic responses than children without speech problems. In form class these subjects appeared to be developing in the normal pattern but at a retarded rate and were less proficient in distinguishing between possible and impossible English phoneme sequences (Whitacre, Luper, and Pollio, 1970).

Furthermore, the degree of deviancy in use of syntactic rules appeared to be significantly correlated with the degree of deviancy in the use of articulation rules. This indicated a strong, dependent relationship between syntactic and articulatory rules for the language-disordered child. In fact, Shriner, Holloway, and Daniloff (1969) have proposed a causal relationship between undeveloped syntax and misarticulation but were unable to indicate the direction of that relationship. Defective articulation or proprioceptive feedback leading to misarticulations, therefore, may actually induce syntactic deficits. Defective syntax, on the other hand, may result in phonetic errors.

Recently, tests have been used to measure the ability of children to comprehend, formulate and repeat certain articulatory, syntactic, and semantic tasks (Aram and Nation, 1975). The subjects ranged in age from 3 years 2 months to 6 years 11 months and had been diagnosed as having a language or language-articulatory disorder. The authors identified certain relationships in the resultant data. Primarily, the younger children displayed a more generalized low level of performance on all language measures while the older children displayed a higher level of performance with specific areas of deficit. In general, the authors concluded that as the children became older, their language improved and the areas of deficiency became more specific. The authors also proposed a hierarchical pattern among the phonological, syntactic, and semantic levels of language. Children who had shown semantic difficulties also showed syntactic and phonological problems. Likewise, children with syntactic deficiencies, usually displayed phonological problems. Only the children who displayed phonological problems had been found to be singly deficient. This proposed hierarchy goes somewhat beyond the previously cited work of Shriner, Holloway and Daniloff (1969).

Each of the studies mentioned so far was designed to relate articulation to the expressive areas of grammar. However, there have been studies (Marquardt and Saxman, 1972; Saxman and Miller, 1973) specifically designed to relate articulation skills to receptive abilities. The studies compared the language comprehension abilities of two groups of children, one having good articulation and the other defective articulation. The children with underdeveloped articulation skills also showed depressed scores on the auditory test of language comprehension and auditory sound discrimination. In addition, the comprehension scores received by the subjects were not simply depressed in general, but were depressed in relationship to the number of articulation errors made by the individual children. The authors found, however, no significant correlation between maximum sentence length recalled and number of articulation errors (Saxman and Miller, 1973). These results, therefore, did not support Locke's (1968) contention that articulatory difficulty could be the result of a limited short-term memory span.

The findings for these studies on grammatical and lexical measures and articulation are not entirely consistent. For some of the studies a substantial relationship between articulation and certain language measures, especially at the young age levels, was demonstrated, and for other studies no relation or only a low relation was found. Even when relationships were established between articulation and other linguistic measures, the relationships were reported using gross, quantitative terms and provided no insight to the qualitative nature of the interaction. In addition, the methods of counting articulatory errors in these studies were general. There was no allowance for "partial" errors, nor were specific sound errors or error-types utilized. Rather, the investigators used an "all or none" assessment to describe the articulation patterns that usually resulted in generalized relationships.

These disparities reflected test differences, test administration differences, and subject population differences. However, it is clear that information about the relationship among the components of grammar in children with a language disorder is necessary to understanding the difficulties encountered by these children and in our planning of therapeutic programs. Dependencies and correlations must be determined. One way in which such relationships might be investigated is by observing and analyzing the qualitative performance of articulation-disordered children on a variety of linguistic tasks. Such was the focus of this study.

CHAPTER III

METHODOLOGY

Subjects

Nine male and four female first grade children diagnosed by the investigator as having defective articulation served as subjects in this study. Articulation patterns were described as defective if the child incorrectly produced one or more phonemes on the picture section of the Fisher-Logemann Test of Articulation Competence (1971). The subjects ranged in age from 6 years 3 months to 6 years 11 months with a mean age of 6 years 7 months. Subjects were selected by the following criteria:

1. Normal hearing as determined by a 15 dB. (ISO, 1964) sweep test at 500, 1000, 2000, and 4000 Hz bilaterally. Subjects were tested in a sound-treated room.

2. Normal intelligence as determined by school records.

3. No obvious physical disabilities as noted in school records and by direct observation.

4. No apparent organic deviations of the speech apparatus as determined by an oral examination.

In addition, each subject was:

1. From a mono-lingual home and displayed the dialect common to northeastern New Jersey.

2. From middle socio-economic families as

determined by income (range: $15,000 to $25,000).

3. Enrolled in the first grade.

Materials

Several testing instruments were used to collect data related to the linguistic functioning of the subjects. This was necessary because there is to date no single comprehensive instrument which examines all grammatical processes in children, and measures for the evaluation of specific language behaviors simply do not exist. In addition, there is no universally accepted or standardized theory of language development. The investigator, therefore, relied primarily on two approaches. First, the use of a structured instrument, the Fisher-Logemann Test of Articulation Competence (1971), designed to elicit specific articulatory responses; and second, the eliciting of a free-speech sample from each subject that was later examined to note the presence, absence, or modification of certain articulatory, morphologic, and syntactic items.

Procedures

Subjects' verbal performances on the articulation test and in the free-speech samplings were recorded by the investigator using a Sony TC-110 tape recorder. The acoustic characteristics of this recorder were established as adequate for the purposes of this study at the City University of New York acoustics laboratory.

Articulatory Production

Each subject selected for the study was given the picture section of the Fisher-Logemann Test (1971) to evaluate his articulatory performance skills. This test is designed to (1) implement the examination of the subject's articulatory system in an orderly framework, (2) provide ease in recording and analyzing phonetic notations of articulation, and (3) facilitate accurate and complete analysis and categorization of articulatory errors. The test items included all English consonant phonemes in systematic occurrence according to syllabic function. Test words in the instrument had been chosen for their familiarity and frequency of occurrence in the vocabulary of young children. The record sheet for each form of the test is organized so that the grouping of articulation errors according to the nature of the articulation deficiency is immediately apparent.

Each subject was told "I want you to look at some pictures and tell me what you see. What is the first picture? the next one..." If an item required verbal prompting, suggested phrases were furnished on the back of the test cards. Responses, which included each phoneme of English in the initial, medial, and final word positions were phonetically transcribed using the IPA (International Phonetic Alphabet) notational system.

Besides the investigator, two speech pathologists (CCC Sp) listened to the tapes of the articulation tests and transcribed each subject's responses. When these phonetic transcriptions were compared with those of the investigator, the inter-judge reliability was found to be 97.5%. After establishing the error patterns based on the Fisher-Logemann test, the investigator attempted to determine the stability of those patterns. This was accomplished by examining free-speech samples and noting the presence or absence of similar articulation patterns. For an error to be considered sufficiently stable to be included in the data analysis, it must have occurred in both the free-speech sample and the structured test situation. All of the articulatory substitution errors produced by the children in the structured test were also present in the free-speech sample and there were no substitutions evident in the free-speech sample which were not evident on the test.

Each of the 13 subjects' articulatory errors was then recorded on an Analysis of Feature Usage Worksheet (Hannah, 1974). This worksheet (see Appendix D) provided the examiner an opportunity to compare the feature composition of the target phoneme, the substituted phoneme(s) and the number of times each response was produced on the test item. All phonemes occurred three times in the test except for /z/, /j/, /ŋ/, and /h/, which occurred only twice. The worksheet was designed to allow for the possibility that a subject might produce more than one substitution for a single target sound. On the worksheet, the examiner recorded and compared the feature composition of the target and substituted phoneme(s) using the Chomsky-Halle (1968) system (see Appendix B). For example, if Subject 1 substituted the /j/ for the /l/ phoneme, the feature data were entered as shown in Table 1.

With this information the investigator was able to determine how closely the subject maintained the features of the target phoneme and which features were altered.

These data were later transferred to a Summary of Data Worksheet (Hannah, 1974) (see Appendix E) which presented the percentage-correct usage of the plus and minus aspects of each feature across all error phonemes. For example, Subject 1's use of the feature +voice was examined across the 11 misarticulated phonemes containing that feature. It was found that Subject 1 had the occasion to use the +voice feature 31 times and used it correctly only 18 times. Subject 1, therefore, received a percentage-correct score of 58.1% for maintenance of that feature.

Since there were plus and minus aspects of the 11 distinctive features used in this study, a total of 22 individual percentage-correct scores were recorded for each subject. This procedure not only permitted the investigator to analyze feature patterns rather than specific phonemes, but to examine the direction of the feature error as well. The appropriate scores for each subject were then averaged and an overall percentage of

Table 1

Analysis of Feature Usage for a Target /l/ and Substituted Phoneme /j/

	Target Phoneme		Substituted phoneme
	/l/		/j/
	Possible number of occurrences	Number of times correct	Number of times produced
	3	2	1
Vocalic	+		-
Consonantal	+		-
Voice	+		+
Continuant	+		-
Nasal	-		-
Strident	-		-
High	-		+
Back	-		-
Low	-		-
Anterior	+		-
Coronal	+		-

maintenance of distinctive feature usage by that subject was determined and recorded (see Table 2).

Following the articulation testing, subjects were seen individually by the investigator on three separate days. The sessions were separated by one week and each lasted for approximately thirty minutes. At each of the three sessions the subject was brought into a small, quiet room in which a Fisher-Price "Play-Family Village" was placed. This three-dimensional toy was selected because it was appropriate to the child's level and interests and represented a variety of possible stimuli to elicit free-speech including stores, cars, trucks, animals, and community helpers. The subject sat on the floor with the toy and usually began engaging in active conversation with himself or the investigator. The subject was encouraged to talk freely and the investigator avoided excessive participation, yet at the same time promoting as much spontaneous speech as possible. Examples of encouragement used by the investigator included "What happened next?", "What would happen if?", and "Tell me about it." The investigator used high-level grammatical forms such as past tense, modals (e.g. may, can, must, etc.), verbs, plural pronouns, etc., so that the child had encouragement and an occasion to use these more advanced forms in his free-speech. The goal in these free-speech sessions was to give the subject ample opportunity to use highly developed grammatical rules if they

Table 2

Example of a Subject's Percentage-Correct Maintenance of Chomsky-Halle Distinctive Features Across Phonemes

Chomsky-Halle features	% of maintenance across phonemes
+vocalic	50
-vocalic	96
+consonantal	88
-consonantal	50
+voice	58
-voice	100
+continuant	59
-continuant	82
+nasal	100
-nasal	100
+strident	91
-strident	100
+high	90
-high	88
+back	100
-back	91
+low	100
-low	100
+anterior	91
-anterior	92
+coronal	87
-coronal	91
Mean feature maintenance	86

were representative of his language level.

Since the subjects presented articulatory errors, it was often difficult to transcribe these free-speech samples. In an effort to overcome this difficulty, the investigator, during the taping, repeated the subject's utterance when necessary to serve as a guide in the later transcription. These verbal guides were not necessarily word for word repetitions and proved valuable in verifying what the subject had said.

The investigator transcribed each of the tape-recorded speech samples immediately after the session in order to heighten the recollection of the child, materials, and context. Portions of tapes were played many times in order to ensure an accurate recording of the utterances. Since the language sample was used for grammatical analysis, the tapes were transcribed in words (graphemes) rather than phonetic symbols, but allowances were made for articulatory errors when they related to other areas of linguistic performance. In the sentence "What i- that?", for example, the subject was given syntactic credit for the copular "is" even though he had misarticulated it. In this way the subject was not penalized for articulation errors, and at the same time was not given credit for linguistic structures that were not demonstrated.

Interruptions in the subject's speech were included in the transcription but deleted from the final analysis, (e.g. (The) the girl (uh...sat, I mean) stood in the hall). Intonational and contextual cues were used to aid in the delineation of individual utterances.

Morphology

Once the 39 tapes were obtained and transcribed, the transcriptions were examined for the presence of specific linguistic items. The first area of analysis was morphology. The presence or absence of the 14 grammatical morphemes (Brown, 1973) produced in obligatory contexts was observed and scored. The constraints of obligatory context were imposed since the use of this criterion reflected the subject's ability to use certain morphologic items as opposed to his choosing to do so (Brown, 1973).

The speech samples of the individual subjects varied in size from 258 to 566 with a mean of 368 utterances. In accord with de Villiers and de Villiers (1973) and Brown (1973) and in order to limit variability in this study, only those morphemes that occurred in six or more obligatory contexts were used for statistical purposes. The number of occurrences in obligatory contexts for each of the 14 morphemes was recorded for each subject. For example, Subject 1 used the present progressive 47 times in obligatory contexts. The percentage-correct score for that morpheme was then determined and recorded for that subject. To illustrate: Since Subject 1 used the present progressive correctly in each occurrence, he received a score of 100% for that morphologic item. This score was then multiplied by Brown's (1973) developmental ranking (see Table 3) for that morpheme. The numerical ranking for the present progressive is 2.33, a low ranking since it is one of the first morphemes in Brown's developmental sequence. The developmental ranking scores for the 14 morphemes ranged from 2.33 for the present progressive to 14 for the contractible auxiliary. Since Subject 1 received a percentage-correct score of 100% for the present progressive and since the developmental ranking for that item was 2.33, that subject's percentage-ranking-score for the present progressive was 233%. The same procedure was used to determine the percentage-ranking-scores for the remaining 13 morphologic items. The sum of these scores was then divided by 103.97, Brown's total ranking score for the 14 items and an overall Developmental Morphology Score (DMS) was determined. The maximum DMS was 100%. Subject 1's DMS was 74.74%. This score can be considered a reflection of how well that subject correctly produced specific morphemes in obligatory contexts in relationship to their developmental appearance.

Syntax

Next, the examiner analyzed the transcribed utterances noting the presence or absence of specific syntactic forms. For this purpose, the investigator used the Developmental Sentence Scoring Procedure (DSS) first developed by Lee and Canter (1971) and recently revised by

Table 3

Mean Order of Acquisition of 14 Morphemes Across Three Children (Brown, 1973, p. 274)

	Morpheme	Average Rank
1.	Present progressive	2.33
2-3.	in, on	2.50
4.	Plural	3.00
5.	Past irregular	6.00
6.	Possessive	6.33
7.	Uncontractible copula	6.50
8.	Articles	7.00
9.	Past regular	9.00
10.	Third person regular	9.66
11.	Third person irregular	10.83
12.	Uncontractible auxiliary	11.66
13.	Contractible copula	12.66
14.	Contractible auxiliary	14.00

Lee (1974). This technique yields weighted scores for certain grammatical structures present in a corpus of 50 sentences. Therefore, 50 sentences from each of the three free-speech samples for each subject were selected to be included in the corpora according to specific criteria provided by Lee (1974). These criteria specified that the sentences must have been (1) complete as judged by the presence of a noun and verb in a subject-predicate relationship, (2) consecutive in their appearance in the sample (intervening non-sentences were disregarded), (3) different (no repetitions of sentences were included), (4) intelligible (all unintelligible utterances were excluded from the corpus), and (5) spontaneous (no echoed utterances were included in the corpus). Since the corpus must be composed of only complete sentences, all fragmentary and incomplete sentences were not considered. In order to separate sentences for the DSS, the guidelines proposed by Lee (1974) relating to conjunctions and pre-sentences were used. Application of these criteria yielded a corpus of 50 consecutive sentences selected from the middle of each of the transcripts obtained in the three free-speech sessions for a total of 150 sentences and three corpora for each subject. The use of 150 sentences, rather than 50, was based on the finding by Johnson and Tomblin (1975) that, for research purposes, a minimum of 95 sentences was necessary to attain a reliability of .85 for the syntactic components.

A DSS score for each subject was then computed for each of his three 50-sentence corpora using the scoring system proposed by Lee (1974) (see Appendix A). This system examined the subject's usage of eight grammatical categories: indefinite pronoun; personal pronoun; main verb; secondary verb; negative; conjunction; interrogative reversal in question; and "wh-" question. With possible scores in each of the eight classifications of grammatical structure, plus the additional sentence point if the sentence was correct in all respects, the subject's ability to handle the "grammatical load" in spontaneous speech was estimated for each sentence. For example, if the subject produced the sentence "I don't know," he would receive 1 point for correct use of the personal pronoun "I"; 4 points for correctly using the main verb "don't know"; and 4 points for the appropriate use of the negative "don't." The subject would also receive a sentence point since all the items within the utterance were correct. The subject's total score for that sentence, therefore, would be 10. The same scoring procedure was used for the other 49 sentences in each corpus. The scores for the 50 sentences were then totaled and the mean score per sentence (DSS) was derived. An example of a DSS scoring procedure is presented in Appendix C.

The DSS scores obtained from each of the three corpora as well as the percentage-correct scores received by the subjects in each of the nine syntactic categories (including sentence point) were then averaged, yielding a total of nine mean scores for each subject. The mean DSS score was then used to compute each subject's percentile and length of language delay in months as proposed by Lee. In addition, the 150 sentences used to compute the DSS were also used to calculate the mean length of utterance (MLU) as described by Brown (1973, p. 54). Brown (1973, p. 53) described MLU as an "...excellent simple index of grammatical development because almost every new kind of knowledge increases length."

Data Analysis

Three Spearman rank-difference correlations were computed to determine whether a statistically significant relationship existed between (1) articulatory proficiency and performance on a measure of morphology, (2) articulatory proficiency and performance on a measure of syntax, and (3) performance on measures of morphology and syntax.

In addition to describing the general pattern of correlation among the linguistic items, the investigator also determined the relations between the individual types of distinctive feature errors (e.g. coronal, strident, etc.) used by the subjects and their performance on measures of morphology and syntax. In order to understand the relationship among the individual items within the areas of articulatory production, morphology, and syntax, a multi-dimensional scaling procedure labeled MD-SCAL

(Kruskal, 1964a, 1964b, 1968; Shepard, 1972a, 1972b) was used. This procedure has been described as a method of generating a picture or spatial representation of the relationships among a set of factors, in this study linguistic items.

As a statistical procedure, MD-SCAL determines (1) the number of factors or dimensions necessary to account for the similarities and (2) the projections or coordinates of each factor on each dimension from which a spatial representation of the items can be constructed. Thus, nonmetric multi-dimensional scaling attempts to reduce a complex matrix of numbers to a picture which shows the interrelationships among the factors.

The MD-SCAL computer program supplies the coordinates of each item which define its position on the pictorial graph. The coordinates locate the objects correctly with respect to one another (i.e. similar objects are close together and dissimilar objects are far apart). The initial configuration of items is not always immediately meaningful and the investigator must use his knowledge or insight about these items in order to transform the configuration into an interpretable form (Shepard, 1972a). The investigator must then produce a reasonable interpretation of the configuration on the basis of his background information and data collection.

In order to analyze the MD-SCAL graph, the investigator observed the groupings or "clusters" of certain items and attempted to determine from background information what the items had in common and how they differed from the items in other clusters.

The basic input data for the MD-SCAL is a square symmetrical matrix containing the measure of correlation between the appropriate factors. Therefore, the investigator constructed three matrices based upon the similarity (correlation) computed between the variables in each of the areas of articulatory production, morphology, and syntax. In addition, a fourth correlation matrix was constructed reflecting the similarities between all the 45 linguistic items examined in this study. Pearson r was used to compute these four correlations using the subjects' percentage-correct performance scores.

Using the appropriate correlation matrices as input data, three separate MD-SCALs were computed to determine relations among the individual items within the areas of articulatory production, morphology, and syntax. These data were gathered to provide a firmer basis for the interpretation of the fourth MD-SCAL. The input data for the fourth MD-SCAL included a matrix correlation of the 45 linguistic items. The purpose of this fourth analysis was to identify the relations among the individual items of articulatory production, morphology and syntax.

Since the Fisher-Logemann test provided information about the subjects' productions of individual phonemes, the investigator computed two additional correlation matrices. The data used to develop these matrices included the percentage-correct usage of the individual phonemes. Using these correlations as input data, the investigator computed two MD-SCALS representing respectively, (1) relations among phonemes based on the subjects' substitution patterns and (2) relations among individual phonemes, morphologic and syntactic items. It was hoped that the pictures generated by these additional MD-SCALs would provide important information relevant to whether distinctive features or phonemes provided the best configuration for the analysis of misarticulations.

For each of these MD-SCALs, solutions utilizing two and three dimensions were obtained to determine which number of dimensions provided the lowest stress factor and thus, the best configuration for the data. The stress of a configuration, expressed as a percent, decreases each time another dimension is added because the additional dimension allows more freedom to rearrange the variable points and brings about closer agreement of the interpoint distances and the order of input similarities.

The MD-SCAL procedure has been used successfully in related research (Singh and Singh, 1972), and can be considered an appropriate method of analyzing correlational data. Furthermore, it appeared to be a valuable research tool to the extent that the resulting summary picture assisted the investigator in understanding the relationships among the linguistic items.

In addition to these statistical analyses, the investigator also examined and described the patterns of linguistic behavior produced by the subjects in their free-speech. These patterns were then compared with the results of the MD-SCAL graphs in order to identify similarities or discrepancies in the findings.

CHAPTER IV

RESULTS AND DISCUSSION

This chapter is divided into three sections: (1) results of the correlational treatment between articulatory production, morphology, and syntax; (2) results of the MD-SCAL procedures that related specific items within and between the three linguistic areas; and (3) a descriptive account of the subjects' linguistic performance in the free-speech samplings.

Correlations

The first area of interest was subdivided for statistical purposes. In order to provide a complete picture of the relationships among the data, the investigator considered the relationship between (1) articulatory production and morphology, (2) articulatory production and syntax, and (3) morphology and syntax.

Articulatory Production and Morphology

The relationship between articulatory production and morphology was investigated using a Spearman rank-order correlation coefficient. The correlation was computed using the subjects' averaged percentage-correct maintenance of distinctive features across phonemes (see Appendix F) and developmental morphology scores (see Appendix H) as input data. The results of the analysis yielded a Rho of

.72, which was found to be significant beyond the .05 level of confidence (see Table 4). This level of statistical significance supported the hypothesis that a significant relationship existed between articulatory proficiency and morphologic proficiency. This finding added further support to the research of Templin (1969) and Menyuk (1971) who suggested an underlying relationship between morphology and articulatory behavior.

Articulatory Production and Syntax

A second rank-order correlation coefficient was then computed to determine the relationship between articulatory production and syntax. The data used in this correlation included the averaged percentage-correct use of distinctive features and DSS scores (see Appendix I). The resulting correlation of .57 was found to be significant at the .05 level (see Table 4) indicating a significant relationship between articulatory production and syntax. The results of previous investigators (Holloway and Daniloff, 1969; Van Demark and Mann, 1965; Whitacre, Luper, and Pollio, 1970) were thus supported.

Morphology and Syntax

A third rank-order correlation coefficient was computed between morphology and syntax to complete the picture of the relationships among these linguistic components. The measure of correlation between the correct use of morphologic and syntactic items was .75 (see Table

Table 4

Results of Spearman Rank-Order Correlation Between Articulatory Production, Morphology, and Syntax

	Morphology	Syntax
Articulatory production	.72*	.57*
Morphology	-	.75**

* $p < .05$

** $p < .01$

4). This correlation value was found to be significant beyond the .01 level. A positive relationship between morphology and syntax was, therefore, established.

MD-SCAL Analyses

While these correlations were statistically significant, they failed to present a clear picture of what types of intimacies existed among articulatory production, morphology, and syntax. To provide a more discriminating analysis of the interaction among these linguistic items, a multi-dimensional scaling procedure (MD-SCAL) was performed to determine the relation between the individual types of distinctive feature errors (e.g. coronal, strident, etc.) used by the subjects and their performance on measures of morphology and syntax. In order for these relationships to be accurately described, it was necessary first to analyze each group of linguistic data separately. The investigator, therefore, ran three separate MD-SCALs using articulatory, morphologic, and syntactic data. Only after the relationships within each of these categories had been examined, did the investigator attempt to analyze the results of the MD-SCAL including the interrelationships among all of the 43 linguistic items.

Articulatory Production: Distinctive Features

The first MD-SCAL described the relationships among the individual distinctive features. Prior to the MD-SCAL, a correlation between each articulatory feature and the remaining features was obtained by means of a standard computer program. The raw data for this procedure consisted of the percentage-correct use by each subject of the individual distinctive features. The correlations generated by this procedure resulted in a matrix showing the similarity among the articulatory features. Since the feature +nasal obtained a correlation of 1.0 it did not contribute to the MD-SCAL analysis and was discounted. The remaining 21 feature matrix was then used as the basic input data for the first MD-SCAL. The stress factor, which is a quantitative measure of how well the configuration matches the data, was computed for two and three dimensions. A low stress value indicated close agreement and high stress values reflected poor agreement. The two-dimensional MD-SCAL resulted in a stress factor of .27 and the three-dimensional MD-SCAL a stress factor of .16. Based upon Kruskal's (1964a) suggested evaluation system (see Table 5) the three-dimensional MD-SCAL was determined as providing the best fit and was used for the analysis.

A three-dimensional configuration of the data was graphed using the plotted values of the feature items (see Appendix J) generated by the computer analysis. Once this three-dimensional figure was constructed, it was carefully inspected for "clusters" of items in close proximity.

The features tended to group into five clusters (see Table 6). These clusters or groupings are presented in Figure 1 for ease of interpretation. Each item on the

Table 5

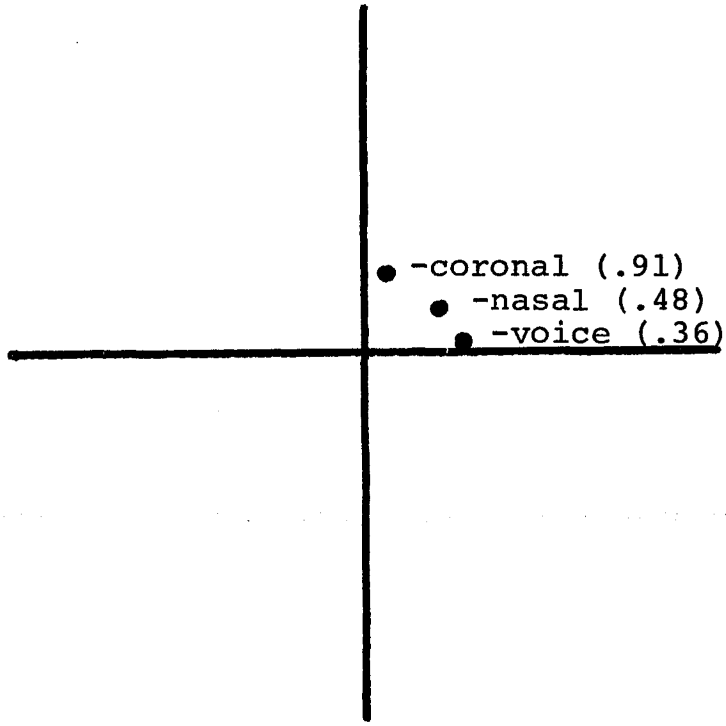
Verbal Evaluation of Stress Percentages
(Kruskal, 1964a, p. 3)

Stress	Goodness of fit
20 %	poor
10 %	fair
5 %	good
2½%	excellent
0 %	perfect

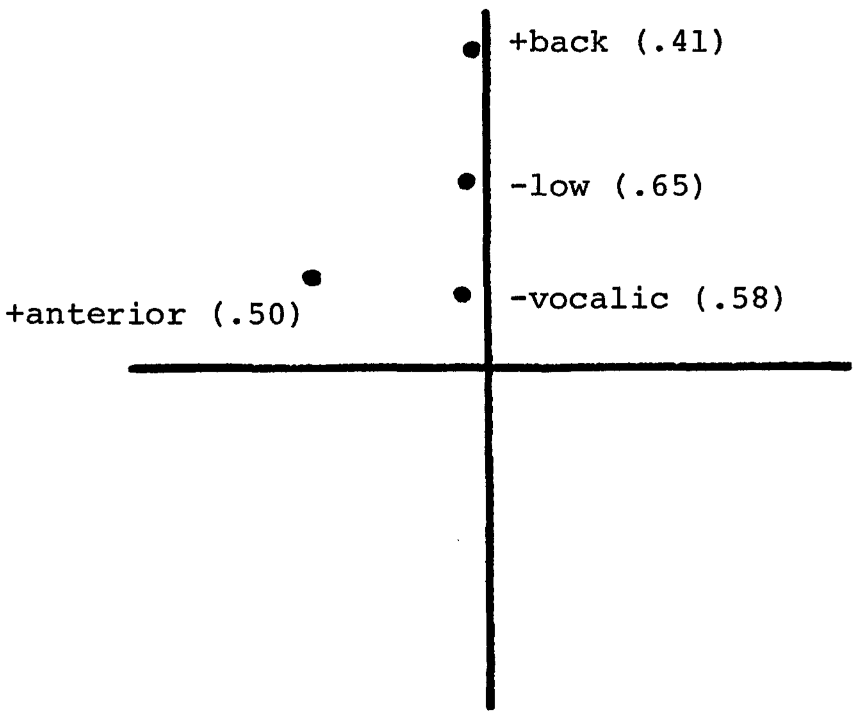
Table 6

Grouping of Distinctive Feature Items
Generated by MD-SCAL Analysis

Group	Distinctive features
I	-nasal
	-voice
	-coronal
II	-vocalic
	+back
	-low
	+anterior
III	-high
	-back
	+consonantal
	+coronal
	-strident
	-continuant
	+vocalic
IV	+low
	+high
	-anterior
V	-consonantal
	+continuant
	+strident
	+voice

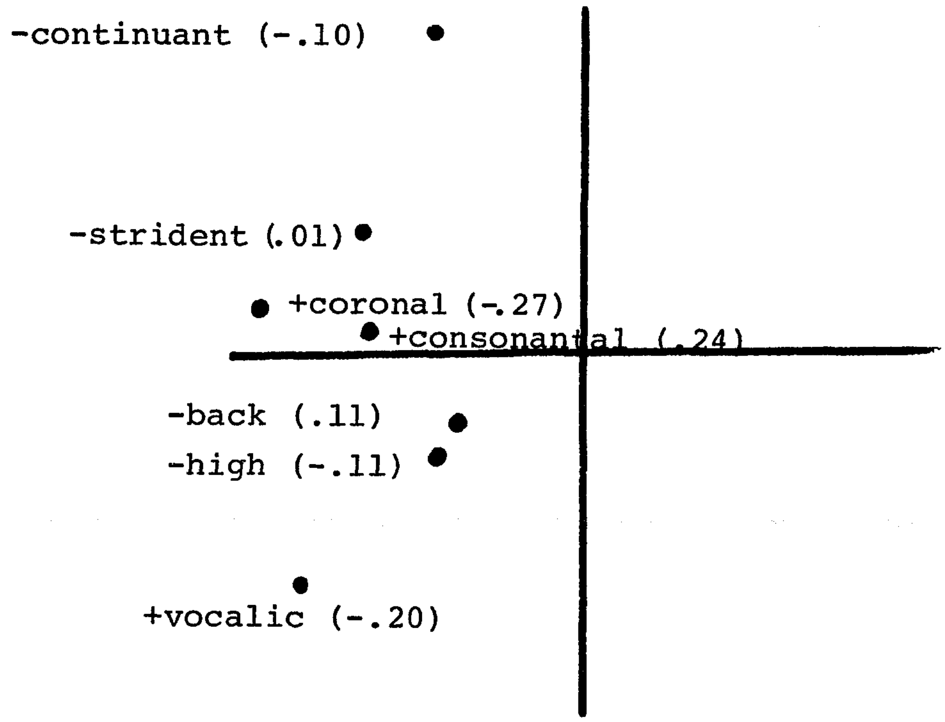


Group I

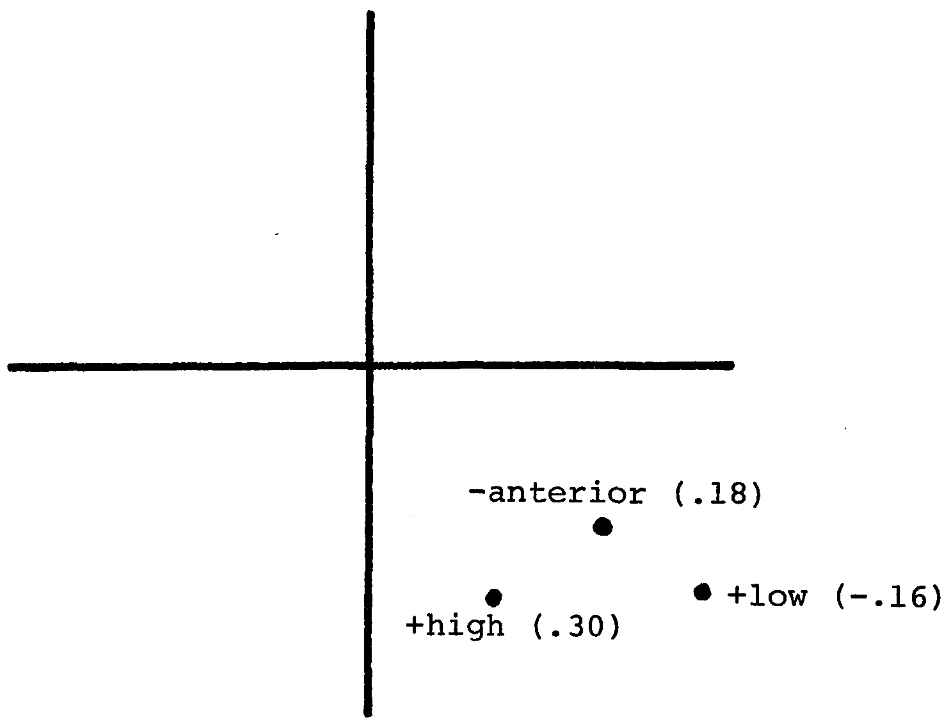


Group II

Fig. 1. Configuration of five groupings of distinctive feature items generated by MD-SCAL analysis. Parentheses () contain the third-dimensional plot value for each item.

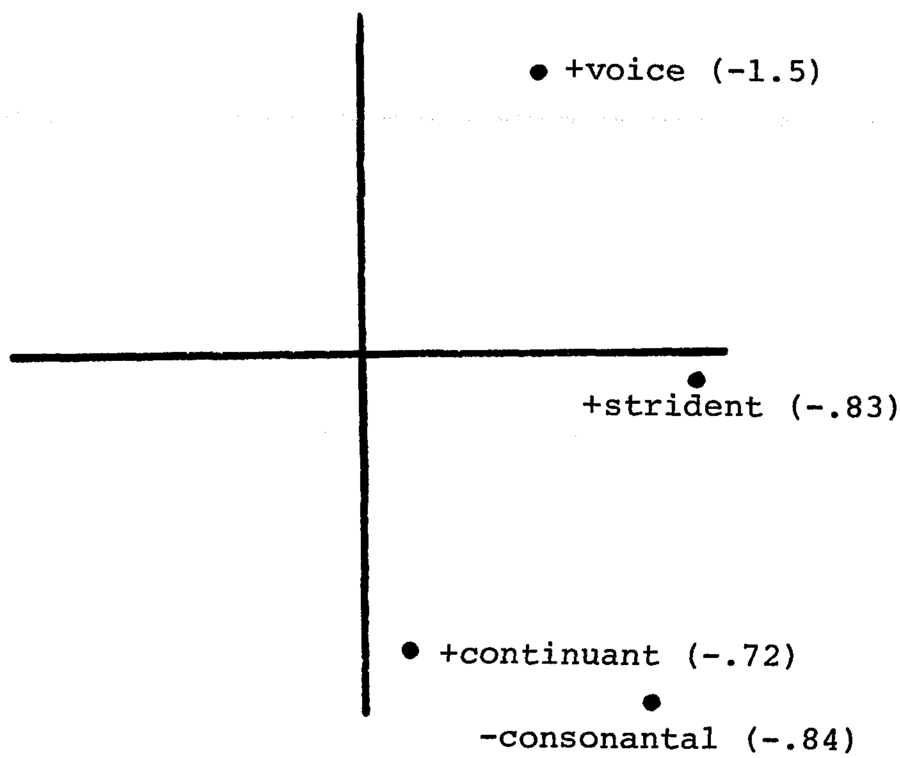


Group III



Group IV

Fig. 1. (continued)



Group V

Fig. 1. (continued)

figure is followed by its third dimension coordinates.

The features within Groups I, II, III and IV formed tight clusters indicating that features within each group were closely related to one another. Therefore, subjects who produced the feature +low correctly tended to produce -anterior and +high correctly since those features were also members of Group IV. The same was true for features within Groups I, II, and III.

The features in Group V formed a looser pattern. The feature +voice was most distant from the group and this interrelated the least with the other features.

Upon closer examination it was noted that the features which were closest to the intersection of the coordinates were those features best maintained by the subjects. These features included those from Group I (i.e. -nasal, -voice, and -coronal) which were all minus (-) features. It should be recalled that the feature +nasal was not included in this analysis since it was always used correctly by the subjects.

In addition, it was noted that those features which clustered farthest from the axis were those which were most frequently misproduced by the subjects. These included the features from Groups V and III: +voice, -consonantal, +strident, +continuant, +coronal, and +vocalic. It is interesting to note that these were all + features and that the data support the work of Menyuk (1968b) who found a similar pattern to distinctive feature errors in her population.

Children develop their articulatory patterns by discriminating perceptually and productively between the + and - aspects of the distinctive features. Since these aspects represent in a sense opposite ends of a feature continuum, a subject would not produce both feature errors (i.e., voice all unvoiced sounds and devoice all voiced sounds). It would be expected, therefore, that the + and - aspects of the features would be separated by their plotted values. An examination of the MD-SCAL graph supported this hypothesis. No + and - aspects of the same feature clustered together, and were, in fact, always in separate cluster groupings.

In general, manner features tended to cluster together in Groups I and V and were less maintained by the subjects than the place features. The features of place also grouped into clusters in Groups II and IV and were easiest for the children to maintain. These findings supported the claim (Cairns and Williams, 1972; Menyuk, 1968b) that the items which are most difficult for children to produce are those which occur later in the developmental sequence and those which are the easiest occur first.

Articulatory Production: Individual Phonemes

Although the primary interest of this part of the study was to examine children's articulatory productions through a distinctive feature analysis, the question of the usefulness of these features as compared to phonemes led to a second analysis of the articulatory data. In an effort to examine this question, the articulatory data were prepared to be examined as individual phonemes using the MD-SCAL procedure.

An MD-SCAL plot was constructed using data available on each subject's percentage-correct articulation of individual phonemes (see Appendix G) on the Fisher-Logemann Test of Articulation Competence (1971). Several of the sounds in the test were subdivided on the basis of their occurrence in the initial and final positions. These sounds were the /s/, /z/, /t/ and /d/. The subdivision of these sounds was made in order to determine whether the subjects differed in the production of these sounds as a function of their position within words. The resultant correlation matrix was then analyzed by means of the MD-SCAL procedure. The sounds /m/, /n/, /ŋ/, /f/, /p/ and /tʃ/ were omitted from the analysis since their correlations did not contribute statistically to the overall matrix.

The stress factor for the two-dimensional MD-SCAL analysis on the phonemes was a very poor .69. The addition of a third dimension only reduced the stress to .51. This value reflected a poor fit for the data thus indicating that the use of phonemes was less effective than distinctive features in generating the best-fitting configuration for the articulatory data.

The investigator constructed a three-dimensional model from the plot values of the phonemes (see Appendix K) and observed how they physically related to one another. The sounds grouped into seven clusters (see Table 7). These clusters are presented in Figure 2 for ease of interpretation.

An analysis of these clusters indicated a general progression of difficulty. The sounds included in Group I, for example, tended to be the easiest. Group II contained somewhat more difficult sounds for the subjects. Groups III and IV were even more difficult, and Groups V, VI and VII contained sounds with which the subjects had the most difficulty.

Another observation was that the most difficult sounds were positioned at points found farthest from the central axis and the easier sounds closer to that axis. In addition, the easier sounds tended to be unvoiced plosives and the more difficult the voiced fricatives and glides. It was also evident that the fricatives and glides tended to form tight groups suggesting that a child who had difficulty with one fricative and/or glide would probably have difficulty with other fricatives and glides as well.

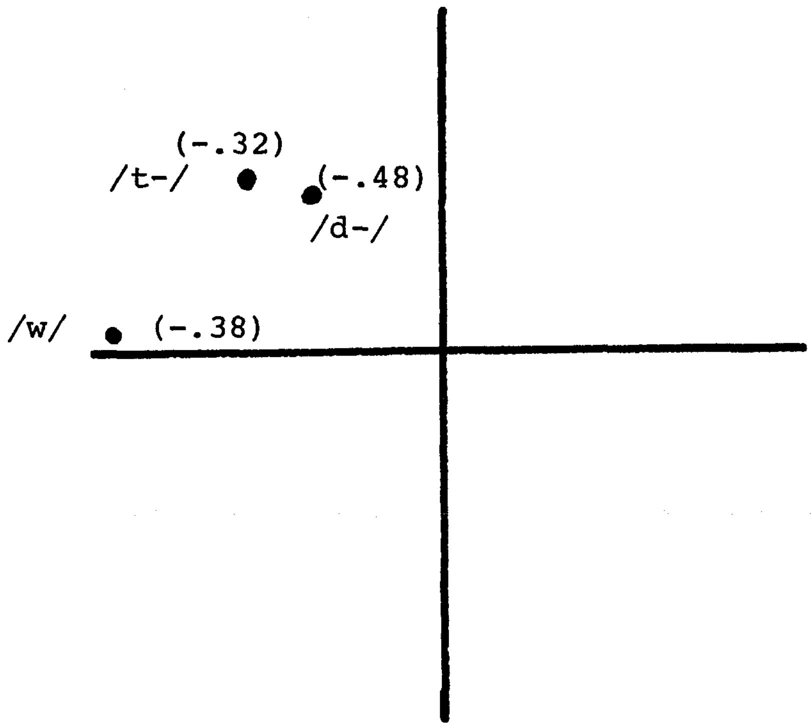
Morphology

Following the analysis of the two MD-SCAL graphs on articulatory production and phoneme analysis, the

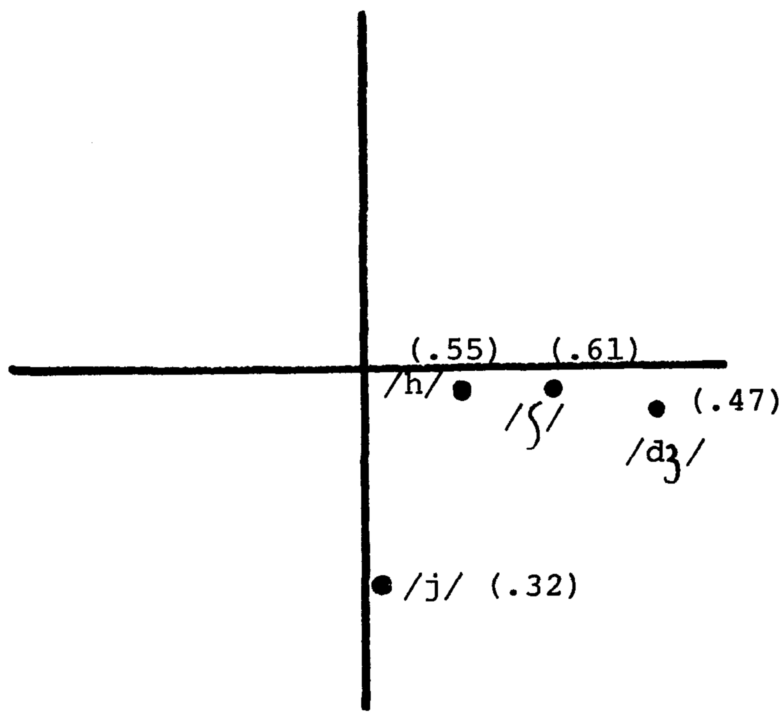
Table 7

Grouping of Individual Phonemes
Generated by MD-SCAL Analysis

Group	Individual Phonemes
I	t-
	d-
	w
II	h
	ʃ
	dʒ
	j
III	k
	-z
IV	g
	ʒ
	-d
V	s-
	z-
	-s
	b
VI	ɣ
	l
	v
	-t
VII	r
	θ

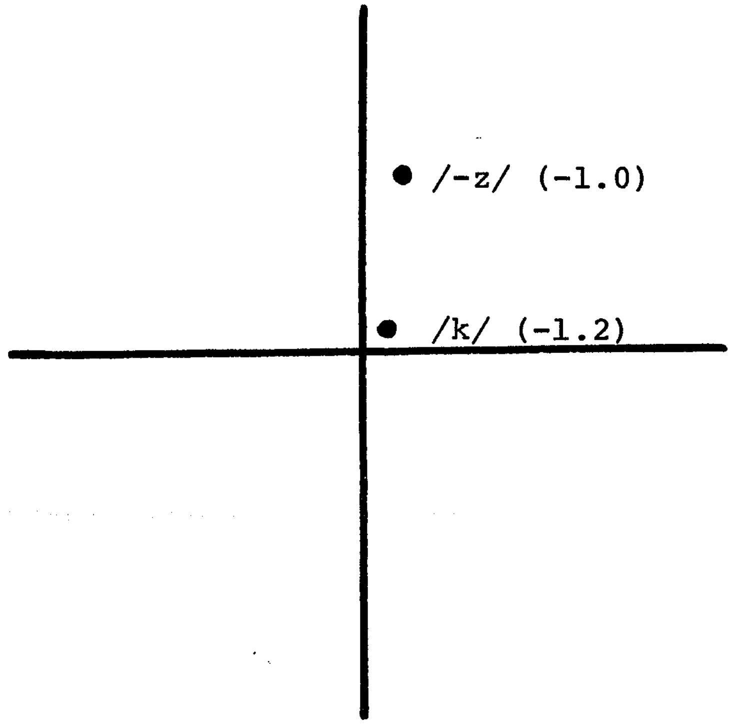


Group I

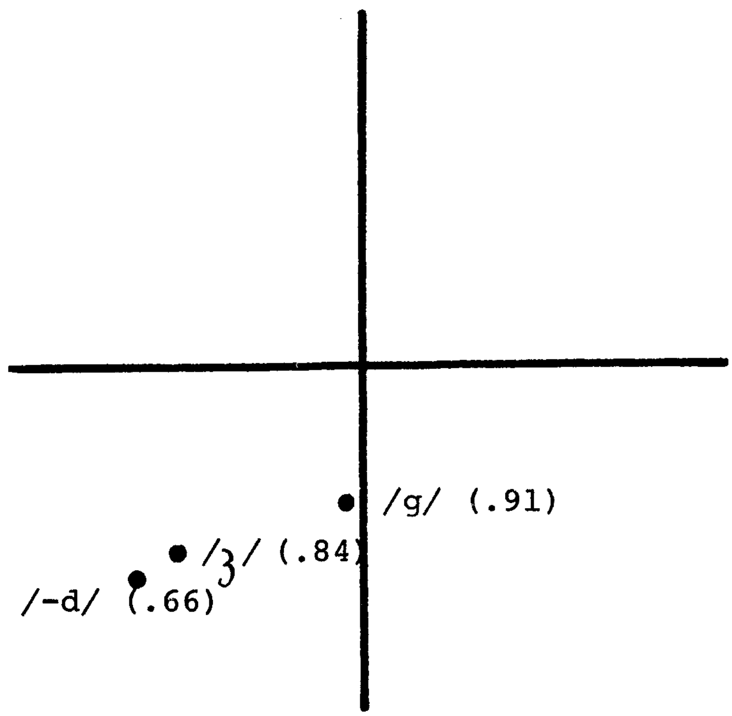


Group II

Fig. 2. Configuration of seven groupings of individual phonemes generated by MD-SCAL analysis. Parentheses () contain the third-dimensional plot value for each item.

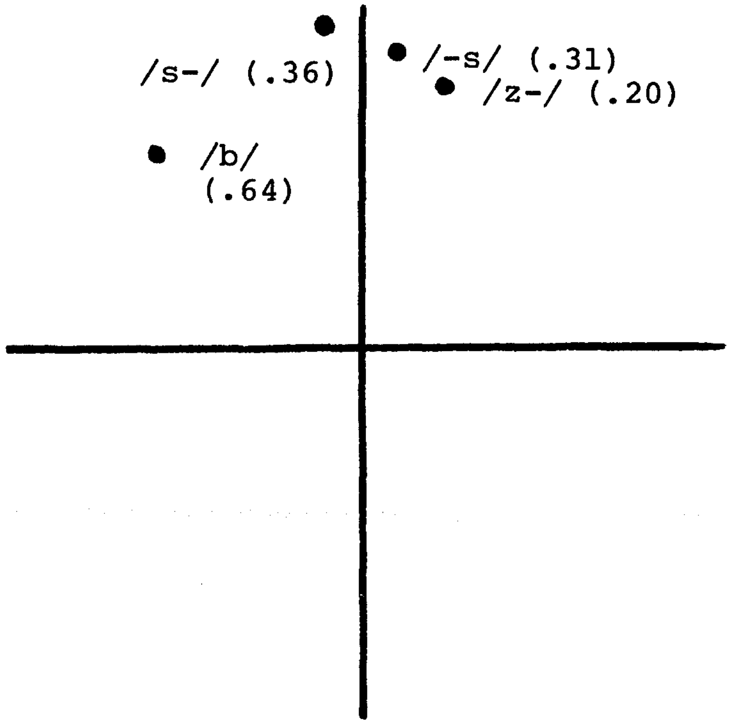


Group III

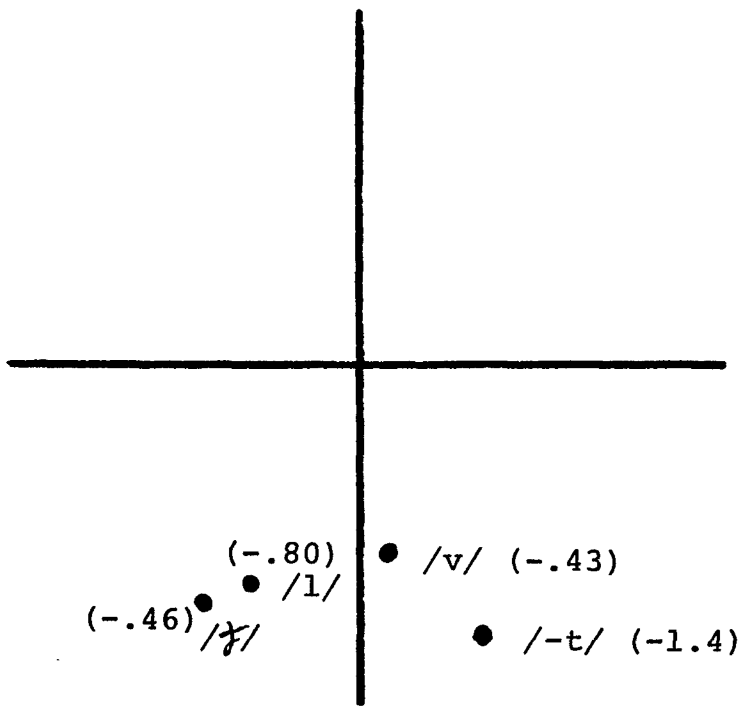


Group IV

Fig. 2. (continued)

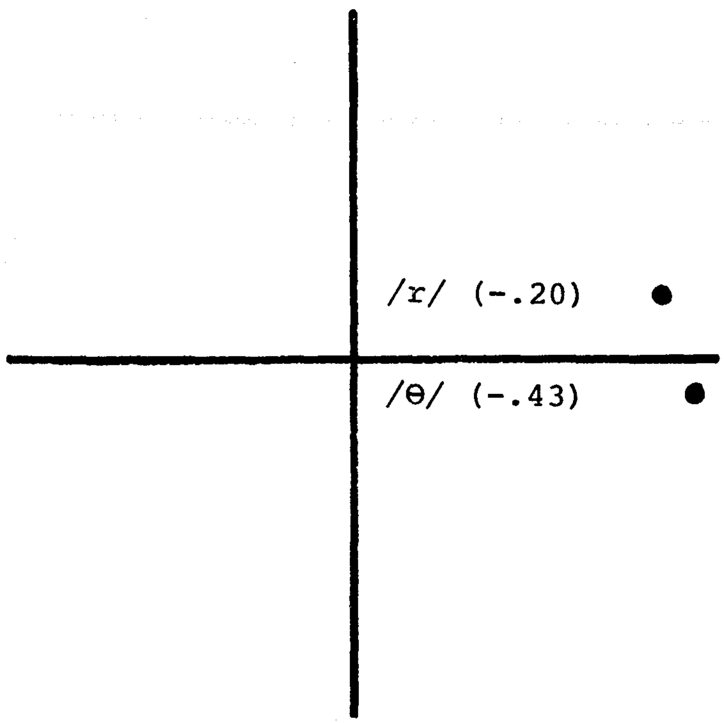


Group V



Group VI

Fig. 2. (continued)



Group VII

Fig. 2. (continued)

morphological data were then prepared for analysis. The data used for this analysis were the subjects' percentage-correct use of the 14 morphological items (see Appendix H) as described by Brown (1973). A correlation matrix of the data was constructed and then subjected to an MD-SCAL analysis. Since no errors on the present progressive occurred, this item was omitted from the MD-SCAL analysis, thus reducing the number of items used in the morphology analysis to 13.

The two-dimensional MD-SCAL analysis yielded a stress factor of .40 reflecting a fairly poor fit for the data. When, however, a three-dimensional analysis was computed, the stress factor dropped to .17. A three-dimensional figure of the analysis was constructed using the plot values generated by the MD-SCAL program (see Appendix L) for the morphologic items. Four clusters were evident from the graph (see Table 8). The groups are presented in Figure 3 for ease of interpretation.

As in the previous MD-SCAL, the morphology items presented several interesting and similar patterns. First, the items appeared to group according to difficulty. The easiest items were those in Group IV, in this case the Group farthest from the central axis. It should also be noted that within this cluster, the item "on" was considerably distant from the other two members and was considered somewhat independent from them. The items which were the most difficult for the subjects were closer to the

Table 8

Grouping of Morphologic Items
Generated by MD-SCAL Analysis

Group	Morphologic Items
I	past irregular (verb)
	third person irregular (verb)
II	contractible copula
	contractible auxiliary
	uncontractible auxiliary
	third person regular (verb)
	past regular (verb)
	plural
III	uncontractible copula
	possessive
IV	"in"
	"on"
	articles "a" and "the"

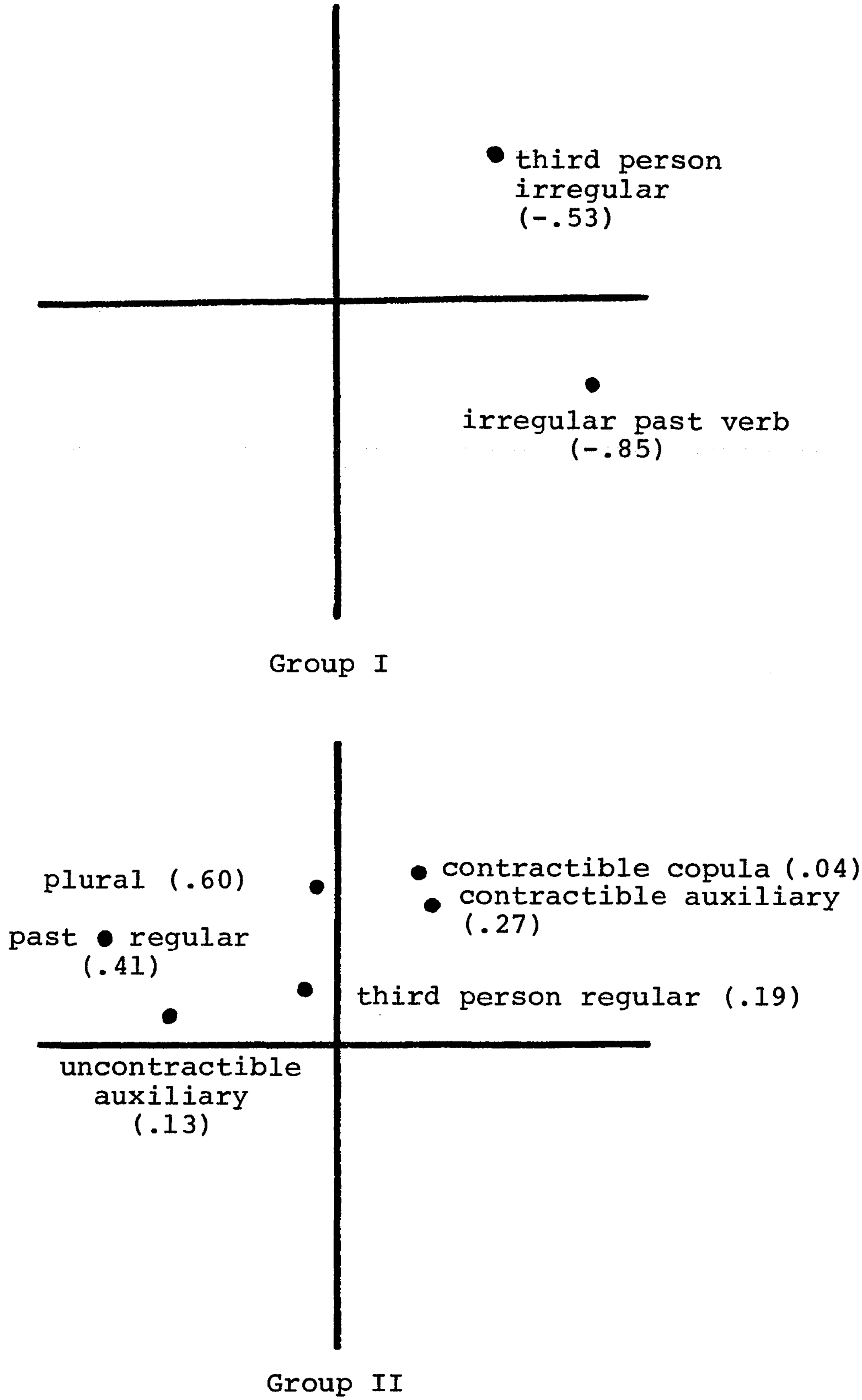
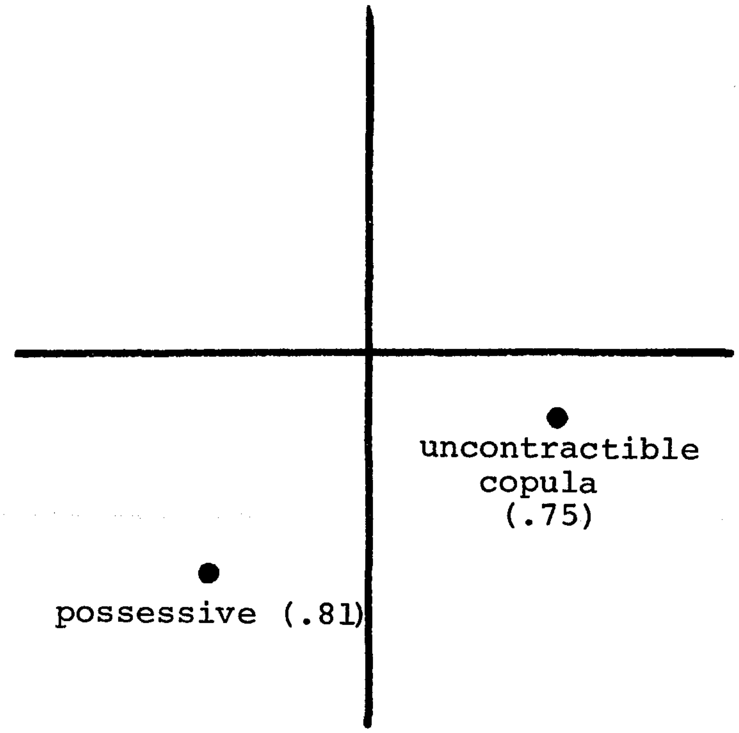
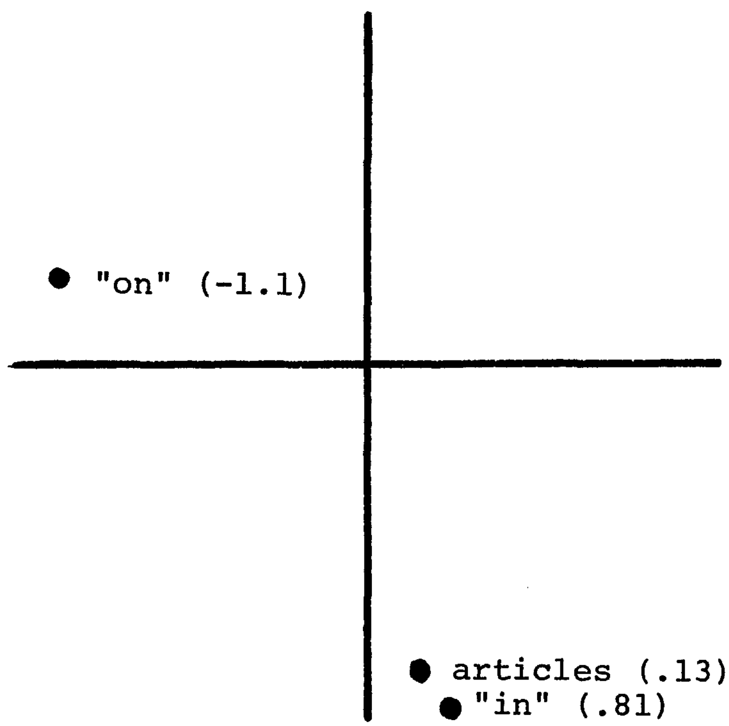


Fig. 3. Configuration of four groupings of morphologic items generated by MD-SCAL analysis. Parentheses () contain the third-dimensional plot values for each item.



Group III



Group IV

Fig. 3. (continued)

axis and included all of the items in Groups I and II. Another interesting observation was that both irregular forms clustered together in Group I. In addition, most of the morphologic items using the /s/ or /z/ (i.e. third person regular form of the verb, the plural, the contractible copula and contractible auxiliary) were all closely joined on the plot. Only the possessive remained independent.

Upon further examination it appeared that the difficulty of each item followed the developmental pattern proposed by Brown (1973). The items that were the most difficult for the subjects in this study also appeared later in Brown's (1973) subjects. In addition, those items which were acquired earlier in Brown's research were those with which the subjects of this study had the least difficulty.

Syntax

The next MD-SCAL analysis was computed using the available syntactic data. This data reflected each subject's percentage-correct use of nine categories of syntax (see Appendix I) defined by Lee (1974) in her Developmental Sentence Scoring procedure. A correlation matrix of the data was tabulated and analyzed by means of the MD-SCAL procedure.

The stress factor for the two-dimensional analysis was .34 and decreased to .17 for the three-dimensional graph. Since the MD-SCAL with three dimensions provided a better fit for the data, it was used to analyze the syntactic categories. The investigator then constructed a three-dimensional figure based on the MD-SCAL plot values for the nine items (see Appendix M).

In examining the plotted diagram, three groups of items tended to cluster together (see Table 9). These groups are presented in Figure 4. The items in Group I, especially main verb and sentence point, were graphically very close to one another reflecting a relationship between them. The children who tended to make errors on use of the main verb were not credited with a sentence point because of that error, thus producing the close relationship between those two items. Although indefinite pronouns were used correctly most of the time, those subjects who had difficulty with their usage also had difficulty with use of the main verb and thereby were penalized on the sentence point.

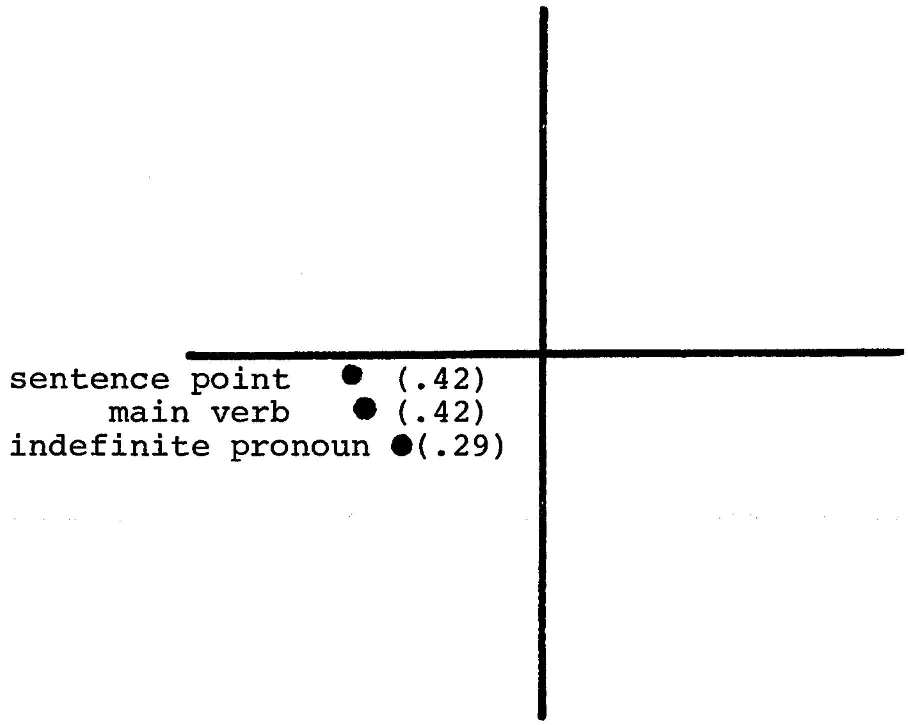
The second group of syntactic items which were less closely positioned to one another included conjunction and negative, and the interrogative reversal. The subjects experienced more difficulty with making the appropriate reversal in a question, than with using negatives and conjunctions correctly.

The third syntactic group was the most loosely-knit and included items which the subjects produced correctly at least 95% of the time. The subjects, therefore, tended to have little difficulty with personal pronouns, "wh-"

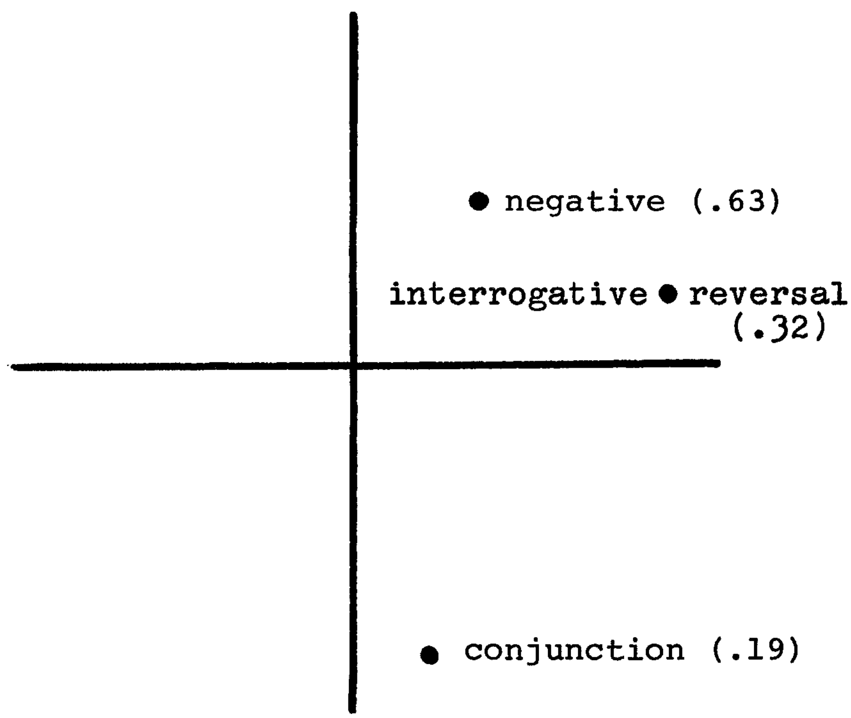
Table 9

Grouping of Syntactic Items Generated by MD-SCAL Analysis

Group	Syntactic Items
I	indefinite pronoun
	main verb
	sentence point
II	conjunction
	negative
	interrogative reversal
III	personal pronoun
	"wh-" question
	secondary verb

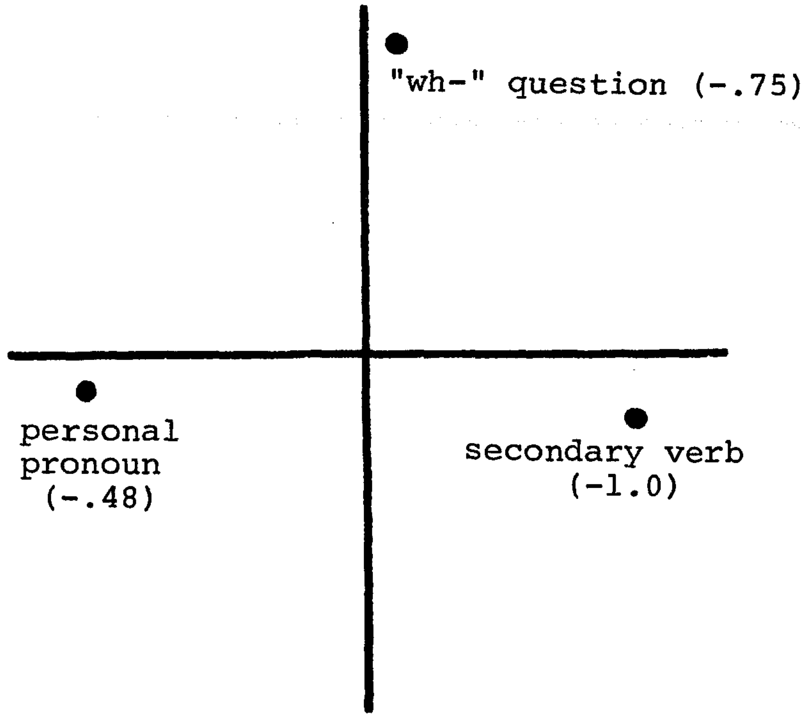


Group I



Group II

Fig. 4. Configuration of three groupings of syntactic items generated by MD-SCAL analysis. Parentheses () contain the third-dimensional plot value for each item.



Group III

Fig. 4. (continued)

questions, and secondary verbs. Of the items in this third cluster the personal pronouns behaved most independently, being almost isolated from the other items. There seemed, therefore, to be little relationship between an error on this item and other syntactic errors.

Distinctive Features, Morphology and Syntax

Having examined the relationships within each of the individual areas of articulatory performance, morphology, and syntax, a correlation matrix for all 43 items was then obtained and utilized for an MD-SCAL analysis of how the items in one group interacted with items from the other linguistic groups.

This overall MD-SCAL was employed to determine a relationship between the individual types of distinctive feature errors (e.g. coronal, strident, etc.) used by the subjects and performance on measures of morphology and syntax.

The final configuration of the 43 points in the MD-SCAL using two-dimensions had a high stress factor of .51. The addition of a third dimension decreased the stress factor to .34. In view of the number of items used in the analysis and the difficulty of interpreting any configuration of four or more dimensions, the three-dimensional configuration was deemed adequate for the purposes of this study.

The investigator constructed a three-dimensional figure based on the MD-SCAL plot values for the 43 linguistic items (see Appendix N). Nine basic groupings were identified (see Table 10). These groupings are presented in Figure 5.

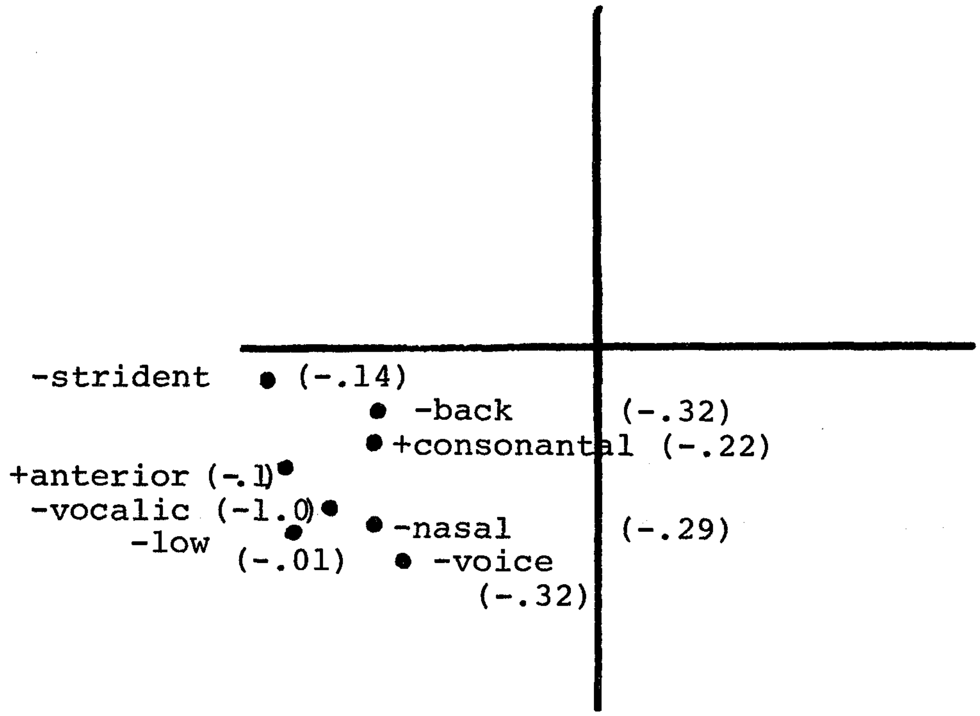
It was interesting to note that the groupings in this overall MD-SCAL analysis followed patterns similar to those of the individual MD-SCAL analyses. Thus, those items that tended to cluster together in articulatory production, also tended to cluster together when combined with syntactic and morphologic items. Groups I, II, IV, and V, for example, contained 15 of the 21 distinctive feature items exclusively. These 15 items were almost isolated from the rest of the 28 items analyzed. This distance indicated little relationship between these items and the other linguistic factors. More interesting was the fact that the remaining 6 distinctive features which did interact were the features on which the subjects demonstrated the most difficulty, which develop later, and which were rather isolated from the other items in the original MD-SCAL articulatory feature analysis. These six items included: -coronal, +voice, -consonantal, +strident, +low, and +continuant.

The investigator's primary interest was to examine the interaction among articulatory production items and linguistic factors, specifically to filter out the articulatory items that tended to be related to other linguistic errors. The results demonstrated by the MD-SCAL indicated

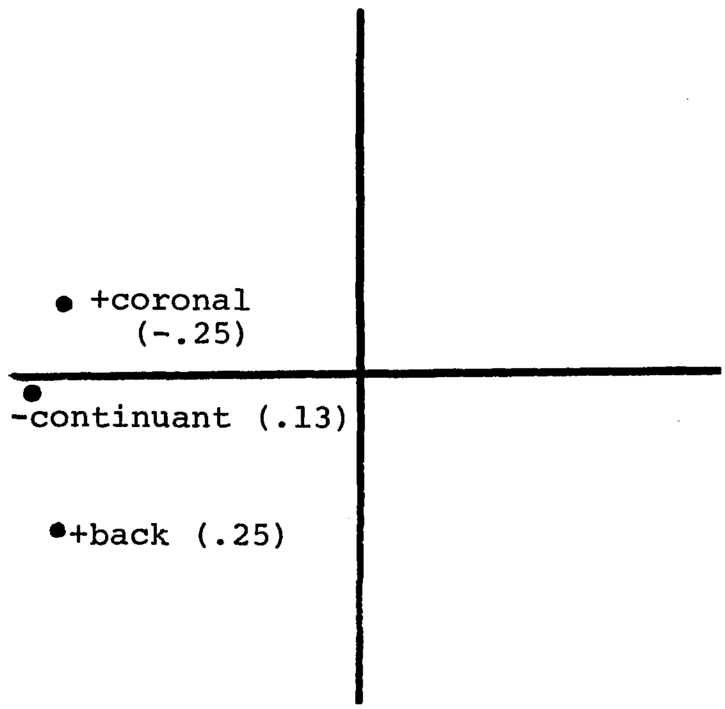
Table 10

Grouping of Articulatory, Morphologic, and Syntactic Items Generated by MD-SCAL Analysis

Group	Articulatory Items	Morphologic Items	Syntactic Items
I	-vocalic -voice -nasal -low +anterior -back -strident +consonantal		
II	-continuant +back +coronal		
III	-coronal	past irregular (verb)	"wh-" question
IV	+vocalic -high		
V	+high -anterior		
VI		uncontractible auxiliary past regular (verb) possessive	personal pronoun
VII	-consonantal	third person regular (verb) plural contractible copula contractible auxiliary	sentence point main verb
VIII	+voice	"on" "in" articles "a" and "the"	secondary verb negative interrogative reversal
IX	+strident +low +continuant	uncontractible copula third person irregular (verb)	conjunction indefinite pronoun

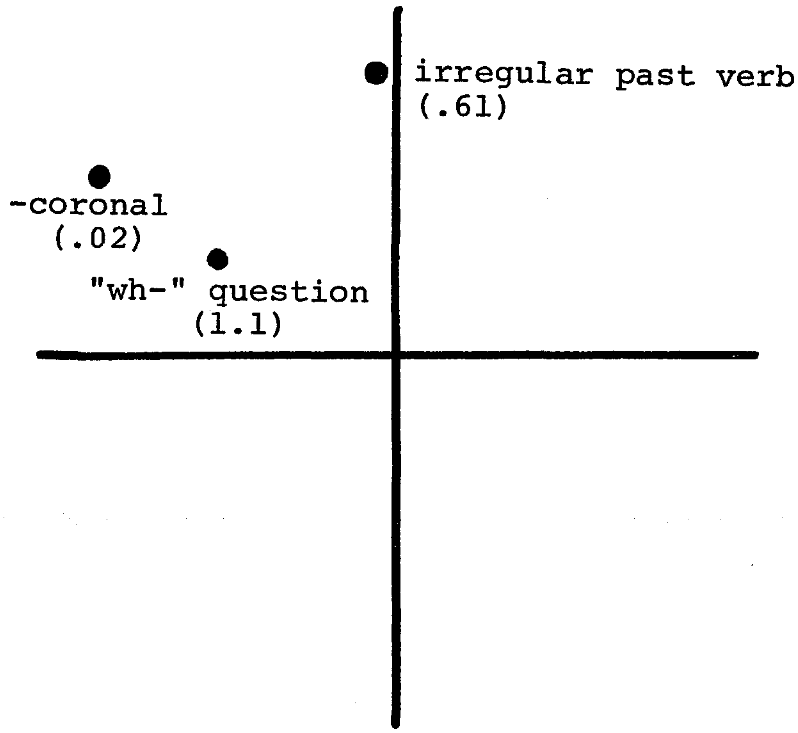


Group I

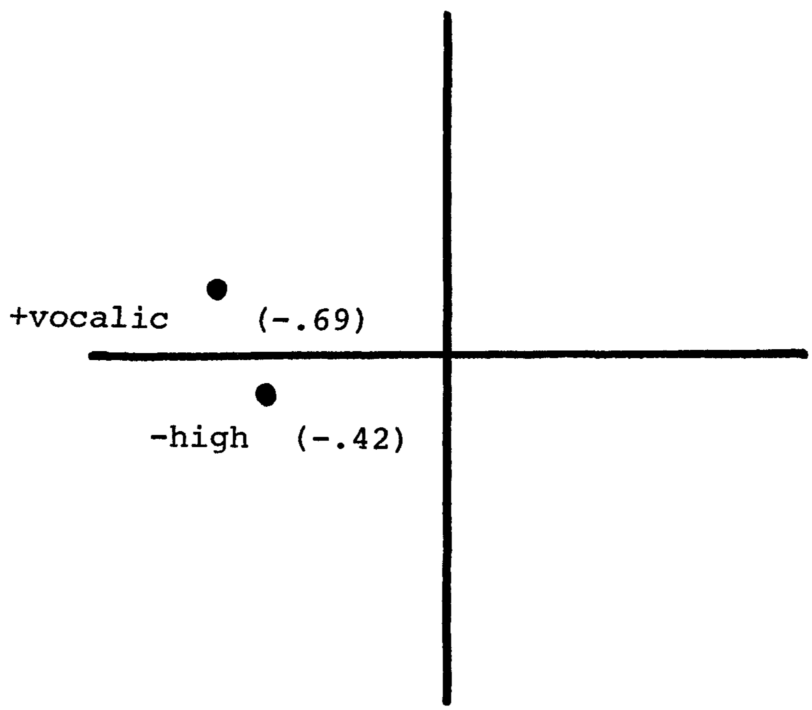


Group II

Fig. 5. Configuration of nine groupings of articulatory, morphologic, and syntactic items generated by MD-SCAL analysis. Parentheses () contain the third-dimensional plot value for each item.

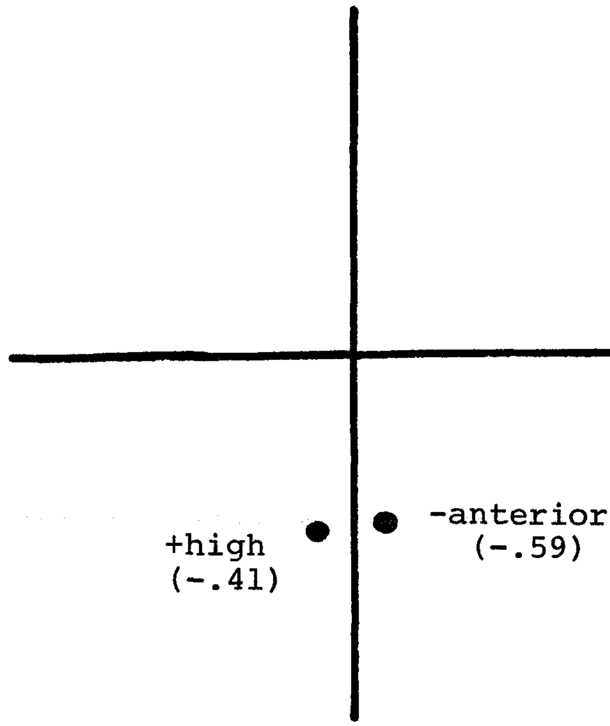


Group III

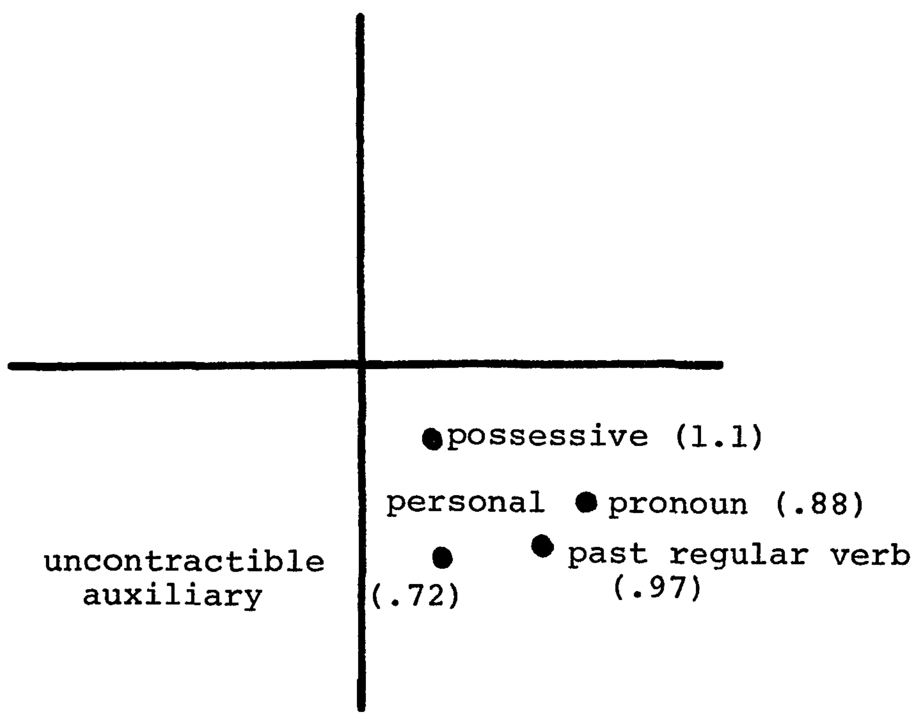


Group IV

Fig. 5. (continued)

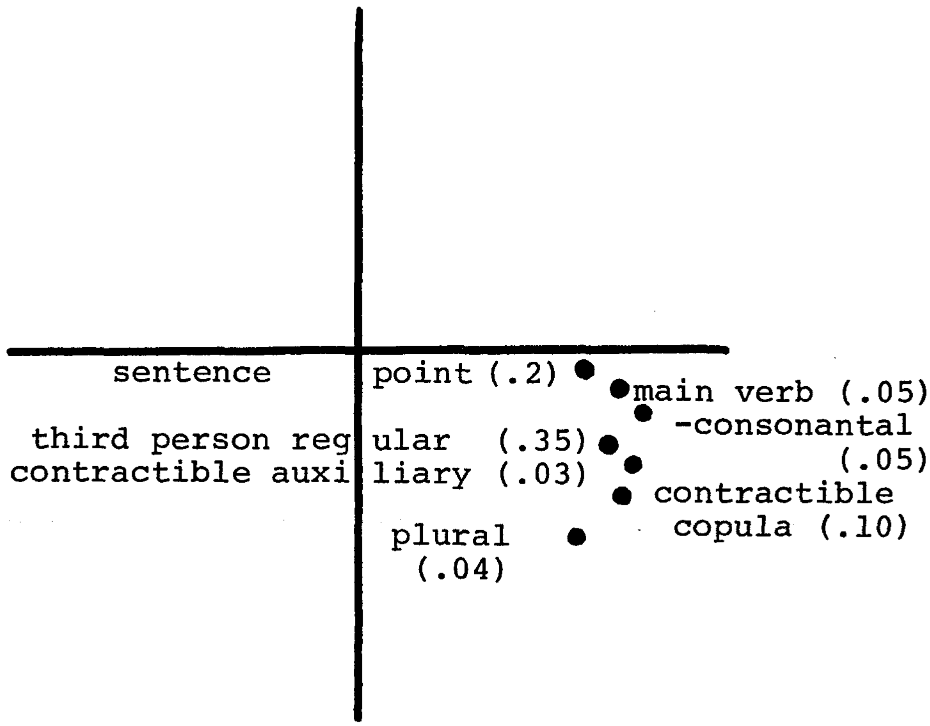


Group V

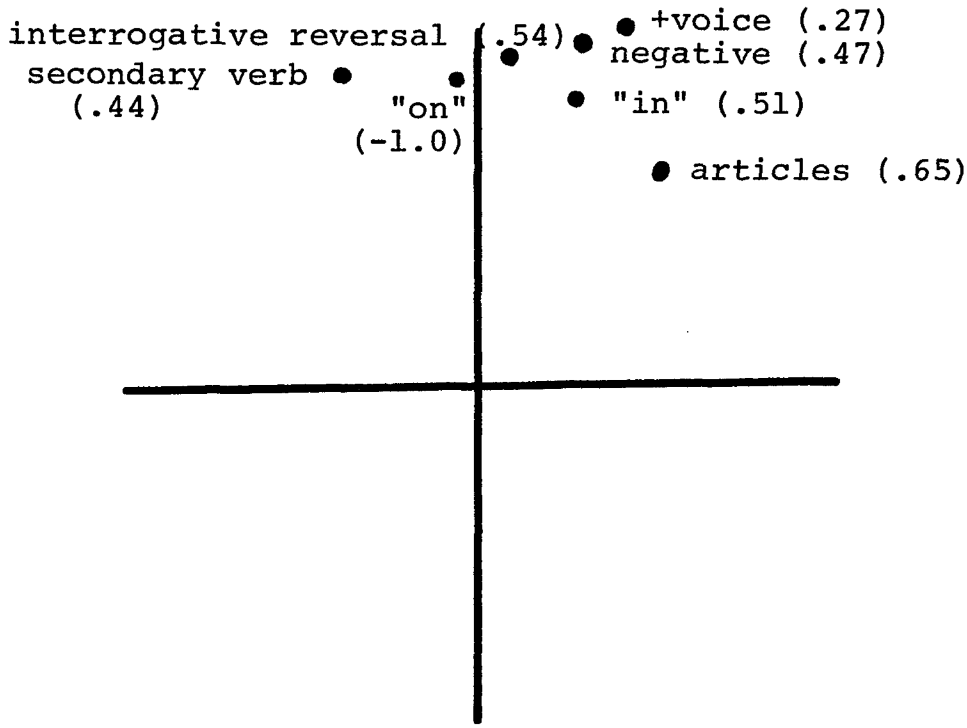


Group VI

Fig. 5. (continued)

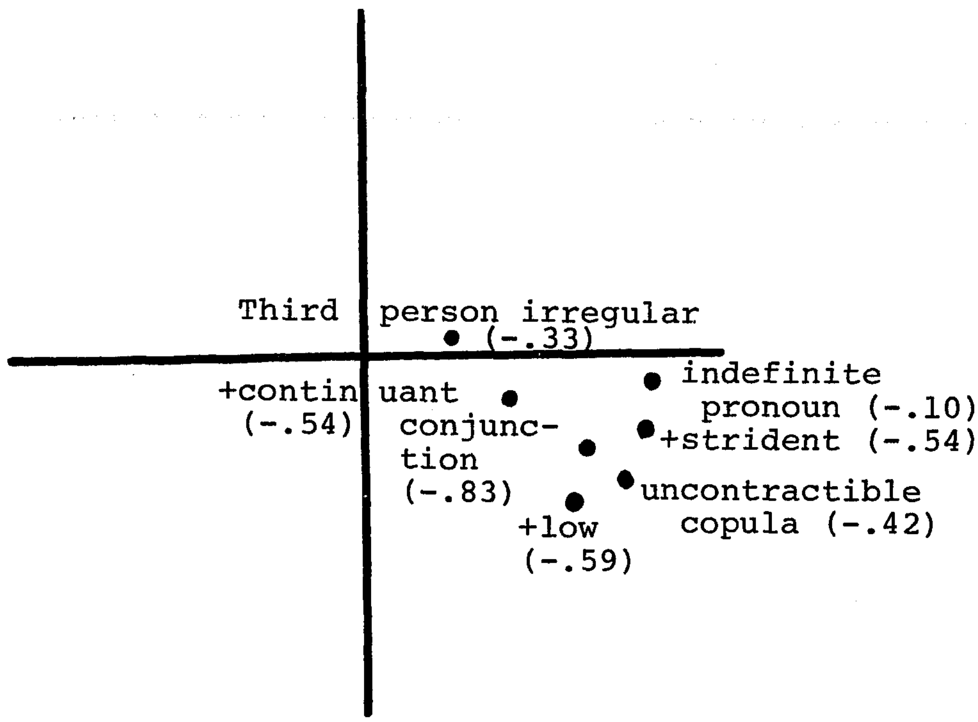


Group VII



Group VIII

Fig. 5. (continued)



Group IX

Fig. 5. (continued)

that there appeared to be several articulatory production features which were prone to error in conjunction with morphologic and syntactic errors. Of the six features mentioned above as demonstrating interaction, four error features, +strident, +continuant, +low and -consonantal, seemed to be most highly associated with errors on certain morphologic and syntactic errors including: third person regular and irregular verb forms; plural; indefinite pronoun; conjunction; contractible and uncontractible copula; contractible auxiliary; main verb; and sentence point. The two remaining articulatory items, +voice and -coronal, had the next highest relationship. These data supported previous findings (Cairns and Williams, 1972; Menyuk, 1968b) that manner errors tended to be generally more severe than errors of place. The data also reflected developmental trends, since the linguistic factors interacting the most were also the factors which appeared later in the developmental sequence.

The morphologic and syntactic items appeared to interact more with each other than any other group. This finding seemed appropriate since these two areas were closely interrelated by their natures. Although there were some differences, the linguistic items within the groupings tended to cluster together in this overall MD-SCAL as they had for the individual MD-SCALs. The prepositions "in" and "on" and the articles, for example, were as closely grouped in this analysis as they had been in the original MD-SCAL on morphology.

An overall inspection of the various groups indicated that Groups VII and IX contained the most difficult items within the areas of articulatory production, morphology, and syntax. The previous individual MD-SCAL analyses had reflected parallels between acquisition time and degree of difficulty. The graph of all 43 items supported that pattern.

As has been noted previously, several articulatory, morphologic, and syntactic items were significantly related by their physical proximity in the MD-SCAL analysis of the combined linguistic areas. Since all of the articulatory items were not isolated from the morphologic and syntactic items, the hypothesis that errors on certain distinctive features (e.g. +strident and +continuant) tended to be associated with errors in other language measures was supported.

These qualitative analyses provided information of the relations among the patterns of the articulatory, morphologic, and syntactic items. These patterns appeared to have a lawfulness based on acquisition time. That is, those items which interacted the most were more difficult and acquired later than the items which remained somewhat independent in the analysis.

Individual Phonemes, Morphology and Syntax

Since an MD-SCAL analysis on the individual phoneme data had already been computed, it appeared appropriate to compute a final MD-SCAL analysis on that data as related to the morphology and syntax items.

Therefore, a correlation matrix was computed using percentage-correct scores for individual phonemes, morphologic, and syntactic items. This matrix was then used as input for the MD-SCAL analysis. The final MD-SCAL configuration for two dimensions had a very high stress factor of .68 and the addition of the third dimension reduced the stress slightly to .59. Since even the third stress factor reflected such a poor fit, and the graph a substantial deviation from the true configuration of the data, an analysis was not attempted. It is interesting to note, however, that the data input for articulatory production using distinctive features was again much more effective in the MD-SCAL analysis than was the use of individual phonemes.

Descriptive Analysis of Data

General Observations

This third section of the discussion contains a descriptive account of the data within the study. Although the two null hypotheses have already been discussed statistically in relationship to the findings, it appeared possible that some of the most important and interesting findings of this study could be uncovered in the raw data.

A closer examination of each subject's linguistic behavior during the testing and free-speech sampling revealed several overall patterns. First, all but one of the thirteen subjects were consistent in their performance on the articulatory, morphologic, and syntactic items being assessed. The one subject who differed from this pattern was Subject 10 whose articulatory skills placed him in the top 30% of the group, but whose morphologic and syntactic skills were in the lower thirtieth percentile. Therefore, the investigator excluded this subject's scores and computed again the rank-order correlations to determine relationships between articulatory behavior and morphology, articulatory behavior and syntax, and morphology and syntax. The new correlation values all increased to beyond the .01 level of significance. Excluding Subject 10, the subjects' scores for linguistic behavior across the three linguistic areas remained within a + or - 10% margin. This strong correlation for each subject across groupings reflected the interaction of the linguistic categories measured and indicated that these subjects with articulatory errors usually had other linguistic errors.

Another interesting observation tended to support the developmental theory of linguistic acquisition. Of the thirteen subjects, those who were older did better in the three linguistic areas than the younger subjects. As would be expected, there were some exceptions. Two children, both aged 6 years 6 months, differed significantly in articulatory performance: one being in the lowest 6% of the group, the other in the 56% range. In the area of morphology, two children of the same age were rated in the sixth and eightieth percentiles respectively. Investigators (Bloom, 1970; Brown, 1973) have stated that children develop linguistically at different rates due to the countless factors that may affect that development. The performance of these children, therefore, was expected to differ. What was interesting to note, however, was the parallel performance of most subjects on all three linguistic parameters.

In addition, the children whose overall linguistic patterns were in the lowest performance percentiles, also displayed "immature" behavioral patterns as judged by the examiner through subjective observation. These children were overactive, more destructive with the toys, and displayed very short attention spans.

The investigator was also interested in the relationships that existed among other available data, including mean length of utterance (MLU) and number of sentences. Several Spearman Rank-Order correlations were computed. No significant relationship was found between number of sentences produced by the subjects in the three sessions and performance on morphology and syntax. In addition, the relationship between number of sentences and MLU was nonsignificant. MLU was then correlated with scores on morphology and syntax. No significant correlations were found for MLU and morphology, but a correlation of .75 was found between MLU and syntax. This correlation was significant beyond the .01 level of confidence. As might be expected, the data in this study supported the use of MLU as an appropriate measure of syntactic complexity (Brown, 1973).

A high correlation of .84, significant beyond the .01 level, was found between MLU and age of the subjects. These data supported Brown's previous work (1973) and reflected a developmental element in the children's performance of syntactic complexity. These general observations, although not directly responding to the hypothesis, provided data that aided in determining qualitative assessment.

Next, the investigator carefully examined the subject's performance in the free speech samples to identify patterns of behavior on specific linguistic items that could not be determined by the statistical correlations.

Articulatory Production: Distinctive Features

In reviewing the data available on articulatory performance using distinctive features, the investigator noted several points. The overall scores for percentage-correct use of all 22 distinctive features ranged from 61.8 to 96.3 with a mean of 84.3%. The distinctive features with which the subjects had the most difficulty included: +vocalic, +continuant, +voice, +coronal, -consonantal, and +strident (see Table 11). The errors made on -consonantal and +vocalic, however, appeared to be the

Table 11

Rank-Ordering of the 13 Subjects' Percentage-Correct Usage of Distinctive Feature Items Across Phonemes

Percentage-Correct Usage	Distinctive Features
100	+nasal
96.65	-nasal
95.84	-vocalic
92.31	+low
91.81	-coronal
91.15	+anterior
90.65	-voice
89.96	-low
89.55	-continuant
88.88	-back
87.52	+consonantal
86.92	-anterior
83.68	-high
83.11	+high
82.15	-strident
81.99	+back
81.56	+strident
78.83	-consonantal
73.29	+coronal
69.36	+voice
68.04	+continuant
40.98	+vocalic

result of the distinctive feature classification system used. Since Chomsky and Halle (1968) classify the phonemes /r/, /l/, /w/, /j/ as both vowels and consonants, any substitution for these sounds would result in errors on those two features. Therefore, the investigator questioned the value of closely examining these particular features since the /r/ and /l/ sounds were often the targets of misarticulation.

The subjects' errors on the distinctive features +voice, +continuant, +coronal and +strident included: (1) the devoicing of voiced sounds; (2) stops substituted for continuants and fricatives; and (3) a feature change from + to -coronal. It was hypothesized that the vulnerability of the feature +coronal was the result of ease of articulation. Since lingual sounds are difficult to articulate, the feature +coronal was altered to an easier, more neutral position. This finding supported the previous research of Cairns and Williams (1972). Likewise, the feature +voice was altered to -voice by most of the subjects. Cairns and Williams had suggested that this error pattern provided a stronger perceptual cue for the subjects. In addition, the features +voice, +continuant, +strident, and +coronal were found by Menyuk (1968b) as being acquired very late, thus suggesting a positive correlation between the percentage-correct use of a feature and its point of acquisition, and ease of perception and production. This finding supported Jakobson's hypothesis of the lawful progression of sounds from the easiest, with many contrasts, to the most difficult, with few contrasts.

In general, more of the subjects omitted features than added them. The only exceptions to this pattern included the features (1) -consonantal which became +consonantal and (2) -anterior which became +anterior. The reason for these exceptions seemed evident. As was previously indicated, the feature profile for /w/ and /j/ identified those sounds as vowels so that any subject who substituted another consonant for them added the +consonantal feature. The -anterior to +anterior substitution resulted from the subjects' substitution of a more front consonant for a post-alveolar one. This pattern was a frequent one among these subjects.

<u>Articulatory Production: Markedness</u>

Since the data were available, the investigator examined the substitution patterns in the light of "markedness" theory (Cairns, 1969), which had already been used to analyze articulation errors (Cairns, Cairns, and Williams, 1974; Cairns and Williams, 1972; Williams, Cairns, and Cairns, 1971). These authors found that when one phoneme was substituted for another, the substituted phoneme was no more complex than the target phoneme. McReynolds, Engmann, and Dimmitt (1974), however, rejected this hypothesis following their analysis which examined changes in features from more complex to less complex and the reverse. They found that the children did not substitute phonemes requiring less effort than the target phoneme consistently and that many of the substitutions required more effort than the target phoneme.

The data on substitutions used by the subjects in this study were used to evaluate further the predictions of markedness theory. Of the 153 substitutions used by the subjects in this study, 70% of the substituted sounds followed the theory proposed by Cairns (1969) and were less complex than the target sounds. This figure was lower than that found by previous investigators (Cairns, Cairns, and Williams, 1974) but higher than the 53% found by McReynolds, Engmann, and Dimmitt (1974), and was considered generally supportive of the theory. In addition, 20% of the substitutions used by the subjects in this study were more marked than the target sounds and 10% had the same markedness values. The data, therefore, reflected a general tendency to follow the markedness theory, but included too large a margin to be considered unequivocal. It is possible, however, that the data available from this study could be further analyzed and used to revise the marking values assigned to phonemes on other grounds.

The concept of markedness, therefore, was highly related to Jakobson's evolutionary development of sounds. The developmental patterns of morphologic and syntactic items also followed the same basic premise of ease of production, complexity, and overall use in the language.

Since the acquisition periods of these linguistic areas overlap, a development lag or deviancy in one may affect development and use of another.

Articulatory Production: Individual Phonemes

In addition to examining the data according to distinctive features and markedness, it was noted that the raw data reflected some general patterns of articulatory behavior in phoneme substitution. Of the sounds that were misarticulated (see Table 12) by 50% or more of the subjects, six (54.54%) were fricatives, three (27.27%) were stops, and two (18.19%) were liquids. The examiner then observed the patterns of the substitutions.

The sounds misarticulated by 50% and more of the subjects included /ʒ/ 100%, /z/ 92%, /b/ 85%, /θ/ 77%, /dʒ/ 72%, /l/ 69%, /v/ 69%, /d/ 62%, /g/ 62%, /r/ 53%. According to the developmental age norms used by Fisher-Logemann, 73% of these sounds are acquired between 6- and 8-years. This suggests a clear relationship between articulatory performance and developmental appearance of phonemes.

Fricatives were misarticulated most frequently by the subjects and made up 51.2% of the total errors. The substitutions most frequently (61%) used by the subjects for fricative target sounds were other fricatives. The remaining 39% of the time the subjects used plosives as the substitution. In 98% of the substitutions the place

Table 12

Rank-Ordering of the 13 Subjects' Percentage-Correct Usage of Individual Phonemes

Percentage-Correct Usage	Phoneme
100	m
100	n
100	f
100	ŋ
94.87	p
93.59	w
92.31	tʃ
92.31	h
88.46	j
87.18	k
84.62	d-
84.61	t-
84.61	ʃ
79.48	g
76.92	-t
69.22	b
69.22	s-
69.22	-s
57.69	z-
53.84	dʒ
53.84	-d
53.84	l
46.15	v
43.59	r
30.77	-z
30.76	θ
25.64	ð
19.23	ʒ

of articulation was the same or more anterior than for the target phoneme and 100% of the time the unvoiced fricative was substituted for by another unvoiced sound. The voicing feature used in the target fricative was only maintained 35% of the time in the substitution.

Plosives were the next highest sound group that was misarticulated by the subjects, making up 23% of the total number of errors. When a subject misarticulated a plosive, 88% of the time the substituted sound was another plosive. The remaining 12% of the substitutions used included fricatives and glides. When another plosive was substituted for the target sound, the substituted plosive was always made at the same point of articulation or more anterior than the original sound. 89% of the time voiced plosives were unvoiced.

The next highest group of misarticulated sounds included the liquids (14.2%). The subjects always used glides as the substituted sounds and appropriate voicing was maintained 100%. Again, 95% of the time the place of articulation for the substitution was anterior to that of the target sound.

Affricates made up the next group of 7.17% of the total errors. In 82% of the occurrences, the substitutions for this sound group were other affricates which were unvoiced. In the other 18% of the instances, plosives were utilized as the substitution. The plosives used were either the appropriate component of that affricate or its unvoiced counterpart. In this group of substitutions, the place of articulation for the substituted sound was always the same as the target sound.

The next highest group (3.2%) included the glides. 80% of the time liquids were used as the substitutions for this sound group and 20% of the time, fricatives. Appropriate voicing was always maintained in the substitutions and 60% of the time the place of articulation for the substituted sound was more anterior than the target sound.

The nasals were rarely misarticulated and made up only .6% of the total errors. The only error made on the nasals was a single instance of a subject devoicing the final /g/ component of /ŋ/.

The last group of sounds included the glottal /h/ which was very stable and never misarticulated.

Since the articulatory skills of the subjects were assessed in a structured and non-structured situation, it was possible to observe the consistency of the errors. The investigator found that the substitutions used by the subjects were the same as those used on the articulation test. The overall articulatory patterns, however, were less precise in the unstructured than the structured situation.

Morphology

In addition to the information on articulatory production provided by a perusal of the free-speech data, interesting morpho-phonemic patterns were also found (see

Table 13). Of the 13 subjects, five displayed consistent substitution errors on both the /s/ and /z/ phonemes, six had difficulty with /z/, and two displayed no errors. The performance of each of these subjects on morphologic items which required the use of the /s/ and /z/ was observed. These items included the plural, the third person regular form of the verb, and the possessive. The subjects had the least difficulty with plurals, using a plurality marker (/s/, /z/, or a substituted phoneme) in 95% of obligatory contexts.

The third person singular form of the verb and the possessive seemed to be equally difficult for the subjects and were produced correctly only 74% and 72% of the time, respectively. The subjects' percentage-correct scores for plurality may have been higher than for the possessive and third person singular verb form since plurality is a morphologic item which is easier and acquired earlier by children than the other items. Whereas, six of the subjects used the plural marker 100% of the time, and five of the subjects correctly used the possessive 100% of the time, only two subjects used the third person singular form of the verb correctly 100% of the time.

Of the five subjects who substituted another phoneme for /s/ and /z/, three omitted the substitution in the possessive 55% or more of the times it occurred and two omitted the substitution for the third person regular form of the verb 70% and more of the time. Only one of the

Table 13

Percentage-Correct Usage of Three Morpho-Phonemic Items in the Free-Speech of 13 Subjects

Subject	Phonemic Errors	Percentage-Correct Usage of: Plural	Third Person Regular Verb Form	Possessive
1	z	95	51	55
2	s, z	80	14	55
3	none	93	82	85.7
4	z	98	98	71
5	s, z	77	31.7	50
6	z	97	96	85
7	none	94	62	0
8	s, z	100	100	33
9	z	100	69	100
10	s, z	100	93	100
11	z	100	76	100
12	z	100	100	100
13	s, z	100	78	100
Mean percentage-correct usage		95	74	72

thirteen subjects received scores of 100% in all three morphologic categories. That subject's articulatory pattern included a substitution for the /z/. Of the five other subjects who misarticulated /z/, one received percentage-correct scores of only 51% and 55% for the use of the third person singular form of the verb and the possessive, respectively. One (Subject 7) of the two subjects who used /s/ and /z/ appropriately, never used a possessive correctly and used the third person singular form of the verb correctly only 62% of the time.

The patterns of morpho-phonemic behavior used by the subjects supported the hypothesis that there was no consistent correlation between articulation errors on /s/ and /z/ and a subject's performance on morphologic items that required those sounds. For example, the data indicated that although a subject correctly articulated the phonemes /s/ and /z/, his performance on the morphologic items requiring the use of those phonemes may have been poor. Furthermore, a subject who substituted other phonemes for /s/ and /z/ may have correctly used those substitutions as appropriate morpho-phonemic markers.

In addition, behavior on these morphological items was not consistent for each subject. As was previously indicated, some subjects received high percentage-correct scores for plurals, but extremely poor scores for the use of the possessive and the third person singular verb form. It was concluded, therefore, that since phonetic errors do not necessarily result in morphologic errors, a clinician should not excuse poor performance on certain morphologic items because of a subject's articulatory patterns.

In examining the morphological behavior of the subjects, a strong developmental pattern seemed to emerge. Those items on which the subjects had the most errors (see Table 14) were also those which Brown (1973) concluded were acquired last. A Spearman Rank-Order correlation was obtained between Brown's acquisition data and the percentage-correct scores for the same morphologic items received by the subjects in this study. A correlation of .68 was computed, significant beyond the .05 level of confidence. The developmental pattern, therefore, for morphology was confirmed.

The overall developmental morphology scores for the subjects ranged from 53.9% to 99.5% with a mean of 82.8%. Of the 13 scores, five were scores of 77% and less, reflecting difficulty with the items tested. The items included in the DMS scores that appeared easiest for the subjects and were produced correctly 90% or more of the time included the present progressive, the prepositions "in" and "on", the plural, and the past regular. The present progressive was the only item which was produced correctly 100% of the time by all of the subjects. The items which were most difficult included the contractible auxiliary, the uncontractible auxiliary, the third person regular form of the verb, the possessive, and the third person irregular

Table 14

Rank-Ordering of the 13 Subjects' Percentage-Correct Usage of Morphologic Items in Free-Speech

Percentage-Correct Usage	Morphologic Item
100	present progressive (verb)
99.69	"in"
97.72	articles
95.38	"on"
93.50	plural
92.65	past regular (verb)
88.50	past irregular (verb)
86.81	contractible copula
86.11	uncontractible copula
77.55	contractible auxiliary
75.35	uncontractible auxiliary
74.58	third regular (verb)
67.51	possessive
65.34	third irregular (verb)

form of the verb. These items were produced correctly less than 77% of the time. Again, it was obvious that many of the difficult items were also those which appeared last in a child's morphologic development.

Syntax

Upon examining the free-speech data on syntax, it was noted that the DSS scores ranged from 6.0 to 11.6. According to Lee's chart (1974, p. 165) of performance percentiles for normal children, the lowest DSS score received by the subjects fell below the tenth percentile and the highest score represented one at the sixtieth percentile (see Appendix I). The data were also transferred into figures representing delays in language age (see Appendix I). Only one subject's DSS score reflected no delay in syntax. The delays for the other subjects ranged from 6 months to 36 months with an average delay of 21 months or almost two years. It was interesting to note that since three separate free-speech samples were collected, it was possible to observe the behavior of the subjects from week to week. The syntactic behavior of the subjects in the three sessions was highly consistent as reflected by similar DSS scores.

Table 15 is a rank-ordering of the percentage-correct use of syntactic items across subjects. The scale, which extends from 99.7% to 79.5%, does not have a high degree of discrimination because of a "ceiling effect."

Table 15

Rank-Ordering of the 13 Subjects' Percentage-Correct Usage of Syntactic Items in Free-Speech

Percentage-Correct Usage	Syntactic Item
99.72	indefinite pronoun
99.22	"wh-" question
98.87	conjunctions
98.43	secondary verb
96.19	negative
94.99	personal pronoun
86.88	main verb
82.04	interrogative
79.47	sentence point

This resulted in some dissimilar findings when compared with the MD-SCAL analysis of syntax. For example, sentence point and indefinite pronoun were highly related items in the scaling analysis but were the first and last items in the rank-ordering scale. A reason for this discrepancy may have been that the sentence point, although more highly correlated with indefinite pronoun, is still affected by errors in any of the other seven syntactic categories. It would, therefore, be appropriately ranked as last in the ordering.

The subjects in this study produced each of the eight syntactic items correctly 82% or more of the time. The personal pronoun, main verb, and use of the interrogative appeared the most difficult. Since the DSS scores reflected use of higher syntactic forms within each category, it was appropriate to assume that a low score reflected either the subject's inability to use the items or his decision not to use the more complex items in the samplings. To presume which course of action each subject took appeared inappropriate.

Articulatory Production, Morphology, and Syntax

In addition to articulatory errors, some of the subjects also produced morphologic and syntactic difficulties. The overall patterns of these linguistic errors reflected (1) general language delay in several linguistic areas, (2) specific delay in articulatory production skills, and (3) deviant errors in language usage.

The general delay was the pattern most frequently displayed by the subjects. That is, the subjects tended to make errors on those linguistic items which appeared latest in development. In addition, these subjects displayed short attention spans, poor facility to tell a sequential story, immature behavior patterns, and delayed gross motor skills. Possible causes of the maturational delays may have included environment, psychological state, a delay in cognitive development, and the possibility of an undiagnosed minimal brain dysfuntion.

Those subjects who experienced difficulty only in articulatory production may have developed those errors because of exposure to inappropriate speech patterns. These subjects did not produce other linguistic errors and their motor and social skills were judged appropriate for their age. In addition, the errors were limited in number and were usually the result of a single feature difference (e.g. /s/ for /z/).

Finally, there were a few subjects who presented articulatory, morphologic, and syntactic errors which could not be explained by a developmental hypothesis. These errors may have resulted from some difficulty in language processing which affected only certain aspects of their linguistic performance. These patterns were general and their causes can only be clearly identified when considered in light of each subject's specific linguistic errors and

and his psycho-socio-educational status.

CHAPTER V

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

Conclusions

The results of this research led to several conclusions:

1. A significant relationship existed between the articulatory performance of first grade children having defective articulation and their performance on measures of morphology and syntax. In addition, a high correlation was found between syntax and morphology reflecting a strong interrelationship of these factors. These correlations supported the hypothesis that interaction exists among linguistic items and that an articulation disorder may be a reflection of a broad-based language disorder. It is possible, therefore, that one may overlook more "subtle" linguistic errors and direct attention only to articulatory production. In this instance, the clinician would be doing an obvious disservice to the child by making an inappropriate assessment of his needs.

2. Using an MD-SCAL analysis the investigator identified a relationship between individual types of distinctive feature errors produced by the subjects and errors on morphology and syntax. The specific features

which displayed the most covariance included +strident, +continuant, +low and -consonantal. These items covaried with the morphologic and syntactic items with which the subjects experienced the most difficulty including: third person regular and irregular verb forms; plural; indefinite pronoun; conjunction; contractible and uncontractible copula; contractible auxiliary; main verb; and sentence point. The interaction that occurred was among the articulatory, morphologic, and syntactic items which were not only the most difficult for the subjects, but also late in their order of acquisition.

3. The investigator provided an account of linguistic performance which identified the general types of errors used by the subjects. The subjects produced combinations of deficient articulatory, morphologic and syntactic errors. The patterns of errors produced by the subjects fell basically into three categories: (a) general language delay in several linguistic areas; (b) specific delay in articulatory production skills; and (c) deviant errors in language usage. Of these, the general delay category was the most common linguistic pattern displayed by the subjects. In addition to the linguistic delays of these subjects, other lags in behavior and motor skills were also noted.

4. A separate MD-SCAL showed that +voice and

-consonantal tended to cluster together with the features +strident and +continuant. This cluster included those features most often misproduced by the subjects. In addition, manner features tended to group themselves together and were found to be more difficult for the subjects than features of place of articulation. These findings support, in general, the conclusion that the most difficult features for the children were those which were acquired last.

5. In addition to the conclusions provided by the MD-SCAL procedure, the raw data also revealed other articulatory patterns. More subjects omitted than added a feature. Further, most substitutions occurred on continuant and fricative sounds with stops typically the substituted sound. The substitutions were almost always (97%) sounds anterior in place of articulation to the target sound. The sounds most frequently misarticulated included /ʒ/, /z/, /ð/, /b/, /dʒ/, /l/, /v/, /d/, /g/ and /r/. In general, the most difficult sounds for the subjects appeared to be those which were acquired last. These data supported the previous findings of the MD-SCAL procedure regarding the clustering of difficult and easy production items.

6. Consistency of sound errors in the articulatory productions of the subjects were observed in both testing and free-speech situations. It was noted that the overall articulatory production patterns of the subjects were not as precise in conversation as they were in the testing session.

7. The strength of the markedness theory was also examined. Of the substitutions made by the subjects 70% followed the pattern set by Cairns, Cairns, and Williams (1974). The data, therefore, reflected a general support for the theory although the percentage was not high enough to be unequivocal. It was suggested, however, that the data available from this study might be further analyzed and used to revise the marking values assigned to phonemes on other grounds.

8. Following an investigation of the morphophonemic patterns displayed by the subjects, it was concluded that phonetic errors do not necessarily result in morphologic errors. A clinician, therefore, should not excuse poor performance on certain morphologic items, particularly plurals, possessives, and third person regular forms of the verb, merely because of a subject's misarticulation of the /s/ and /z/ phonemes.

9. According to the MD-SCAL data, the morphologic items with which the subjects had the most difficulty included the contractible copula, contractible and uncontractible auxiliary, third person regular, and past regular. These items were the same items which were acquired late in previous acquisition studies (Brown, 1973). The degree of difficulty, therefore, for a particular morphologic item tended to follow a developmental sequence for the subjects. In addition, the clusters set up by the MD-SCAL reflected another interesting pattern. Morphologic

items which required a suffix (i.e. third and past regular verb forms, and plural) tended to be highly related. A subject who made an error on one of these items usually made errors on the other items in that group. This pattern also held true for the items that required internal changes (i.e. past irregular and third irregular verb forms). It might be concluded, therefore, that the subjects in this study had difficulty in applying the linguistic rules that would permit them to generate the appropriate morphologic responses for related items.

10. Analysis of the MD-SCAL data results for syntax reflected scattered patterns of groupings among the items. It was obvious, however, from an item-analysis that the interrogative reversal was the most difficult item followed by conjunctions, negatives, and use of the main verb.

11. The syntactic data gathered from the free-speech samples indicated delays in syntax in all but one of the subjects. It was possible, therefore, to conclude that a substantial number of the subjects with articulatory problems also experienced difficulties in syntactic performance. In addition, the DSS scores of the subjects were consistent across the three free-speech samples reflecting the use of similar syntactic structures.

12. The investigator found MLU to be an appropriate measure of syntax and free-speech sampling a worthwhile basis for linguistic analysis. The large sampling provided a wealth of data sufficient for this study as well as for

future analysis.

The results of this study indicated that a number of children who are presently being seen in schools and clinics for obvious articulation problems, especially those with errors on distinctive features +strident and +continuant, may also present inappropriate morphologic and syntactic behaviors. Since clinicians do not always evaluate each child's morphologic and syntactic skills, it is possible that many children's total linguistic needs are presently not being met. The strong interaction of articulation, syntax, and morphology, evident in this research underlined the importance of a complete linguistic evaluation and the use of naturalistic data analysis as an appropriate means of assessing morphology and syntax.

Limitations

The investigator recognized the factors limiting the scope of this study. These include the following:

1. There was a relatively small number of subjects used in the research. This limitation, however, was considered an asset by the investigator since it allowed fuller investigation of the linguistic patterns of the subjects than would otherwise have been possible.

2. The practicality of the Chomsky-Halle (1965) distinctive feature system used in this study has been questioned (Walsh, 1974). There was, however, no other system available to this investigator that provided a more

accurate and practical approach to phonetic analysis.

3. Although MD-SCAL analyses provided a profile of the data for all subjects, it failed to identify individual patterns of behavior.

4. The investigator used varied unstructured free-speech samples to assess specific morphologic and syntactic patterns rather than structured linguistic tests. Although the free-speech sampling may have limited the complexity of the child's linguistic patterns to what he chose to use rather than his potential production performance, it did provide a natural corpus of data. For this study the corpus was a worthwhile and realistic measure of linguistic performance when compared with the alternative battery of tests which necessitate limited responses.

Recommendations

On the basis of the data presented by this study, the investigator proposed the following areas for further research:

1. A comparison of the subjects' data in this study with similar data from "normal" children three years of age to note similarities or dissimilarities in error types. This comparison would hopefully provide a basis for discriminating between developmental and deviant linguistic patterns.

2. An overall assessment of behavioral skills in first grade children who have (a) articulatory and other

linguistic difficulties and (b) articulatory difficulties only, to determine the basis for the differentiation.

3. An investigation of a larger group of children with articulatory errors to determine the percentage of children who display other types of linguistic errors. Such a project might provide important data to school clinicians whose caseloads are heavily weighted with children displaying these performance patterns.

4. Further investigation of the data in this study using IND-SCAL - a scaling procedure that would provide individual linguistic profiles for each of the subjects.

APPENDIX A

DEVELOPMENTAL SENTENCE SCORING (DSS) REWEIGHTED SCORES (Excerpted from *Developmental Sentence Analysis* by Laura L. Lee © Northwestern University Press, 1974)

	Noun Modifiers	Pronouns	Main Verbs	Secondary Verbs
1	it, this, that	1st and 2nd person: I, me, my, mine, you, your(s)	A. Uninflected verb: I see you. B. copula, is or 's: It's red. C. is + verb + ing: He is coming.	
2		3rd person: he, him, his, she, her, hers	A. -s and -ed: plays, played B. irregular past: ate, saw C. Copula: am, are, was, were D. Auxiliary am, are, was, were	Five early-developing infinitives: I wanna see (want to see) I'm gonna see (going to see) I gotta see (got to see) Lemme [to] see (let me [to] see) Let's [to] play (let [us to] play)
3	A. no, some, more, all, lot(s), one(s), two, (etc.), other(s), another B. something, somebody, someone	A. Plurals: we, us, our(s), they, them, their B. these, those		Non-complementing infinitives: I stopped to play. I'm afraid to look. It's hard to do that.

	Noun Modifiers	Pronouns	Main Verbs	Secondary Verbs
4	nothing, nobody, none, no one		A. can, will, may + verb: may go B. Obligatory do + verb: don't go C. Emphatic do + verb: I do see.	Participle, present or past: I see a boy running. I found the toy broken.
5		Reflexives: myself, yourself, himself, herself, itself, themselves		A. Early infinitival complements with differing subjects in kernels: I want you to come. Let him [to] see. B. Later infinitival complements: I had to go. I told him to go. I tried to go. He ought to go. C. Obligatory deletions: Make it [to] go. I'd better [to] go. D. Infinitive with wh-word: I know what to get. I know how to do it.

	Noun Modifiers	Pronouns	Main Verbs	Secondary Verbs
6		A. Wh-pronouns: who, which, whose, whom, what, that, how many, how much I know who came. That's what I said. B. Wh-word + infinitive: I know what to do. I know who(m) to take.	A. could, would, should, might + verb: might come, could be B. Obligatory does, did + verb C. Emphatic does, did + verb	
7	A. any, anything, anybody, anyone B. every, everything, everybody, everyone C. both, few, many, each, several, most, least, much, next, first, last, second (etc.)	(his) own, one, oneself, whichever, whoever, whatever Take whatever you like.	A. Passive with get, any tense Passive with be, any tense B. must, shall + verb: must come C. have + verb + en: I've eaten. D. have got: I've got it.	Passive infinitival complement: With get: I have to get dressed. I don't want to get hurt. With be: I want to be pulled. It's going to be locked.

	Noun Modifiers	Pronouns	Main Verbs	Secondary Verbs
8			A. have been + verb + ing had been + verb + ing B. modal + have + verb + en: may have eaten C. modal + be + verb + ing: could be playing D. Other auxiliary combinations: should have been sleeping	Gerund: Swinging is fun. I like fishing. He started laughing.

	Negatives	Conjunctions	Interrogative Reversals	Wh-Questions
1	it, this, that + copula or auxiliary is, 's, + not: It's not mine. This is not a dog. That is not moving.		Reversal of copula: Isn't it red? Were they there?	
2				A. who, what, what + noun: Who am I? What is he eating? What book are you reading? B. where, how many, how much, what ...do, what... for Where did it go? How much do you want? What is he doing? What is a hammer for?
3		and		
4	can't, don't		Reversal of auxiliary be: Is he coming? Isn't he coming? Was he going? Wasn't he going?	

	Negatives	Conjunctions	Interrogative Reversals	Wh-Questions
5	isn't, won't	A. but B. so, and so, so that C. or, if		when, how, how + adjective When shall I come? How do you do it? How big is it?
6		because	A. Obligatory do, does, did: Do they run? Does it bite? Didn't it hurt? B. Reversal of modal: Can you play? Won't it hurt? Shall I sit down? C. Tag question: It's fun, isn't it? It isn't fun, is it?	
7	All other negatives: Uncontracted negatives: I can not go. He has not gone. Pronoun-auxiliary or pronoun-copula contraction: I'm not coming. He's not here.			why, what if, how come, how about + gerund Why are you crying? What if I won't do it? How come he is crying? How about coming with me?

	Negatives	Conjunctions	Interrogative Reversals	Wh-Questions
(7)	Auxiliary-negative or copula-negative contraction: He wasn't going. He hasn't been seen. It couldn't be mine. They aren't big.			
8		A. where, when, how, while, whether (or not), till, until, unless, since, before, after, for, as, as + adjective + as, as if, like, that, than I know where you are. Don't come till I call. B. Obligatory deletions: I run faster than you [run]. I'm as big as a man [is big]. It looks like a dog [looks].	A. Reversal of auxiliary have: Has he seen you? B. Reversal with two or three auxiliaries: Has he been eating? Couldn't he have waited? Could he have been crying? Wouldn't he have been going?	whose, which, which + noun Whose car is that? Which book do you want?

	Negatives	Conjunctions	Interrogative Reversals	Wh-Questions
(8)		C. Elliptical deletions (score 0): That's why [I took it]. I know how [I can do it]. D. Wh-words + infinitive: I know how to do it. I know where to go.		

APPENDIX B

DISTINCTIVE FEATURE COMPOSITION OF ENGLISH PHONEMES

(Chomsky and Halle, 1968, pp. 176-177)

	r	l	p	b	f	v	m	t	d	θ	ð	n	s	z	tʃ	dʒ	ʃ	ʒ	k	g	ŋ	h	j	w
vocalic	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
consonantal	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	−	−
high	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	+	+	+	+	+	−	+	+
back	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	+	−	−	+
low	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−	−
anterior	−	+	+	+	+	+	+	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−	−	−
coronal	+	+	−	−	−	−	−	+	+	+	+	+	+	+	+	+	+	+	−	−	−	−	−	−
voice	+	+	−	+	−	+	+	−	+	−	+	+	−	+	−	+	−	+	−	+	+	−		
continuant	+	+	−	−	+	+	−	−	−	+	+	−	+	+	−	−	+	+	−	−	−	+		
nasal	−	−	−	−	−	−	+	−	−	−	−	+	−	−	−	−	−	−	−	−	+	−		
strident	−	−	−	−	+	+	−	−	−	−	−	−	+	+	+	+	+	+	−	−	−	−		

APPENDIX C

EXAMPLE OF A DSS SCORING PROCEDURE

DSS ANALYSIS

Subject 1

Sentence	Indef. Pro.	Pers. Pro.	Main Verb	Sec. Verb	Neg.	Conj.	Inter. Rev.	Wh-Q	Sent. Point	Total
1. I took a big snow-ball.		1	2						1	3
2. I throw it right on her back.	1	1,2	-						0	4
3. Her gots a big snowball.		-	-						0	0
4. That was a block of ice.	1		2						1	4
5. We can't make a snowman		3	4		4				1	12
6. I opens the door.		1	-						0	1
7. I'm higher than you.		1,1	2			8			1	13
8. Him has to sit on there.		-	1	5					0	6
9. Can you hand me that ladder?	1	1,1	4				6		1	14
10. They're by the camper.		3	2						1	6

APPENDIX D

ANALYSIS OF FEATURE USAGE WORKSHEET

(Excerpted from Applied Linguistic Analysis by Elaine Hannah, Ph.D.

Feature	Target Phoneme		Substitutions					
	P. #1	# CO.	P.	#	P.	#	P.	#
vocalic								
conson.								
voice								
continuant								
nasal								
strident								
high								
back								
low								
anterior								
coronal								

P. #1 = Phoneme #1

CO. = Number of times correct

P. = Phoneme

= Number of times produced

APPENDIX E

SUMMARY OF DATA WORKSHEET (Excerpted from _Applied Linguistic Analysis_ by Elaine Hannah, Ph.D. © Joyce Motion Picture Co., 1974)

Plus Feature

Vocalic			Conson.			Voice			Contin.			Nasal			Strid.			High			Back			Low			Ant.			Coronal		
P.	P.O.	C.O.	P.	P.O.	C.O.	P.	P.O.	C.O.	P.	P.O.	C.O.	P.	P.O.	C.O.	P.	P.O.	C.O.	P.	P.O.	C.O.	P.	P.O.	C.O.	P.	P.O.	C.O.	P.	P.O.	C.O.	P.	P.O.	C.O.
Total			Total			Total			Total			Total			Total			Total			Total			Total			Total			Total		
% Cor.			% Cor.			% Cor.			% Cor.			% Cor.			% Cor.			% Cor.			% Cor.			% Cor.			% Cor.			% Cor.		
% Inc.			% Inc.			% Inc.			% Inc.			% Inc.			% Inc.			% Inc.			% Inc.			% Inc.			% Inc.			% Inc.		

Minus Feature

Vocalic			Conson.			Voice			Contin.			Nasal			Strid.			High			Back			Low			Ant.			Coronal		
P.	P.O.	C.O.	P.	P.O.	C.O.	P.	P.O.	C.O.	P.	P.O.	C.O.	P.	P.O.	C.O.	P.	P.O.	C.O.	P.	P.O.	C.O.	P.	P.O.	C.O.	P.	P.O.	C.O.	P.	P.O.	C.O.	P.	P.O.	C.O.
Total			Total			Total			Total			Total			Total			Total			Total			Total			Total			Total		
% Cor.			% Cor.			% Cor.			% Cor.			% Cor.			% Cor.			% Cor.			% Cor.			% Cor.			% Cor.			% Cor.		
% Inc.			% Inc.			% Inc.			% Inc.			% Inc.			% Inc.			% Inc.			% Inc.			% Inc.			% Inc.			% Inc.		

P. = Phoneme P.O. = Possible Occurrence C.O. = Correct Occurrence

APPENDIX F

PERCENTAGE-CORRECT USAGE OF DISTINCTIVE FEATURES ACROSS PHONEMES

Percentage-Correct Usage							
Subject	1	2	3	4	5	6	7
Age	6-3	6-6	6-6	6-8	6-4	6-6	6-8
Distinctive Feature							
+vocalic	50	66.7	0	66.6	16.4	33.3	33.3
-vocalic	96.4	96.5	73.1	100	89.6	100	94.1
+consonantal	87.5	90.6	65.5	95.4	86.0	91.3	86.8
-consonantal	50	66.6	100	100	25	66.6	50
+voice	58.1	87.5	65	60.8	67	69.6	67.7
-voice	100	100	44.4	100	56.5	100	88
+continuant	58.8	78.3	71.4	78.6	35.8	71.4	56.5
-continuant	82.4	91.6	60	100	90.4	91.6	93.3
+nasal	100	100	100	100	100	100	100
-nasal	100	100	75.8	100	83.1	100	97.5
+strident	90.9	64.3	100	100	15	100	72.7
-strident	100	90.4	47.6	100	75	80	85.2
+high	90	87.5	62.5	100	43.8	90.9	84.6
-high	87.5	88.9	66.6	94.4	71.1	86.6	81.5
+back	100	66.7	0	100	100	66.6	100
-back	91.2	90.6	73.7	95	81.2	100	86.5
+low	100	100	100	100	0	100	100
-low	100	100	75.8	100	96.2	100	97.5
+anterior	90.5	91.6	66.6	94.4	90	100	91.6
-anterior	92.3	100	62.5	100	29.2	92.8	93.7
+coronal	86.7	76.9	50	92.85	71.42	71.42	75.8
-coronal	90.9	88.8	66.6	100	84.2	100	90.9
Mean percentage-correct maintenance	87.95	87.69	61.77	94.40	64.11	88.80	85.24

Percentage-Correct Usage (continued)

Subject	8	9	10	11	12	13
Age	6-8	6-5	6-10	6-10	6-11	6-9
Distinctive Feature						
+vocalic	0	0	33.3	0	100	66.6
-vocalic	100	95.6	100	100	100	100
+consonantal	90.6	76.9	84.6	85.3	100	97.1
-consonantal	100	66.6	100	100	100	100
+voice	73.9	65.4	88.2	64.5	57.1	76.9
-voice	100	100	88.8	100	100	100
+continuant	73.9	60	73.9	50	90.9	85
-continuant	100	88.8	66	100	100	100
+nasal	100	100	100	100	100	100
-nasal	100	100	100	100	100	100
+strident	88.2	90.9	45.45	100	100	92.8
-strident	100	55.5	66	82.6	100	85.7
+high	72.7	66.6	100	100	100	81.8
-high	85.7	71.4	83.3	75	100	95.8
+back	100	66.6	100	100	100	66
-back	89.6	76.9	84.6	89.6	100	96.5
+low	100	100	100	100	100	100
-low	100	100	100	100	100	100
+anterior	100	83.3	95.2	85.9	100	95.8
-anterior	78.5	90.9	100	100	100	90.9
+coronal	86.95	45	60.9	50.5	100	78.3
-coronal	100	88.8	100	100	100	83.3
Mean percentage-correct maintenance	89.84	78.13	83.49	88.47	96.28	89.3

APPENDIX G

PERCENTAGE-CORRECT USAGE OF INDIVIDUAL PHONEMES

	Percentage-Correct Usage													
	Subject	1	2	3	4	5	6	7	8	9	10	11	12	13
	Age	6-3	6-6	6-6	6-8	6-4	6-6	6-8	6-8	6-5	6-10	6-10	6-11	6-9
Phoneme	p	100	100	100	100	33.3	100	100	100	100	100	100	100	100
	b	66.6	66.6	66.6	66.6	66.6	66.6	66.6	66.6	66.6	100	66.6	66.6	66.6
	w	100	50	100	100	100	66.6	100	100	100	100	100	100	100
	m	100	100	100	100	100	100	100	100	100	100	100	100	100
	f	100	100	100	100	100	100	100	100	100	100	100	100	100
	v	33.3	66.6	66.6	66.6	0	66.6	33.3	66.6	0	66.6	0	66.6	66.6
	θ	100	33.3	0	100	0	33.3	0	33.3	0	0	0	100	0
	ð	0	33.3	0	33.3	0	100	0	66.6	0	0	0	33.3	66.6
	t-	50	100	50	100	50	100	50	100	100	50	100	100	100
	-t	100	100	0	100	0	100	0	100	100	100	100	100	100
	d-	50	50	50	100	50	100	100	100	100	100	100	100	100
	-d	0	100	100	0	0	100	0	100	100	100	0	100	0
	l	33.3	66.6	0	66.6	33.3	100	66.6	100	0	66.6	0	100	66.6
	n	100	100	100	100	100	100	100	100	100	100	100	100	100
	s-	100	0	100	100	0	100	100	100	100	0	100	100	0
	-s	100	0	100	100	0	100	100	0	100	0	100	100	100
	z-	0	0	100	100	0	100	50	50	50	0	100	100	100
	-z	0	100	100	100	0	0	0	100	0	0	0	0	0
	ʃ	100	66.6	100	100	0	100	66.6	66.6	100	100	100	100	100
	ʒ	0	50	50	0	0	0	0	0	50	50	0	50	0
	tʃ	100	100	100	100	0	100	100	100	100	100	100	100	100
	dʒ	66.6	33.3	66.6	100	0	66.6	33.3	0	0	100	66.6	100	66.6
	j	50	100	100	100	50	100	50	100	100	100	100	100	100
	r	66.6	66.6	100	100	0	33.3	0	0	0	0	0	100	100
	k	100	100	0	100	66.6	100	100	100	100	100	100	100	66.6
	g	100	100	100	66.6	33.3	66.6	66.6	66.6	100	100	66.6	100	66.6
	ŋ	100	100	100	100	100	100	100	100	100	100	100	100	100
	h	100	100	100	100	0	100	100	100	100	100	100	100	100

APPENDIX H

PERCENTAGE-CORRECT USAGE OF MORPHOLOGIC ITEMS AND MEAN DMS SCORES

Percentage-Correct Usage								
	Subject	1	2	3	4	5	6	7
	Age	6-3	6-6	6-6	6-8	6-4	6-6	6-8
Morphologic Item	present progressive	100	100	100	100	100	100	100
	past regular (verb)	92.95	58.69	90.9	100	95.5	90	86.9
	past irregular (verb)	71.42	80.67	97.4	98.3	92.9	97.9	93.9
	third person regular (verb)	51.51	14.28	82.3	98.2	31.7	96.4	61.9
	third person irregular (verb)	33.33	50	57.14	100	0	100	100
	plural	95	80.9	93.93	98.3	76.9	96.7	93.8
	possessive	55.55	25	85.71	70.8	50	84.6	0
	"in"	96	100	100	100	100	100	100
	"on"	91.66	100	100	100	100	73.3	100
	articles	92.71	98.46	98.3	99.3	96.3	100	92.1
	contractible copula	81.35	60	96.4	96.2	56.1	95.6	97.2
	uncontractible copula	91.17	85	97.2	98.1	60	82.4	66.7
	contractible auxiliary	75	41.7	90.5	100	23.6	86.9	74.2
	uncontractible auxiliary	84.61	16.7	60	100	65	100	33.3
Mean Developmental Morphology Scores		74.74	53.95	85.41	97.28	63.91	92.76	77.12

Percentage-Correct Usage (continued)

Subject	8	9	10	11	12	13
Age	6-8	6-5	6-10	6-10	6-11	6-9
Morphologic Item						
present progressive	100	100	100	100	100	100
past regular (verb)	100	95.5	100	94	100	100
past irregular (verb)	90.5	75	79.3	82.1	100	91.11
third person regular (verb)	100	68.4	93.1	75.5	100	96.3
third person irregular (verb)	100	33.3	70	27.8	100	77.8
plural	100	100	100	100	100	100
possessive	33.3	100	100	72.72	100	100
"in"	100	100	100	100	100	100
"on"	83.3	91.7	100	100	100	100
articles	98.4	96	100	100	100	98.8
contractible copula	100	70	94.3	93.1	96.87	91.35
uncontractible copula	94.4	82.6	87.5	82.8	100	90.9
contractible auxiliary	100	28.6	92.6	100	100	95.12
uncontractible auxiliary	100	50	100	100	100	70
Mean Developmental Morphology Scores	98.29	65.76	92.08	85.06	99.54	91.10

APPENDIX I

PERCENTAGE-CORRECT USAGE OF SYNTACTIC ITEMS; MEAN DSS SCORES AND PERCENTILES; AND DELAYS IN LANGUAGE AGE

Percentage-Correct Usage							
Subject	1	2	3	4	5	6	7
Age	6-3	6-6	6-6	6-8	6-4	6-6	6-8
Syntactic Item							
indefinite pronoun	98.9	99.1	100	100	98.4	100	100
personal pronoun	90.6	61.7	98.3	100	95.6	99.2	98.6
main verb	64.6	69.9	90.7	97.8	56.6	94	95.1
secondary verb	100	100	100	100	100	96.3	100
negative	56.1	100	94.4	100	100	100	100
conjunction	100	100	100	100	88.9	100	100
interrogative reversal	25.3	91.6	81.1	94.4	100	100	63.4
"wh-" question	100	100	96.6	93.3	100	100	100
sentence point	52	50.7	82.7	92	46	93.3	89.3
$\bar{x}$ DSS Score	6.56	7.73	8.05	10.03	6.04	8.34	9.09
$\bar{x}$ DSS Percentile	-10	-10	-10	45	-10	17	20
Delay in Language Age	34 mos.	26 mos.	24 mos.	6 mos.	35 mos.	22 mos.	16 mos.

Percentage-Correct Usage (continued)

Subject	8	9	10	11	12	13
Age	6-8	6-5	6-10	6-10	6-11	6-9
Syntactic Item						
indefinite pronoun	100	100	100	100	100	100
personal pronoun	100	97	100	95	100	98.9
main verb	98.6	85.7	95.6	84.7	99.4	96.8
secondary verb	100	91.6	100	97.4	100	100
negative	100	100	100	100	100	100
conjunction	100	100	97.1	97.3	96.3	100
interrogative reversal	86.9	38.9	91.6	100	93.3	100
"wh-" question	100	100	100	100	100	100
sentence point	94.6	76	94.6	71.3	96.6	94
$\bar{x}$ DSS Score	9.83	6.38	11.61	9.62	9.38	9.65
$\bar{x}$ DSS Percentile	40	-10	60	40	25	30
Delay in Language Age	9 mos.	36 mos.	none	13 mos.	15 mos.	13 mos.

APPENDIX J

PLOT VALUES FOR THE FINAL CONFIGURATION OF DISTINCTIVE FEATURES IN THREE DIMENSIONS GENERATED BY MD-SCAL ANALYSIS

Distinctive Feature	Dimension 1	2	3
+vocalic	-0.857	-0.620	-0.203
-vocalic	-0.085	0.273	0.584
+consonantal	-0.641	0.062	0.244
-consonantal	0.837	-1.018	-0.841
+voice	0.465	0.868	-1.495
-voice	0.280	0.040	0.361
+continuant	0.091	-0.866	-0.723
-continuant	-0.437	0.915	-0.101
-nasal	0.249	0.109	0.484
+strident	1.081	-0.049	-0.830
-strident	-0.760	0.322	0.016
+high	0.350	-0.613	0.296
-high	-0.433	-0.293	-0.108
+back	-0.017	0.951	0.406
-back	-0.461	-0.186	0.108
+low	1.190	-0.611	-0.156
-low	-0.052	0.534	0.645
+anterior	-0.543	0.284	0.501
-anterior	0.689	-0.439	0.178
+coronal	-0.953	0.131	-0.276
-coronal	0.008	0.207	0.910

APPENDIX K

PLOT VALUES FOR THE FINAL CONFIGURATION OF INDIVIDUAL PHONEMES IN THREE DIMENSIONS GENERATED BY MD-SCAL ANALYSIS

Individual Phonemes	Dimension 1	2	3
b	-0.574	0.647	0.639
w	-1.083	-0.040	-0.383
v	0.145	-0.606	-0.428
θ	1.118	-0.111	-0.434
ð	-0.516	-0.733	-0.463
t-	-0.610	0.479	-0.326
-t	0.422	-0.812	-0.141
d-	-0.422	0.496	-0.483
-d	-0.688	-0.592	0.660
l	-0.319	-0.692	-0.806
s-	-0.137	1.097	0.362
-s	0.102	0.913	0.313
z-	0.254	0.843	0.199
-z	0.106	0.537	-1.005
ʃ	0.533	-0.037	0.610
ʒ	-0.565	-0.511	0.844
dʒ	0.929	-0.051	0.474
j	0.020	-0.636	0.315
r	0.914	0.225	-0.191
k	0.067	0.021	-1.220
g	-0.013	-0.386	0.912
h	0.315	-0.052	0.553

APPENDIX L

PLOT VALUES FOR THE FINAL CONFIGURATION OF MORPHOLOGIC ITEMS IN THREE DIMENSIONS GENERATED BY MD-SCAL ANALYSIS

Morphologic Item	Dimension 1	2	3
past regular verb	-0.824	0.390	0.408
irregular past verb	0.910	-0.301	-0.850
third person regular verb	-0.091	0.246	0.189
third person irregular verb	0.599	0.525	-0.528
plural	-0.103	0.549	0.603
possessive	-0.472	-0.687	0.812
"in"	0.196	-1.093	-0.819
"on"	-0.898	0.301	-1.139
articles	0.114	-0.975	0.126
contractible copula	0.258	0.606	0.038
uncontractible copula	0.607	-0.177	0.755
contractible auxiliary	0.304	0.529	0.276
uncontractible auxiliary	-0.600	0.087	0.129

APPENDIX M

PLOT VALUES FOR THE FINAL CONFIGURATION OF SYNTACTIC ITEMS IN THREE DIMENSIONS GENERATED BY MD-SCAL ANALYSIS

Syntactic Item	Dimension 1	2	3
indefinite pronoun	-0.455	-0.236	0.293
personal pronoun	-0.933	-0.112	-0.481
main verb	-0.553	-0.158	0.423
secondary verb	0.844	-0.267	-1.039
negative	0.427	0.503	0.633
conjunction	0.168	-0.894	0.187
interrogative reversal	1.094	0.248	0.316
"wh-" question	0.013	0.995	-0.754
sentence point	-0.604	-0.079	0.422

APPENDIX N

PLOT VALUES FOR THE FINAL CONFIGURATION OF ARTICULATORY, MORPHOLOGIC, AND SYNTACTIC ITEMS IN THREE DIMENSIONS GENERATED BY MD-SCAL ANALYSIS

Articulatory Item	Dimension 1	Dimension 2	Dimension 3
+vocalic	-0.740	0.225	-0.696
-vocalic	-0.818	-0.444	-0.100
+consonantal	-0.921	-0.164	-0.220
-consonantal	0.861	-0.101	0.046
+voice	0.449	1.255	0.274
-voice	-0.611	-0.477	-0.325
+continuant	0.405	-0.014	-0.540
-continuant	-1.120	-0.086	0.136
-nasal	-0.650	-0.496	-0.294
+strident	0.802	-0.169	-0.542
-strident	-0.963	-0.012	-0.141
+high	-0.111	-0.521	-0.416
-high	-0.592	-0.144	-0.428
+back	-0.976	-0.448	0.255
-back	-0.689	-0.156	-0.329
+low	0.601	-0.392	-0.586
-low	-1.000	-0.445	-0.005
+anterior	-0.910	-0.222	-0.117
-anterior	0.051	-0.521	-0.589
+coronal	-0.915	0.270	-0.252
-coronal	-0.727	0.572	0.022

Morphologic Item	Dimension 1	Dimension 2	Dimension 3
past regular verb	0.554	-0.498	0.969
irregular past tense of verb	-0.073	0.860	0.612
third person regular verb	0.709	-0.210	0.356
third person irregular verb	0.295	0.004	-0.330
plural	0.659	-0.475	0.035
possessive	0.283	-0.215	1.149
"in"	0.270	1.110	0.510
"on"	-0.085	0.966	-1.000
articles	0.531	0.627	0.650
contractible copula	0.795	-0.312	0.098
uncontractible copula	0.774	-0.325	-0.417
contractible auxiliary	0.634	-0.277	0.035
uncontractible auxiliary	0.251	-0.539	0.720

Syntactic Item	Dimension 1	Dimension 2	Dimension 3
indefinite pronoun	0.836	-0.062	-0.055
personal pronoun	0.687	-0.363	0.881
main verb	0.746	-0.059	0.047
secondary verb	-0.547	1.059	0.441
negative	0.267	1.193	0.471
conjunction	0.659	-0.255	-0.830
interrogative reversal	0.089	1.109	0.544
"wh-" question	-0.489	0.385	1.163
sentence point	0.731	-0.085	0.202

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