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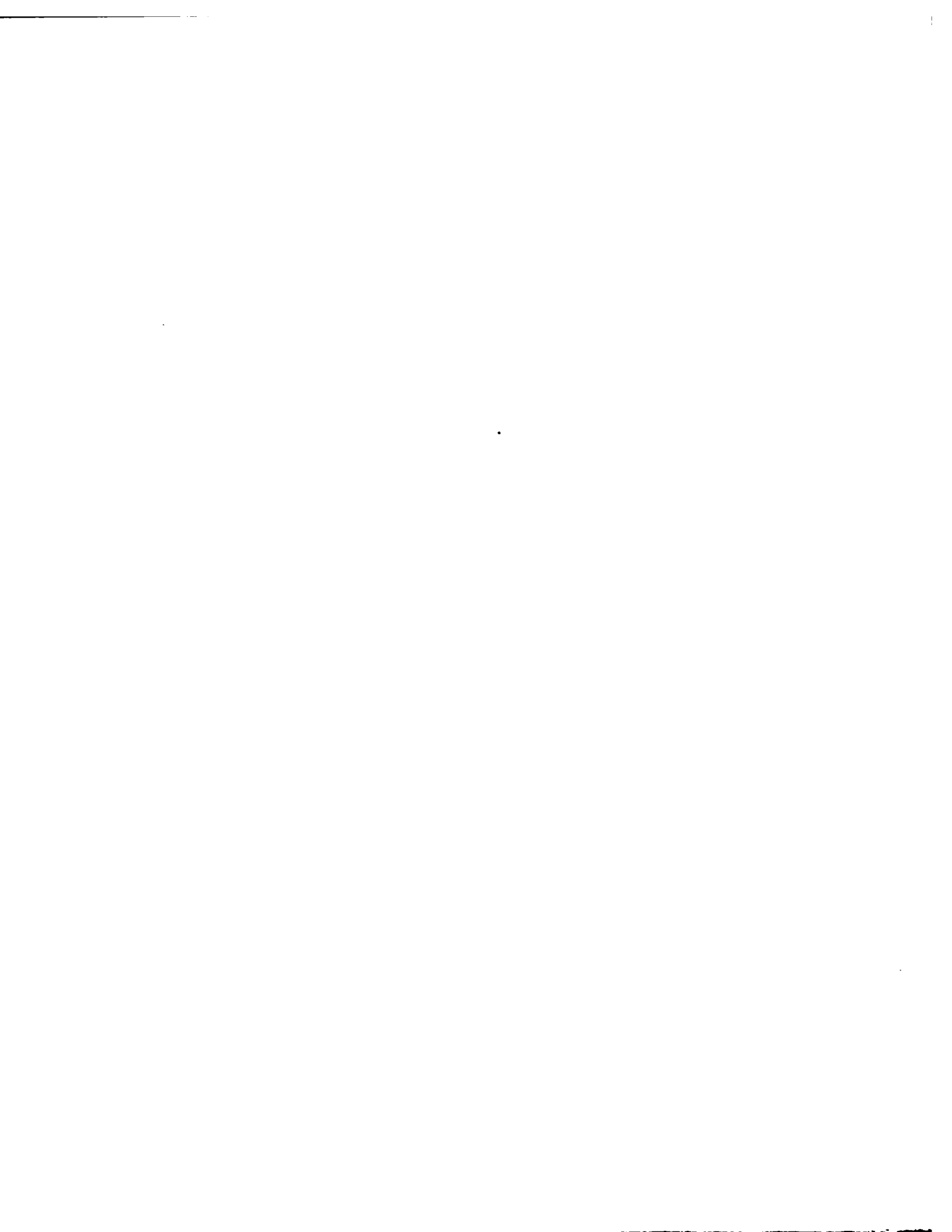
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**Klink, Marcia Lynn**

**A COMPARISON OF PHONOLOGICAL PROCESS USAGE IN YOUNG  
EDUCABLE MENTALLY RETARDED CHILDREN WITH PRE-SCHOOL  
CHILDREN OF NORMAL INTELLIGENCE**

*City University of New York*

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YOUNG EDUCABLE MENTALLY RETARDED CHILDREN WITH  
PRE-SCHOOL CHILDREN OF NORMAL INTELLIGENCE

by

MARCIA KLINK

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## ABSTRACT

### A COMPARISON OF PHONOLOGICAL PROCESS USAGE IN YOUNG EDUCABLE MENTALLY RETARDED CHILDREN WITH PRE-SCHOOL CHILDREN OF NORMAL INTELLIGENCE

by

Marcia Klink

Adviser: Professor Lawrence Raphael

The speech production skills of young educable mentally retarded children and pre-school children of normal intelligence from local schools were examined. The experimental group contained 20 mentally retarded children with I.Q. scores between 50 and 75. The first control group contained 10 children of normal intelligence who demonstrated a communication handicap. The second control group contained 10 children of normal intelligence who had no communication handicap. All children were matched on the basis of mean length of utterance scores between 3.0 and 5.0 which were obtained in a spontaneous speech sample. The subjects in the study were administered the Weiner Phonological Process Analysis Tool.

The results of the investigation showed that the phonological processes can be ordered with certain processes precluding the existence of others in children's speech patterns. This ordering of the processes, based on preva-

lence, was evident for all the children in the study.

The retarded and communication handicapped used a significantly greater total number of processes, and used the processes more frequently, than the normal speaking group. No significant difference was found between the retarded and the communication handicapped groups in the frequency analyses. Syllabic structure analysis demonstrated that the retarded and communication handicapped children used the phonological processes most often in CVCC structures. Normal speaking children used the processes most often in CCV structures.

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## CHAPTER I

### INTRODUCTION

#### Significance of the Project

Articulation problems have long been recognized as the most prevalent of all disorders of speech. Peckham (1973) showed that 10-13% of the young school population has speech problems. The largest category of speech defects, over 60%, is that of articulation disorders. According to Schlanger (1953) the incidence of articulation problems for retarded school children is higher than that for the rest of the school age population. The pervasiveness of articulation disorders in retarded children is obvious. Many of these children spend years in speech therapy attempting to correct their multiple articulation disorders. According to Gibson (1978) it is not unusual for a child to be labeled as speech disordered after having spent his/her school career receiving speech remediation. Thus, it is obvious that more research is needed in the area of articulation disorders so that remediation procedures can be made efficient and effective.

Most analyses of retarded children's articulation errors in the past have failed to look for patterns of errors. Studies by Karlin and Strazzula (1952), Tarjan, Dingman, and Miller (1960), and Lyle (1961) examined phoneme errors on a single-sound basis only. As a result, they failed to consider sound changes that might have been influenced by phonetic contexts. Context-sensitive errors are not revealed and so remediation cannot possibly be efficient since an important cause of sound change is omitted from the analyses.

Another type of error that is omitted from single-phoneme analyses is the patterned context-free error. Such an error, not affected by context, is typified by misarticulations of a set of related sounds. For example, in a single-phoneme analysis, a misarticulation pattern such as [ʃ → s, ʒ → d, k → t] may be characterized as a multiple articulation problem. In fact, the multiple errors are better and more simply characterized as the result of fronting. Remediation may be more efficient if the therapist focuses on a single, patterned error, rather than three different phoneme errors.

In an effort to describe the patterns of errors found in young children's speech, researchers have used phonological process analysis. This system of analysis attempts to describe the errors in terms of sound changes caused by simplification procedures (Stampe, 1973, Ingram (1974).

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During the period of phonological acquisition, it has been suggested that children systematically misproduce sounds in their attempts to produce complex adult models. Through the application of the phonological processes utterances are simplified by reducing the number of phonemic contrasts. The processes that cause these sound changes can be either context-sensitive or context-free.

Shriberg and Kwiatkowski (1980) have asserted that most normal speaking children use phonological processes during the early stages of speech acquisition. However, the frequency of the various processes in the children's patterns seems to vary widely. For any child some processes may be used rarely, (e.g. epenthesis and metathesis), while other processes may be used frequently (e.g. stopping and weak syllable deletion).

Research by Lenneberg, Nichols, and Rosenberger (1962) has shown that retarded children develop speech skills in the same manner as normal I.Q. children. However, the retarded children never reach the complexity levels that normal I.Q. children achieve, and they proceed at a slower rate to that earlier plateau in speech development. Thus, a comparison of retarded and normal I.Q. children's speech productions ought to reveal similar patterns of phonological process usage with the retarded failing to eliminate certain processes.

### Need for the Study

Recent investigations by Stoel-Gammon (1980) and Dodd (1976) have shown the need for research into the phonology of retarded children. Both of these studies successfully identified phonological processes in this special population. Although Stoel-Gammon and Dodd demonstrated that phonological process analysis is a fruitful area of study, they failed to produce results that could be generalized. Stoel-Gammon used only four mentally retarded children with no normal I.Q. children for comparison. None of her conclusions could be tested for statistical significance. The Dodd investigation used a population of ten severely retarded children. Although the retarded children were matched to normal I.Q. children, none of the results was subjected to statistical analysis.

The need for a study with a larger population of retarded children is evident so that conclusions can be drawn that can be generalized to the broad population of educable mentally retarded children. Only in this way can statements be made about the frequency and patterned use of phonological processes by these special children.

It is also evident from the above-cited studies that a research investigation with retarded children is needed that more carefully controls for confounding effects of language skills. Matthews (1971) has emphasized that language problems often accompany articulation problems in

retarded children. Thus, retarded children who usually show language and articulation problems might be at an inherent disadvantage when matched to normal children. In the past, researchers have controlled for this variable by matching the children on mean length of utterance, a good measure of language development (Brown, 1973). However, in the present study an additional measure was undertaken in securing control groups by locating and separating normal I.Q. children who demonstrated language and articulation problems from those who had no such problems. Thus, it was possible to compare the speech skills of the retarded with normal I.Q. children with and without articulation and language problems.

Through a carefully controlled matching of educable mentally retarded children with normal I.Q. children insight ought to be gained about the phonological problems of the retarded. The comparison should reveal similarities and/or differences between retarded and normal I.Q. children in the frequency and use of phonological processes. These similarities and/or differences will have important implications concerning strategies for the remediation of phonological problems in the retarded. At the present time no literature has been published that suggests how remediation for these problems should be designed.

If the retarded children use the processes with the same frequency and pattern as normal children, then the

results would indicate that the techniques recommended for normal children should be effective for retarded children. Very little research has been completed with respect to principles of remediation of phonological errors through process analysis. However, Ingram (1976) and Hodson (1980) suggest that phonological processes might be eliminated in a certain order. On the other hand, a very different implication might be drawn if there were significant differences between the retarded and normal I.Q. children's use of phonological processes. If the retarded use phonological processes more frequently (which is quite possible since the retarded generally have more phonological errors than normal I.Q. children) and use the processes in a different pattern from the normal I.Q. children, then different techniques should be investigated for remediation of their phonological problems. A different pattern of usage might suggest that the retarded need to focus on eliminating certain processes that normal I.Q. children do not need special help to eliminate.

A comparison of the phonological process usage by retarded with normal I.Q. children should also provide support for theories of speech development in mentally retarded children. If the retarded children show a pattern of dissolution of phonological processes that is similar to normal children's, this might lend support to the biologically based theories of speech development. Lenneberg et al. (1962) and other innate theorists maintain that

normal I.Q. and retarded children acquire speech in the same sequence but at a different rate because of differences between their biological predispositions to speech acquisition.

Alternatively, the behaviorist theory might be supported if the data from this study showed that the retarded children demonstrated a phonological process pattern that was different from that of the normal I.Q. population. The pattern differences might illustrate that environmental stimulation and training are crucial to speech development. Since the retarded have limited intellectual skills, they may not profit from the stimulation in the same manner or degree as the normal I.Q. children. Thus, differences in the order of acquisition of phonological skills, (i.e. order of process dissolution) would be expected in the behaviorist view, and if found, would support that view.

#### Purpose of the Study

The primary aim of this study was to determine whether educable mentally retarded children's pattern of phonological process use (and dissolution) is significantly different from the pattern of usage of normal I.Q. children. A criterion reference system (see p.44 for a description) was developed in order to insure that the children were consistently employing phonological processes in their speech patterns rather than using processes only in isolated instances. Thus, the system provided a basis for guaranteeing an accurate description of the children's phonological

errors. The established criteria provided a basis for testing the statistical significance of the data relevant to the hypotheses of this study. Tests of statistical significance based on criteria for process usage have not been carried out in previous investigations in process analysis, although they have been strongly recommended as crucial tests by such researchers as, McReynolds and Elbert (1981).

Specifically, the study was implemented to determine whether there is a significant difference between the frequencies and types of phonological processes used by mentally retarded children and two control groups of normal intelligence. The two control groups differed by the absence vs presence of a communication handicap. The communication handicapped group provided data on process usage by children whose language patterns, like those of the retarded, contain many phonological and grammatical errors. The second control group contained children who are developing speech and language skills normally. The use of two groups instead of one provided for more definitive statements about similarities and differences between retarded and normal I.Q. children.

In summary, the purposes of the present study were:

- (1) to determine whether retarded children differed significantly from the two control groups in the frequency and pattern of use of the phonological processes examined by Weiner's (1979) Phonological Process Analysis.

- (2) to characterize intragroup variability with respect to frequency and pattern of use of the phonological processes.

#### Hypotheses of the Study

The study was designed to compare the performance of educable mentally retarded children with normal I.Q. children using the Weiner (1979) Phonological Process Analysis. It is hypothesized that:

- (1) Educable mentally retarded children will use a significantly greater number of the 16 phonological processes examined than normal I.Q. children.
- (2) Those phonological processes that are used by both the retarded and normal I.Q. children will be more frequently used by the retarded than the normal I.Q. children.
- (3) Educable mentally retarded children will differ from the normal I.Q. children in their pattern of dissolution of the phonological processes examined.

#### Definition of Terms

The following section contains a glossary of terms that are germane in the discussion of phonological processes in children. Each process entry provides a concise definition and example for easy identification extracted from

Weiner's (1979) manual on Phonological Process Analysis.

Deletion of Final Consonants is a process in which the final consonant in a word is omitted (e.g. back → [bæk]).

Cluster Reduction is a process in which the speaker simplifies a cluster of two or three contiguous consonants by deleting one or more (e.g. sleep → [sɪp]).

Weak Syllable Deletion is a process in which the unstressed syllable in a two or three syllable word is omitted (e.g. envelope → [ɛn'loʊp]).

Glottal Replacement is a process in which a glottal stop is substituted for a consonant in a word (e.g. boat → [boʔ]).

Labial Assimilation is a process in which a dominant labial consonant assimilates another consonant to a (bi) labial articulation (e.g. mother → [mʌmɹ]).

Alveolar Assimilation is a process in which a dominant alveolar consonant assimilates another consonant to an alveolar articulation (e.g. kitten → [tɪtɪŋ]).

Velar Assimilation is a process in which a dominant velar consonant assimilates another consonant to a velar articulation (e.g. dog → [gɔg]).

Pre-vocalic Voicing is a process in which a word-initial voiceless consonant assumes the voicing feature (e.g. pig → [bɪg]).

Final Consonant Devoicing is a process in which a voiced consonant becomes devoiced (e.g. head → [hɛt]).

Stopping is a process in which fricatives sounds are replaced by homorganic stops (e.g. soup → [tʌp]).

Affrication is a special case of stopping in which fricatives become affricates (e.g. sugar → [tʃʌgə]).

Fronting is a process whereby sounds are produced anterior to their normal place of articulation (e.g. shoe → [ʃu]).

Gliding of Liquids is a process in which a glide replaces a liquid (e.g. red → [wɛd]).

Gliding of Fricatives is a process in which a glide replaces a fricative (e.g. fine → [waɪn]).

Denasalization is a process in which a nasal is replaced by a homorganic stop (e.g. mat → [bæt]).

Vocalization is a process in which a syllabic consonant is replaced by a vowel (e.g. button → [bʌtə]).

Phonological Disorders refers to the use of non-standard phonological patterns in distributing the sounds that are uttered. Phonological disorders result when there is a restriction in knowledge and use of the phonological rules which change phonological representations into phonetic features (Shelton and McReynolds, 1979).

Phonological Processes are patterns which simplify syllables through deletion of final consonants, cluster reduction, deletion of weak syllables, glottal replacement, assimilation, pre-vocalic voicing, final consonant devoicing, stopping, and gliding of fricatives, affrication, fronting, denasalization, gliding of liquids, and vocalization (Weiner, 1979).

Mental Retardation refers to subaverage general intellectual functioning which originates during the developmental period and is associated with impairment in adaptive behavior (Matthews, 1971).

Communication Handicap is a disability in the use of language which can be characterized by disorders in speech and language skills (Matthews, 1971).

## CHAPTER II

### REVIEW OF THE LITERATURE

This chapter contains a critical review of the literature of the phonological skills of young children. The first section includes a review of the studies concerning phonological usage in children exhibiting normal speech development. The second section contains studies that describe deviant speech patterns of children with normal intelligence. Section three covers research on the speech problems of the mentally retarded population.

#### Phonological Processes in Normal Speaking Children

It is obviously true that the speech of young children differs from the speech of adults. Children's phoneme production and use deviates from the adult norm. Linguists such as Smith (1973) have suggested that these sound deviations are non-random in character and that they differ in regular and predictable ways from that of their models. Researchers, such as, Stampe (1969) and Ingram (1974) view these sound changes as the result of the application of simplification procedures to reduce the number of phonemic contrasts. These simplification procedures have been called phonological processes. According to Weiner (1979) phono-

logical processes apply in speech to substitute for a class of sounds or sound sequence, an alternative class, otherwise identical except for the absence of the difficult property. For example, voiced stops are difficult to articulate because their characteristic obstruction of the nose and mouth impedes the air-stream on which the glottal vibration depends. Thus voiced stops become voiceless stops in the example, cab  $\rightarrow [k^h \text{æ} : \rho]$ .

Substantiation of phonological process use in children has come from researchers in the field of speech and linguistics. Longitudinal studies cited by Ingram (1976) and Macken (1980) have shown that both English-speaking and Spanish-speaking children use identical phonological processes.

A cross-linguistic study by Ferguson (1978) also provides proof of phonological process usage by speakers of English, Spanish, Greek, Arabic, Aramaic, and Danish. In all cases there were strong evidences of context-free and context-sensitive simplifying processes of fricative stopping and spirantization of stops. While Ferguson used a small population of young natives in his study, so that generalization is impossible, his results are impressive with respect to individual usage.

Longitudinal case studies by Branigan (1976) and Smith (1973) show evidence of syllable reducing processes and sound simplification processes in children 16 to 24 months

of age. Smith postulates that certain rule ordering tendencies are apparent in the application of the simplification processes. Thus, vowel and consonant harmony rules are used earliest in phonological development. Later in development, cluster reduction processes are implemented. Finally, context-free sound simplifications are produced. Other authors, such as Ingram (1976) and Klein (1981) have suggested that certain processes such as reduplication, which is a special case of vowel and consonant harmony, may indeed be one of the earliest sound simplification processes used by children. However, more research is needed to substantiate the claim that the phonological processes appear in a distinct order. Smith drew his conclusions from one case study. More studies, involving bigger populations of children are needed before real credence can be given to Smith's postulation of ordering in the appearance of the phonological processes.

The above studies concentrated on substantiation of phonological process usage by identifying several different types of processes in each child's pattern including: stopping, reduplication, consonant and vowel harmony, cluster reduction, and spirantization. The next section will review studies of particular processes.

### Assimilation

Assimilation is a harmony process. In assimilatory processing a segment takes on the features of a neighboring segment. In the cases of labial, alveolar, and velar assimi-

lation, one consonant in a word influences another consonant to take on all or some of the features of the consonant. For example, the word "kite" pronounced as [tʰaɪtʰ] demonstrates alveolar assimilation. Evidences of assimilation have been noted in a longitudinal study by Menn (1971), and in a cross-sectional study by Compton and Streeter (1980). Various opinions of the causes of assimilation have been offered. Schane (1973) concludes that assimilation has a structural explanation in coarticulation. During the formation of a sound, the articulatory organs may be anticipating the articulation for another sound, and consequently, the first sound will be modified in the direction of the second. Progressive assimilation may cause the articulation of the first sound to carry over into that of the second. Other kinds of assimilation may be related to inherent constraints on the articulatory mechanism.

Vihman (1978) challenges Schane's explanation as valid only in explaining adult assimilation. Vihman concludes that consonant assimilation may function in child phonology as a source of substitutions for sounds that the child cannot pronounce and/or by allowing the child to produce a multisyllable word by reducing the overall complexity of the word..

#### Final Consonant Devoicing

Final consonant devoicing is the process of unvoicing voiced consonants when they appear at the end of a word. According to Leopold (1947) devoicing of final consonants

has been observed in several languages. Oller, Wieman, Doyle, and Ross (1976) and Ingram (1974) suggest that devoicing serves as a means of simplifying children's production through the basic assimilatory process.

Smith (1979) offers an aerodynamic explanation for final consonant devoicing. As the volume of air in the lungs decreases, subglottal pressure decreases unless expiratory muscle activity is increased. This causes more devoicing finally than initially. Since children and adults cannot often overcome physiological restraints, they devoice final consonants. Stampe (1973) sees consonant devoicing as the result of universal phonological process which causes voiceless stops to be substituted for voiced ones. He agrees that lack of physiological control is a factor in consonant devoicing but emphasizes that a universal phonological process is also operating in children. However, Stampe has not as yet offered any proof that the two factors are present in children's speech.

#### Pre-vocalic Voicing

Pre-vocalic voicing is the process of changing voiceless stops, such as [p] to a voiced stop [b] when they appear before vowels in the initial position of words. Ingram (1976) identified pre-vocalic voicing as a process in the Velton diary study, and conjectures that most, if not all, children have a period of phonological development that includes voicing initial voiceless stop consonants. Kewley-

Port and Preston (1974) reached the same basic conclusion in their spectrographic study of initial stop production in children six months to four and one-half years. They concluded that short voicing lag stops (English /bdg/) have less complex articulations for the child to control than long voicing lag stops (English /ptk/). Their data reveal that there is a predominance of English /bdg/ in children's early utterances. The voicing pattern of /bdg/ fits into Stampe's pre-vocalic voicing category. However, he contends that since the child can produce a voiceless stop in other sound positions, this is proof that a process is in operation. Many would object to Stampe's view since the same articulatory maneuvers and skills are not used in initial and final consonant production. Phonetic context plays an important role in sound production and so must be considered when equating the two sound productions.

#### Deletion of Final Consonants

Deletion of final consonants is a syllable structure process that operates most especially on CVC syllables and so results in reducing words to a basic CV syllable. According to Albright and Albright (1956), this process has been noted in the early speech development literature for many years. It seems that most children start to talk using the open syllable. Usually, in less than three years, they have also learned to use consonants for closing the syllable. Renfrew (1966) and Panagos et al. (1979) state that final con-

sonant deletion is used to reduce syllable complexity in the direction of the CV syllable. The child has the mental representation of the CVC structure, but perhaps, because of cognitive and linguistic shortcomings produces the CV. Ingram (1974) on the other hand, believes that the child passes through a significant part of his early phonological development with incorrect perception of the adult sound system. The CVC syllable may be heard as only a CV syllable. No conclusion can be made at this time as to whose interpretation is correct. Research is still in progress to determine the relationship between perception and production. Some researchers, such as Braine (1974), believe that perception skills are ahead of production skills. The question of the relationship between perception and production is an area of discussion that affects not only the use of final consonant deletion, but the use of other processes in simplification.

#### Cluster Reduction

Cluster reduction is the process by which the child simplifies contiguous groups of consonants. These deletions are usually non-random. Greenlee (1974) proposes general stages of development of consonant clusters:

Stage 1: Deletion of entire cluster

Stage 2: Reduction of cluster to one member

Stage 3: Use of cluster with substitution for  
one of the members

Stage 4: Correct production

Greenlee collected data from studies of children learning

six languages. Although the use of cluster reduction was widespread among the children, not all words gave evidence for each stage. Greenlee conjectured that the absence of certain stages might be the results of infrequency of the words of a particular type of cluster in the child's vocabulary, use of an avoidance strategy, and/or gaps in the data collection. Greenlee's conclusions can be only tentatively held as possibilities, since none of his data were subjected to statistical analysis because of his small population. In addition, Greenlee only examined stop + liquid clusters, and so the results cannot be automatically generalized to all types of sound clusters.

Bond (1981) proposes that some children do not just reduce clusters but use long voice onset times (VOT lags) to mark stops that substitute for clusters. These children may be perceptually unaware of the difference between voiced stops, and clusters. Or, they may substitute VOT lags because they are unable to control the complex articulatory gestures required for the articulation of clusters.

Menyuk and Klatt (1975) presented spectrographic evidence that seems to contradict Bond's proposal. Menyuk and Klatt found that stops in clusters did not show long VOT lags. The VOT of stops in initial clusters when spoken by eleven children were compared to the VOT of stops in clusters by two adults. The VOT was longer for the children than the adults in cluster production but not significantly, according to their data. The discrepancy

in the results of the Bond and Menyuk and Klatt studies may be due to the different stimuli and age of the children employed in the studies. Bond (1981) examined only /s/ plus stop clusters with 3.0 to 8.7 year old children, and Menyuk and Klatt (1975) used stop + liquid clusters with children between the ages of three to four years.

#### Weak Syllable Deletion

Weak syllable deletion is a common syllable structure process that occurs when the child attempts a word that contains more than one syllable. The unstressed syllable is deleted in two or three syllable words. Ingram (1974) notes the following stages of development:

1. Deletion of unstressed syllable in two-syllable words
2. Deletion processes in multi-syllable words
  - a. Initial unstressed syllables reduced in two-syllable words
  - b. Deletion of all unstressed syllables in three-syllable words
  - c. Deletion of only unstressed initial syllable in three-syllable words

Ingram (1974) admits that the above proposed stages are only impressionistic stages gleaned from his review of diary studies by Leopold (1947), Velton (1943), Menn (1971) and himself. Ingram (1974) further notes that weak syllable deletion lasts longer than deletion of final consonants in

normal speech development. Weak syllable deletion is often found through age four.

Klein (1981) concurs with Ingram that there are developmental stages in children's mastering of multi-syllable word production. Klein suggests that the production of only the accented syllable when attempting a multi-syllable word is the most primitive of the syllable-reducing processes. Weak syllable deletion is a process which is eliminated later.

### Glottal Replacement

Glottal replacement is a special syllable structure process. The glottal stop serves to mark the place of the consonant that is deleted. In the word "kitchen" pronounced as [kɪʔən] the glottal stop marks the place of /tʃ/ which was deleted. Glottal replacement frequently accompanies deletion of final consonants, and most often occurs in the intervocalic position. Bernthal and Weiner (1977) observed that glottal replacement in some children served a contrastive function to prevent homonyms (e.g. tooth [tuʔ] and two [tu]). Shriberg and Kwiatkowski (1980) noted that while glottal replacement is used by some children, it is not a prevalent process in normal speech development. According to Schlanger<sup>1</sup>, glottal replacement might be only a dialectal variation that is used among certain groups of people, especially among speakers in Ireland, Scotland, and New York City.

<sup>1</sup>Schlanger, B. (personal communication, City University, New York.

## Stopping

Stopping is a feature contrast process. It affects entire classes of sounds in a context free manner. Stopping occurs when a fricative or affricate is replaced by a homorganic stop. Examples of stopping include the following substitutions:

[ v → b vacuum → bækjum  
 z → d zipper → dɪpə  
 θ → t thumb → tɪm  
 tʃ → t chew → tu  
 dʒ → d jump → dɪmp ]

The substitution of stops for fricatives and affricates in early speech development has been noted by many researchers. Jakobson (1968) identified this pattern without specifically calling it stopping. More recently, Moskowitz (1975), Clumeck (1977), Willbrand and Kleinschmidt (1978), and Waterson (1978) have proclaimed this process a frequent one in early childhood speech.

None of the above studies firmly established that the process of stopping was actually in the children's patterns. No criterion was set as to how many times the process occurred so that it could be considered a process in consistent use. Also, the authors failed to establish that the process affected more than one sound in a child's pattern. If the process affected only one sound, an argument might be offered that stopping of a fricative is just

another description that yields no new information beyond previous descriptions of distinctive feature analysis that stopping is just  $\begin{bmatrix} - \text{sibilance} \\ - \text{continuance} \end{bmatrix}$  in a  $[b/v]$  substitution.

### Gliding

Gliding is a process that consists of the substitution of a fricative or affricate for a glide. Thus, it has been associated with stopping. Examples of gliding include:  $[j\text{op}]$  for soap,  $[w\text{ɪ}ʃ]$  for fish, and  $[j\text{ɔɪ}]$  for joy. Based on observations and a review of 15 diary studies, Ingram (1976) proposes five stages of acquisition of fricatives and affricates that show gliding and stopping intricate processes in development:

Stage 1: Non-use or deletion of fricatives  
and affricates

Stage 2: Stopping of fricatives and affricates

Stage 3: Widespread appearance of continuants  
with glides and liquids as possible  
early substitutions

Stage 4: Acquisition of most fricatives except  
 $/\theta, \text{ʒ}, v/$

Stage 5: Acquisition of fricatives and affricates  
complete.

Thus in the course of normal speech development, stopping and gliding of fricatives and affricates are but two stages in the final mastery of these two classes of sounds.

Ingram's stages now need to be statistically tested in controlled speech samples to determine whether these trends are verifiable stages of phonological development.

### Fronting

Fronting is a process whereby sounds are produced anterior to their normal place of production. Fronting commonly occurs in velar stops but also can occur in fricatives. Examples of fronting include: [tʰi] for key, [sʉ] for shoe, and [dʉ] for go. This process has been cited in the speech of normally developing children by Shibamoto and Olmsted (1978). Ingram (1976) also noted the process in a cross-language study of two children, one English and one French. He suggests that fronting reflects a constraint on the order of appearance of consonants in children's words. Fronting has been explained by Ingram (1976) as part of the universal markedness theory. Fronting appears to show that there is an unmarked/marked relationship between the target phoneme and the substitution. The sound substitution involves the use of an unmarked sound for a marked sound. It is proposed that front consonants are less marked than back consonants in syllable initial position. This causes a fronting of the back consonants in sound substitution. Ingram found evidence of this in his study. However, researchers such as Menn (1975) have found

instances where the principles of the markedness theory have not been substantiated in children's speech patterns.

### Gliding of Liquids

Gliding of liquids is a process in which /l/ and /r/ may be replaced by /w/ or /j/. This replacement is seen as a simplifying process because /w/ and /j/ are two of the earliest sounds used by a child. Examples of gliding of liquids are [wɔg] for log and [wɛd] for red. Evidence of this process has been found in the cross-sectional studies by Schwartz et al. (1980) and Locke (1972), and in a longitudinal case study by Edwards (1971).

Ingram (1976) claims that gliding of liquids is but one stage of normal acquisition of liquids. He stipulates that the order of acquisition of liquid production includes the following stages:

1. Stopping
2. Gliding
3. Liquid Substitution

Edwards (1971), however, did not note these stages in her longitudinal study. It appears that more research is needed, since these conclusions are based on so few subjects.

### Vocalization

Vocalization is a process in which syllabic consonants are replaced by vowels, most frequently /ʌ/ and /o/.

Examples of this process are [t<sup>h</sup>e<sup>r</sup>b<sup>o</sup>r] for table and [k<sup>h</sup>ʌv<sup>r</sup>] for cover. Two longitudinal studies (Leopold, 1947; Adams, 1972) provide numerous examples of vocalizations. Leopold (1947) found that the vowel that replaced the liquid was assimilated totally to the preceding vowel (e.g. hammer → [həmə]). Adams (1972) found that [ɪ] and [ɹ] became [u] at 1.7 years, and [o] at 1.11 years. No detailed analysis was given by Hodson and Paden (1981), but their cross-sectional study contains evidence of vocalization in 60 four year old subjects.

According to Bronstein (1960), vocalization of syllabic consonants can be considered dialectal variations. Thus, carefully controlled research is needed to rule out the possibility that vocalization is not a dialectal variation, and is a process in usage in children identified as using phonological processes. The above cited studies did not address this problem in their results and discussion.

#### Denasalization

Denasalization is a process that affects an entire class of sounds. The nasals / m, n, ŋ / are replaced by their homorganic stops. This process usually affects word-initial and word-medial nasals more often than word-final nasals. Velton (1943) showed this process in his

case study. However, according to Ingram (1976), the process does not appear to be an especially prevalent one.

Denasalization has been cited in studies by Shelton and McReynolds (1979) as a distinctive feature error. They describe the  $[m \rightarrow b, n \rightarrow d, \eta \rightarrow g]$  substitutions as an error in which  $[+nasal] \rightarrow [-nasal]$ . It is difficult to verify whether denasalization is a process or a feature error. Both descriptions appear applicable in describing children's speech patterns.

#### Affrication

Affrication is a special case of stopping. In this process fricatives become affricates. The process seems to happen more often for sibilant fricatives than any of the other fricatives. Through affrication "zipper" becomes  $[dzɪpə]$  and "seen" becomes  $[tsi:n]$ . Hodson (1980) conjectures that affrication takes place when the child is in the process of learning specific continuant phonemes. Affrication is an interim process in stabilizing the correct use and production of fricatives. In the first stage stops are substituted for fricatives. In the second stage, affricates are substituted for fricatives. In the final stages, fricatives are used according to the adult standard model. While Hodson (1980) states that children often demonstrate this process, she provides no documentation. However, it has been identified on a some-

what consistent basis in the speech of phonologically disordered speakers by Compton (1970) and Weber (1970).

#### Miscellaneous Processes

The list of natural processes could be considerably extended to include epenthesis, metathesis, diminution, backing, and coalescence. Shriberg and Kwiatkowski (1980) contend that these processes are rarely used by children during normal speech acquisition. In addition, since these processes were not specifically tested in this research project, they will not be discussed in this section.

#### Deviant Speech Patterns of Children of Normal Intelligence

##### Unintelligible Speakers

The studies in this section were of children whose speech is characterized as unintelligible. Their articulation errors are all described as phonological disorders which reflect the operation of simplification processes. It is proposed here and by such researchers as Weber (1970), Hass (1963), and Willbrand and Kleinschmidt (1978) that the processes used by unintelligible speakers are the same as those used by normal speakers, differing only in the number and extent of process usage.

Weber (1970) examined the speech of 18 subjects who demonstrated 20 or more errors on the Templin-Darley Articulation Test. He noted that children with moderate to severe speech problems used the processes of fronting, stopping, denasalization, consonant devoicing, gliding of liquids and affrication. These same processes have been noted in the patterns of normal developing speech children. However, according to Ingram (1981), the extensive use of denasalization and affrication is unusual among normals.

Hodson and Paden (1981) tested the speech of 60 unintelligible and 60 intelligible children. The unintelligible children showed evidence of liquid deviation, cluster reduction, stridency deletion, stopping, assimilation, and, to a lesser extent, final consonant devoicing, backing, syllable reduction, pre-vocalic voicing, and glottal replacement. The intelligible children used only final consonant devoicing consistently, and did not use glottal replacement and backing. They did use other processes, but less frequently than the unintelligible children. Hodson and Paden concluded that the unintelligible children differed from the intelligible children not only in the number, but in the kinds of processes that were used. This sweeping conclusion may be seen as a slight distortion of facts, if we considered that only two processes were not used by the normal speaking children. It might have been

because of the sampling techniques employed that these rare processes were not tapped. It is doubtful that one can say that the unintelligible children were deviant or bizarre in their use of the processes based on the data from this study.

In a study by Weiner (1981), the speech patterns of 14 unintelligible children between the ages of 3.5 and 5.10 were examined. While the patterns were not analyzed with respect to specific phonological processes, certain extrapolations can be made from the data. Weiner noted that sound replacement was usually specific to a particular phonetic environment. This means that certain phoneme changes were context sensitive, as in labial, velar, and alveolar assimilation. He also pointed out that a group of sounds having certain features in common was represented by a restricted feature arrangement. Again, this finding suggests the presence of phonological processes. That is, errors in several sounds can be expressed as one error pattern affecting several sounds, rather than as several individual unrelated errors.

Hass (1963) completed a case study of one child whom he labeled as a multiple articulation disorder case. He identified the following processes in the child's speech: glottalization, cluster reduction, deletion of final consonants, and gliding of liquids. Although this was a single-subject investigation, it does support the general

findings of larger population studies.

Another single-subject study was completed by Willbrand and Kleinschmidt (1978). Their subject was a four-year old child with unintelligible speech. They found the following processes in the child's pattern: pre-vocalic voicing, devoicing of final consonants, stopping, fronting, gliding of liquids, and context-sensitive errors. Again, the same processes are noted as in the other studies of unintelligible children, except for pre-vocalic voicing. According to the diary studies of Leopold (1947) and Velton (1943), this process is often found in the speech of very young children. Therefore, it is not a bizarre process, just one that is normally eliminated from their pattern by the time they are four years old.

All the children in the studies reviewed so far in this section were labeled unintelligible. One wonders whether they are any different from the children in the following section who were labeled language disordered/delayed with speech problems. In none of the studies did the authors describe any efforts to test the language skills of the phonological disordered children. It could be that some or all of the phonologically disordered children also had weaknesses in grammar and vocabulary, skills that rendered them as being language disordered/delayed.

### Language Disordered/Delayed Speakers

Schwartz et al. (1980) examined the speech of three language disordered and three normal speaking children who ranged in age from 1.7 to 3.7 years, with a mean length of utterance range from 1.0 to 1.3. The total number of processes evidenced was the same for both groups. In general, the phonological processes used by the language disordered were not substantially different from those used by the normal speaking children. The most frequent process in both groups was deletion of final consonants.

Edwards and Bernhardt (1973) found some evidence which conflicts with the Schwartz et al. study. They tested the speech of four language disordered children who exhibited a greater total number of processes and who applied them less consistently than normal speaking controls. Although the language-disordered children used more processes, the processes were not unique to this population. A unique aspect of their patterns of process use was that they were using processes at a time when they were producing multi-syllable words. The normal speaking children exhibited the processes only during the period when monosyllables predominated. This fact has been shown by other researchers, who have shown that language disordered children use processes for a longer time than normals. As a result, their speech and language profiles look

disordered rather than merely delayed. Their profiles are characterized by growth in the use of complex syllables with a lack of phonological development because of the retention of processes normally found only in simple CV and CVC structures.

In another study by Oller (1973), five children with delayed speech showed cluster reduction, vocalization of liquids, and reduplication. These processes are seen in normal speaking children.

The final study in this section is an investigation by Bond (1981) which focused on /s/ stop clusters. Ten children diagnosed as language delayed were tested. The children ranged in age between 3.0 and 8.7 years. Ninety-five percent of the /s/ clusters were produced as singleton stops. This type of cluster reduction is commonly found in normal speaking children.

Although each of the studies involving language disordered children employed only a few subjects, their findings were similar to those studies of the normal speaking and unintelligible children. One is left with the impression that the phonological processes used by the language and speech delayed population are the same as those used by other populations. Further, there is the possibility that the high total number and inconsistent use of the processes to a relatively late chronological age are distinguishing characteristics of this group. More research is needed using larger and better defined popula-

tions.

### Speech Problems of the Retarded

According to Tarjan et al. (1960), one of the most commonly occurring handicaps among retarded children is speech impairment. Numerous incidence studies by Burt (1937), Sirkin and Lyons (1941), Schlangner (1953) and Reynolds and Reynolds (1979) have yielded rates of speech impairment as low as 5% and as high as 94% for these children. The broad range of figures may be attributed to the fact that the studies employed, variously, retarded children from institutions and community-based residences, with ranges in I.Q. from trainable level to educable level. For the purpose of this study, the figures of Spradlin (1963) might be most realistic since he drew his population from special education classes in the public schools (as this researcher has done). Spradlin reported that some classes had speech impairment rates as low as 8% and other class had rates as high as 26%.

Certain researchers, such as Gibson (1978) and Dodd (1976), have proposed that one cannot group retarded children with different medical etiologies when describing their characteristic speech patterns. Because of this notion, Down Syndrome children have often been separated from other retarded children. It is emphasized by Gibson (1978) that Down Syndrome children might demonstrate more severe articulation problems than other retarded children

because of their structural vocal differences. However, Siegel (1972) points out that the vocal system is very robust and capable of sustaining considerable insult. Individuals have learned to speak effectively without a tongue or a larynx, or with extreme deviations in dental structures. It is clear that a person can make compensations for an abnormal speech mechanism. Therefore, deviant speech cannot be entirely attributed to the deviant structures.

Lenneberg, Nichols, and Rosenberger (1962) illustrated this point in a study with Down Syndrome children. They concluded that the physical deficiencies of three of these children did not significantly correlate with either the onset of language or clarity of articulation. It was, rather, intellectual limitations that made the significant impact on speech behavior. Speech skills appeared to plateau at a primitive level as compared with normal developing children. Thus, a universality of physical structures coupled with speech lag or deficit in Down Syndrome individuals is difficult to support.

A more recent study of the speech skills of Down Syndrome children attempted to explain their speech problems as phonological errors, rather than looking at possible but weakly correlated, physical factors as causes. Stoel-Gammon (1980) gathered speech samples from four children who ranged in age from 3.10 years to 6.3 years. Ninety

percent of the phonological errors occurred on consonants.

The following phonological processes were noted:

1. Deaspiration of voiceless stops
2. Stopping of fricatives and affricates
3. Gliding of liquids
4. Vocalization
5. Final consonant devoicing
6. Final consonant deletion
7. Glottalization

Except for glottalization and deaspiration, Stampe (1973), Ingram (1974), and Weiner (1979) have noted all the cited phonological processes in the speech of young normal developing children. According to Shriberg and Kwiatkowski (1980), glottalization and deaspiration are rare but evident processes in normal I.Q. children. The main difference, according to Stoel-Gammon (1980), that separates the retarded children's speech pattern from the normal children's pattern is the retention of the phonological processes to a later chronological age. This conclusion, however, could not be generalized to the broad retarded population, since only four subjects participated in the study.

In a study by Dodd (1976), phonological processes were reexamined in ten retarded children matched in mental age to ten children of normal intelligence. The results showed that both groups used the processes of cluster reduction, consonant harmony, unstressed syllable deletion,

gliding of liquids, denasalization, and final consonant deletion. It was also noted that the Down Syndrome children showed more instances of the processes than the other retarded children in the study. No statistical significance was attached to this latter result.

A comparison of the results of the Stoel-Gammon (Down Syndrome children) and Dodd (retarded children) studies reveals both similarities and differences in process usage by the two retarded groups. Both groups used gliding and final consonant deletion. However, Stoel-Gammon identified deaspiration, stopping, vocalization, final consonant devoicing and glottalization, while Dodd found cluster reduction, consonant harmony, weak syllable deletion, and denasalization. The identification of different processes in the two studies may be caused by the use of different sampling techniques. Stoel-Gammon gathered spontaneous speech samples. This method might have restricted the appearance of certain processes because of topic and/or word choice. The Dodd study elicited the speech sample through a picture naming task. This method insured the appearance of certain processes and eliminated others. Studies with large populations of both types are needed before one can draw any definite conclusions about the differences between them.

## CHAPTER III

### METHODOLOGY

#### Subject Selection

The children in the experimental group and the control groups were matched on the following characteristics:

1. Mean length of utterance between 3.0 and 5.0 morphemes
2. No emotional disturbance or significant hearing loss and oral mechanism within normal limits as determine by peripheral speech examination
3. Membership in a non-institutional community-based living unit
4. Membership in the lower middle class of socio-economic status as determined by the Parent Occupation Scale of the Index of Status Characteristics (Warner, Meeker, and Eells, 1960)
5. Equal percentage of males and females in each group

The experimental group contained 20 children (ten males and ten females) who were educable mentally retarded (EMR) and possessed the following characteristics:

1. School records of psychological evaluations that showed diagnostic classification for EMR placement, and Peabody Picture Vocabulary Test scores that yielded an IQ. between 50 and 75.
2. Chronological age between 4.0 and 7.2 years
3. Demonstration of a communication handicap characterized by multiple articulation problems and language problems
4. Participation in a speech therapy group

The first control group contained 10 children (five males and five females) who were communication handicapped (HNC) and demonstrated the following qualities:

1. Peabody Picture Vocabulary Test score that yielded an I.Q. between 92-112
2. Chronological age between 3.0 and 4.7 years
3. Demonstration of a communication handicap as diagnosed by school speech therapist
4. Participation in a speech therapy group

The second control group contained 10 children (five males and five females) who were normal speaking (NC) and demonstrated the following traits:

1. Peabody Picture Vocabulary Test score that yielded an I.Q. between 91 to 141
2. Chronological age between 3.0 and 4.4 years
3. No communication handicap
4. No speech therapy experience

The public school or educational center records provided the above background information. The I.Q. scores were derived from the Peabody Picture Vocabulary Test (Dunn, 1965). The mean length of utterance measure was obtained by eliciting a spontaneous speech sample after showing the child a story sequence picture set. Guidelines for scoring the responses were followed as suggested by Roger Brown (1973). (See mean length of utterance rationale section, p.51.) Statistical analysis of variance showed no significant difference between the experimental groups, based on MLU. The mean was 3.7 with a standard deviation of  $\pm .7$ .

The children in the EMR and the HNC groups were diagnosed as communication handicapped by the school certified speech pathologist. All these children showed multiple phonemic errors and grammatical errors that rendered them unintelligible at times.

### Research Materials and Procedures

#### Protocols

The following protocol was observed for each child who participated in the study:

1. A speech sample was obtained by having the child respond to the Weiner Phonological Analysis tool (PPA) as specified in the manual (Weiner, 1979; see Appendix A for sample).

2. The spontaneous speech sample was obtained by having the child tell a story in response to a picture set.
3. A peripheral speech examination was performed on each child.
4. The Peabody Picture Vocabulary Test was given to each child.

### Speech Samples

The speech samples were audio recorded on a Centrex KD-12 recorder, model number WE-065777. The data were transcribed and analyzed by the author and corroborated by an independent ASHA certified speech pathologist, and a speech scientist. The speech pathologist and speech scientist listened to the tapes and transcribed the utterances, which were then compared to the stimuli and the author's transcriptions. Three practice sessions were held by the transcribers in the study. Results were verified by an onsite listener at the taping session. Inter-scoring reliability was .95 on the tapes for the study. Listener reliability scores were .97. When the listeners transcribed the utterances differently, a consensus of opinion was reached after listening to the tapes several times.

### Phonological Process Analysis

The speech sample, elicited through the use of the PPA, was then used to identify the following phonological

processes (see p.49 below, for a description of the major process categories):

1. Syllabic Structure Processes
  - a. Deletion of Final Consonants
  - b. Cluster Reduction
  - c. Weak Syllable Deletion
  - d. Glottal Replacement
2. Harmony Processes
  - a. Labial Assimilation
  - b. Alveolar Assimilation
  - c. Velar Assimilation
  - d. Pre-vocalic Voicing
  - e. Final Consonant Devoicing
3. Feature Contrast Processes
  - a. Stopping
  - b. Gliding of Fricatives
  - c. Affrication
  - d. Fronting
  - e. Denasalization
  - f. Gliding of Liquids
  - g. Vocalization

The PPA manual suggested that a process profile be used to report the frequency of each of the 16 phonological processes sampled. The test score represented the number of times that processes occurred within stimuli specifically chosen to elicit that process. For example,

eight words were chosen by the author of the PPA to elicit final consonant deletion. Since each word is repeated twice by the child, 16 occurrences of final consonant deletion are possible. The nontest score represented the number of times a process was used during the PPA sampling, while specifically testing for a different process. As a result, the examiner noted, for instance, the occurrence of final consonant deletion, while testing for the process of affrication. The total frequency score was the sum of the test scores and the nontest scores. This was labeled sum structures. A statistical analysis showed a high correlation between the test score and the nontest score (see Appendix B). Weak syllable deletion was the only process that did not have a nontest score. No opportunities were available in the PPA for observing weak syllable deletion, except for the test items.

#### Criterion Reference System of PPA

The process profile also contained a column for a process usage decision. This plus or minus scoring represented whether, for each process, the child was actually using the process on a consistent basis or if the scores reflected an infrequent or rare occurrence which would not require remediation by a clinician. Because the PPA manual did not present criteria for determining process usage, this researcher devised a scoring procedure that was effective in analyzing the results of the PPA sample.

A score of one represented repeated usage and a score of zero meant rare or non-usage. A zero usage score was given if the subject amassed no more than two instances from the test score. For instance, a process would receive a zero usage score if the subject scored 2/16 test and 0/42 nontest. A score of one was given if the subject scored 3/16 test and 0/42 nontest.

The final score in the profile was the sum process score. The sum process score was simply the sum of all process usage scores. Thus, a sum process score of 14 represented 14 usage scores of one and two usage scores of zero. High Spearman correlations (see Appendix C) were found between the sum process scores and the frequency of process scores, or sum structure scores for each group of children.

#### Phonological Process Analysis Rationale

The Phonological Process Analysis is designed to elicit responses in an imitative task. Studies have led to differing opinions concerning the effects of imitation in the child's articulatory responses. Of these studies, only three have tested pre-school children. In Templin's (1947) classic study, 100 pre-school and kindergarten children were tested. Her results indicated that the difference between the articulation scores on the spontaneous and imitative methods were not significantly different for the

children tested. A similar study was completed by Kresheck and Socolofsky (1972). The assessment of spontaneous and imitative articulations of four-year-old children yielded no significant difference between the two methods, except in the assessment of sound blends. A final study by Paynter and Bumpas (1977) showed no statistical difference in imitative and spontaneous methods of articulatory assessment of three-year-old children. Therefore, using an imitative task is a valid method to assess articulatory skills in young children.

The imitative technique of articulatory assessment has inherent benefits that made it the preferred method in this study. An imitative task insured that all the phonological processes under examination could appear in the sample of each child. In addition, the task also permitted counts of possible occurrences of a process. By controlling the vocabulary produced by the child, counts could be equalized for all the children. For example, there were 92 words in the PPA that contained liquids. This meant that the child had 92 opportunities to use the process of gliding of liquids. Since each child had the same 92 opportunities, comparisons could be made between the children in terms of either absolute number or the percent of usage. If spontaneous speech samples had been used the basis for comparisons could have been only percent of usage, and intersubject variability in number of oppor-

tunities for use of a particular process would have limited the validity of such comparisons. For example, if a child used gliding of liquids ten times and another child used it five times, it would be misleading to note that the first child used the process more often than the second. If the first child said 20 words that contained liquids, his rate of use would be 50%. If the second child used five words that contained liquids, his rate of use would be 100%. And, of course, the second child's rate of use might be artificially high because of the restricted sampling; one cannot be sure that the next 15 possible occurrences would have resulted in an unvarying use of gliding of liquids.

Another problem that might occur with the word choice freedom of spontaneous speech would be that a certain process might not be tapped just because a child did not happen to use any words that day from his repertoire that would give him the opportunity to use that process. A zero process score for process usage in such an instance would, of course, be meaningless if that particular process were part of the child's phonological system.

Another benefit that made the choice of the PPA instrument imperative was that the task insured correct identification of the target word. Since all the children in the educable mentally retarded group and the communication handicapped group were unintelligible at times, it

was extremely valuable to know the target words when assessing their phonological productions. Having a definite reference for analysis meant that responses that were radically phonemically different from the model still could be used in the analysis. Spontaneous speech samples would contain utterances with multiple sound substitutions. It would be difficult for the listener to know what the target was. As a result potentially valuable responses would have been eliminated from the data.

Another point in the rationale for the use of an exclusively imitative speech sample is that a combination of spontaneous speech sample and imitative speech sample would not have accrued any significant benefits for this study. Since research by Templin (1947) has shown that both types of samples yield results that are not significantly different in the description of phonological errors, the additional materials would not have made a significant impact on the results. In addition, since the spontaneous speech responses would have to be a simple count of process usage as opposed to the percent of possible occurrence usage of the PPA, the combined results would have caused skewing of the data.

A final point in the rationale for the use of the PPA is that a primary purpose of the study, to examine differences between the retarded and normal I.Q. populations, would not have been well served by obtaining exclusively spontaneous speech samples. Spontaneous speech sampling is

appropriate for small group studies, such as those of Stoel-Gammon (1980) and Menn (1976). Since the purpose of this study demanded a large number of subjects, the spontaneous speech task would not have been a practical or efficient method of eliciting a large corpus of utterances from a large group of children. Thus, a delayed imitative task was the best choice of examining instrument.

According to Weiner (1979) Phonological Process Analysis is a diagnostic tool that is designed to provide a description of a child's sound system on the basis of syllable development and influences of phonetic context. One hundred thirty-six action pictures are used to elicit articulatory responses. All responses are sampled both as single words and in context of a sentence by the elicitation techniques of delayed imitation and sentence recall. The stimulus items are organized by phonological processes. Identification of these processes is based on the assumption that children use phonological processes to simplify their speech production.

There are three major categories of phonological processes (see p. 43). The first category is called Syllable Structure Processes and contains processes that operate to simplify syllabic structure in the direction of the CV syllable. The Syllable Structure Processes include: deletion of final consonants, cluster reduction, weak syllable deletion, and glottal replacement. The second category is

called Harmony Processes and it operates to preserve sound harmony within words. Harmony is achieved when a sound becomes similar to another sound within the word (e.g. dog → [gɔg]). The Harmony Processes include: labial assimilation, alveolar assimilation, velar assimilation, pre-vocalic voicing, and final consonant devoicing. The third category is called Feature Contrast Processes and it operated to reduce feature contrasts to a manageable number. The Feature Contrast Processes include: stopping, gliding of fricatives, affrication, fronting, denasalization, gliding of liquids, and vocalization. It is believed that, as the child begins to gain control over his speech and suppresses these early tendencies, syllable structure becomes more like that of an adult, and as a result the words become less symmetrical and the repertoire of features is expanded.

The Phonological Process Analysis is a diagnostic assessment tool that has been standardized on 100 children with phonological disabilities (Weiner, 1979). Sixteen processes are included in the PPA. Weiner chose those 16 processes in an effort to produce a plausible instrument for administration to young children. Realizing that investigations in the literature have identified as many as 43 different phonological processes, Weiner selected the 16 processes that are most frequently found in the patterns of young speech delayed children. The other processes occur so rarely and at such low rates that their inclusion would not substantially affect the results of a study of the

processes considered here. Moreover, we may note that, other authors have also limited the number of processes in their investigations. Shriberg and Kwiatkowski (1980) advocate testing for only eight processes. Ingram (1981) includes 12 processes in his investigation sheet for phonological process analysis. Therefore, since Weiner provided an instrument that efficiently samples the 16 most frequent processes in young children, it was deemed an effective instrument for examining the phonological skills of the children in this study.

#### Mean Length of Response Sample

Mean length of response has been shown to be a reliable measure of language development. Shriner (1969) found a high correlation between mean length of response and a scale of values of language development derived from a psychological rating scale. The study obtained results from 200 children who ranged in chronological age from 2.6 to 12.0 years.

Some researchers, such as Bloom (1978), have criticized the use of mean length of response with children in the upper age range of six to twelve years. Within this range, mean length of response is not a reliable indicator of gross language development because of the varying complexity of the child's sentence structure. Bloom suggests that mean length of response is a reasonable index of language development up to a ceiling of four to five words. In this study all children had mean length response scores in the three to five range. This procedure helped to insure the reliability of the measure.

Rules for calculating mean length of response are offered by Brown (1973). The rules followed in this study include:

1. Use 100 utterances for the sample
2. Use only fully transcribed utterances
3. Include all exact utterance repetitions
4. Do not count such fillers as mm or oh
5. Count all compound words, proper names, and ritualized reduplications as single words
6. Count as one morpheme all irregular parts of the verb
7. Count as one morpheme all diminutives
8. Count as separate morphemes all auxiliaries and inflections

#### Peabody Picture Vocabulary Test

The Peabody Picture Vocabulary Test was used for the limited purpose of equating the two control groups and separating them from the experimental group. Although the Peabody Test has been criticized because it generally yields only a gross estimate of I.Q., it served the purpose of this investigation, since a precise measure of I.Q. was not the reason for its use. The test was only employed to insure that the children could be separated into educable mentally retarded and normal I.Q. groups, and for this end it was an efficient tool.

## CHAPTER IV

## RESULTS AND DISCUSSION

Phonological Process Usage in Children

The mentally retarded, communication handicapped, and the normal speaking children showed the same pattern of phonological process usage. The process scores were arranged in a Guttman Scale, since the results met the special properties which define a Guttman Scale (Nie, Hull, Jenkins, Steinbrenner, and Bent, 1975). The Guttman system of statistical analysis is a means of analyzing the underlying characteristics of multiple items in order to determine their interrelationships. This Scale effectively displayed the cumulative, undimensional index of phonological process scores. The scores were based on prevalence of usage by the children. The hierarchical nature of the Scale can be seen in Table 1. The Scale shows, for example, if a child used only one process it would be the most prevalent process, stopping. If the child used two processes, they would be stopping and fronting. If five processes were used, they would include stopping, fronting, cluster reduction, final consonant deletion, and gliding of liquids. If a total of seven processes were evident in the child's pattern, they

would be stopping, fronting, cluster reduction, final consonant deletion, gliding of liquids, vocalization, and weak syllable deletion. There were few exceptions to this general rule of process hierarchy when all the scores of the children were considered.

Table 1 includes the following information:

1. Case number of the subject
2. Sum process score, which is the total number of processes consistently used by the subject
3. 16 phonological process categories with usage scores of "1" or "0" for each.

The first row of the table indicates that case 7 was a retarded child who consistently used a total of 14 different phonological processes. The sum 14 can be derived by adding the ones in columns headed by the names of the processes. An entry of "1" indicated a consistent use of that process and a "0" indicated a non-consistent use of that particular process (See Chapter III for a discussion of consistency criteria, p. 44.) Therefore, Case R7 consistently used all the processes except for alveolar assimilation and glide fricative. The remaining 39 cases were arranged in descending order of total process usage scores. The bottom row of the table reflects the total number of children who consistently used each phonological process.

The Guttman Scale exemplified in Table 1 is not a statistically perfect scale, but conforms to the Guttman



R=Retarded  
 H=Handicapped  
 N=Normal

CASE	Rank	
R16 N3 N6 N8 NO N5 N7 N9 N1 N4 SUM		
4 5 3 2 2 1 1 1 1 0 0	Sum Process	
2 0 0 0 0 0 0 0 0 0 0	Denasalization	16
4 0 0 0 0 0 0 0 0 0 0	Glottal Replacement	15
4 0 0 0 0 0 0 0 0 0 0	Alveolar Assimilation	14
4 0 0 0 0 0 0 0 0 0 0	Velar Assimilation	13
6 0 0 0 0 0 0 0 0 0 0	Glide Fricative	12
9 0 0 0 0 0 0 0 0 0 0	Prevocalic Voicing	11
7 0 0 0 0 0 0 0 0 0 0	Affrication	10
9 0 0 0 0 0 0 0 0 0 0	Labial Assimilation	9
12 0 0 0 0 0 0 0 0 0 0	Final Consonant Devoicing	8
19 0 0 0 0 0 0 0 0 0 0	Weak Syllable Delete	7
22 0 0 0 0 0 0 0 0 0 0	Vocalization	6
28 0 0 0 0 0 0 0 1 0 0	Glide Liquid	5
29 0 0 0 0 0 0 0 0 0 0	Final Consonant Delete	4
31 0 0 0 0 0 0 0 0 1 1	Cluster Reduction	3
34 0 0 0 0 0 1 1 1 1 1	Fronting	2
37 0 0 1 1 1 1 1 1 1 1	Stopping	1

TABLE 1-CONTINUED

model on a statistically significant basis. A perfect Guttman Scale would have contained a bottom row of all zero scores and a top row of ones. The center of the scale would have a staircase of ones as additional processes were added to the sum score. The scale found on Table 1 conforms to the principles of the perfect model in most instances. The bottom row contains all zeros and the top row all ones except for two processes. The staircase is evident from the total sums at the bottom enumerated from two to 37. There are few instances that do not conform to the ideal scale. For example, Case N6 should have a "1" in cluster reduction instead of glideliqid since he has a sum score of three. On the other hand, Case R11 should have a "1" in stopping since he has five processes in his pattern.

The McNemar test showed that there was no regularity in the deviances from the perfect Guttman Scale. The validity of the Guttman Scale of Phonological Processes was attested to by the high coefficient reproductivity score of .91. The reliability coefficient of .85 Cronbach alpha over 16 processes showed that the 16 processes were measuring the same underlying phonological skill.

#### Between Group Analysis

Reliability analysis of the process usage scores for the experimental and control groups yielded similarities and differences among them. The Cronbach alpha for the retarded group was .77 and for the normal speaking group was .73. These high reliability scores demonstrated the coherence of the phonological process scores. The same

staircase of scale means was observed for the two groups. The retarded group was separated from the normal group on higher means but not hierarchy. Further evidence that the retarded and normal speaking children were using the same pattern of process usage was the combined reliability score of  $\alpha = .88$  for the two groups. The fact that the combined alpha was higher than either of the individual alphas showed that both groups were adhering to the same hierarchical pattern of processes. Decreased process usage resulted in the orderly elimination of processes from denasalization to stopping.

The reliability score for the communication handicapped group revealed that this group presented a slightly different pattern of process hierarchy. The reliability score for this group was only .14. Their scale mean scores failed to show the close adherence of the order of process elimination found in the other two groups. When the process usage scores for the retarded and handicapped were combined, the reliability alpha was .70. This score represented a lower reliability score than the individual group reliability score for the retarded. These statistics thus confirmed, again, that the communication handicapped group did not always conform to the orderly process usage pattern of the retarded and normal speaking groups.

Frequency analysis of the process usage scores also showed significant differences and similarities between the groups. The sum process scores on Table 1 showed

that the normal group consistently used a fewer number of processes than the communication handicapped and retarded groups. The Mann Whitney U test showed significance at the .001 level between the normal group and the other two experimental groups. No significant difference in the total process usage scores was noted between the retarded and handicapped group.

The retarded group and the handicapped group could not be separated statistically on individual process usage scores on 15 of the 16 processes, as seen in Table 2. Only final consonant devoicing separated the two groups according to the Chi Square Test. A greater number of the retarded used this process consistently than the handicapped, at the .05 level of confidence.

Chi Square Analysis showed that the most frequently used processes were the processes that separated the retarded and the normal speaking groups. Statistical significance was reached on the following seven processes:

1. Final Consonant Devoicing
2. Weak Syllable Deletion
3. Vocalization
4. Gliding of Liquids
5. Final Consonant Deletion
6. Cluster Reduction
7. Fronting

Stopping was the only high frequency process that did not statistically separate the two groups. Stopping was the

TABLE 2

PERCENT OF CHILDREN USING EACH PROCESS BASED ON  
PROCESS USAGE SCORES

BETWEEN GROUP COMPARISON

Process	Retarded	Communication Handicapped	Normal Speaking	Retarded	Retarded	Handicapped
				VS Handicapped	VS Normal	VS Normal
Denasalization	20	0	0	NS	NS	NS
Glottal Replacement	16	10	0	NS	NS	NS
Alveolar Assimilation	10	20	0	NS	NS	NS
Velar Assimilation	20	0	0	NS	NS	NS
Gliding of Fricatives	20	20	0	NS	NS	NS
Pre-vocalic Voicing	20	20	0	NS	NS	NS
Affrication	26	20	0	NS	NS	NS
Labial Assimilation	36	10	10	NS	NS	NS
Final Consonant Devoicing	66	10	0	*	**	NS
Weak Syllable Deletion	66	80	0	NS	**	***
Vocalization	66	90	0	NS	**	***
Gliding of Liquids	85	90	20	NS	**	**
Final Consonant Deletion	95	90	10	NS	***	***
Cluster Reduction	95	100	20	NS	***	***
Fronting	100	90	50	NS	**	~
Stopping	95	100	80	NS	NS	NS
Sum Process Scores				NS	***	***

\* Significant at .05 Level

\*\* Significant at .01 Level

\*\*\* Significant at .001 Level

Trend

NS Not Significant

most consistently used process across the three groups and so appears at the extreme right of the Guttman Scale.

The communication handicapped group showed statistically higher usage scores than the normal speaking group on five of the same processes that separated the retarded and normal speaking groups. The Fisher's Exact Test showed differences in usage scores on weak syllable deletion, vocalization, gliding of liquids, final consonant deletion, and cluster reduction. The handicapped and normal speaking groups were not separated on the remaining eleven processes, which were infrequently used.

#### Discussion of Phonological Process Scale

##### Introduction

The following review of the literature compares the results of phonological process usage as revealed in the Guttman Scale and present day theories of phonological development and acquisition.

The Guttman Scale of Phonological Processes in this study presented the following hierarchy of process usage:

1. Stopping
2. Fronting
3. Cluster Reduction
4. Final Consonant Deletion
5. Gliding of Liquids
6. Vocalization
7. Weak Syllable Deletion
8. Final Consonant Devoicing

9. Labial Assimilation
10. Affrication
11. Pre-vocalic Voicing
12. Glide Fricative
13. Velar Assimilation
14. Alveolar Assimilation
15. Glottal Replacement
16. Denasalization

Based on the prevalence of usage among the children, the processes would be eliminated from denasalization to stopping, as the total number of processes used decreased. A rationale for the hierarchy of phonological process usage can only be hypothesized at this point. It may be the result of the interaction of perceptual, motor, and linguistic factors which determine the complexity of the processes and so which processes would be most prevalent in children's speech patterns. No body of literature has related these areas to phonological usage. However, studies that ordered phonemes based on perceptual ease, articulatory ease, and frequency in English provide useful information that can be related to the phonological process hierarchy. It can be reasoned that those phonemes that are easy to perceive and produce would be articulated closest to the adult standard by most children. Therefore, processes that involve the easiest phonemes would be infrequently used by children. Those processes that involve phonemes that are difficult to perceive and to produce would be the most frequently used since the use of phonological processes

results in phonological errors. However, since a phonological process often affects more than one phoneme, it is difficult to directly relate the findings of the literature, which predict single phoneme error rate, to the results of this study. For example, stopping involves the substitution of stops for the sound / s, f, v, θ /. Thus, one process causes sound change on four phonemes. It would then be impossible to classify the process as difficult or easy since it might contain phonemes from both of the previously labeled easy and difficult categories.

Distinctive feature analysis research and phoneme acquisition studies also provide a reference point for discussion of this data. A case can be made that the most prevalent phonological processes are, perhaps, those that contain the most difficult sounds and so the last to be eliminated in the developmental sequence. Therefore, those sounds that have been designated as the latest to appear in normal speech should be the sounds involved in the most prevalent phonological processes. However, since this was not a longitudinal study it can only be conjectured that the most prevalent processes are those which would be eliminated last in the developmental sequence. It is a plausible conclusion, but one that needs further research for verification. However, it does provide a basis for discussion of the results of this study.

In summary, the following discussion will compare the results of the phonological process usage scores with the

data from the studies in ease of perception, ease of articulation, distinctive feature usage on children, frequency of phonemes in English, and developmental speech sequence in children.

#### Ease of Perception and Scale

According to Olmsted (1966), children learn the phones of English based on ease of perception. The phones consist of articulatory components. These components generate characteristic acoustic qualities. The acoustic qualities contribute differentially to the discriminability of phones. As a result, phones of low discriminability will be learned late and phones of high discriminability will be acquired early. While Olmsted admitted that he could not predict individual errors, he did offer a general direction of error. Based on ease of discrimination, most errors, at any stage before the phones of the language are learned to asymptote, are errors of place, followed closely by errors of friction and duration, with fewest errors in voicing and nasality.

Since Olmsted's theory does not include manner errors, his predictions are difficult to interpret with respect to the results of this study. However, with this limitation in mind, we may note that Olmsted's theory would predict that the following processes would be the last ones to be eliminated from children's patterns and so be the most prevalent in a sampling of children in the pre-school age range:

1. Stopping
2. Gliding of Fricatives
3. Affrication
4. Gliding of Liquids
5. Labial Assimilation
6. Alveolar Assimilation
7. Velar Assimilation
8. Fronting

Use of the first four processes results in errors that involve a change in manner as a function of the change in friction and duration. Use of the processes five through eight results in errors that involve changes of place of articulation.

According to the present study, stopping, fronting and gliding of liquids were prevalent processes. However, the five remaining processes were not the most prevalent. In addition, since Olmsted's categories failed to include cluster reduction and final consonant deletion, these two prevalent processes were omitted from Olmsted's predictions. Olmsted's theory failed to provide for these latter processes because place, friction, and duration errors do not adequately describe the sound changes that result when cluster reduction and final consonant deletion are used. Olmsted's description of the most common speech errors fails to adequately account for common phonological errors in children.

Olmsted's theory further predicted that few errors would be made in sounds that require the discrimination of voicing and nasality. Thus, the following processes should be eliminated early by most children and therefore not be as prevalent as processes involving errors of place, friction, and duration.

1. Pre-vocalic voicing
2. Final consonant devoicing
3. Vocalization
4. Nasalization

The results of this study supported these predictions, except for vocalization. Vocalization was a prevalent process in this study. Twenty-two subjects out of forty used it. It might be the case that Olmsted did not consider a liquid → vowel change when predicting the voicing error category.

The two remaining processes in the phonological hierarchy, weak syllable deletion and glottal replacement, could not be discussed in relation to Olmsted's theory since it applied only to phones. Weak syllable deletion involved the omission of a syllable that contains more than one sound, and glottal replacement involved the use of a glottal stop for a phoneme.

In summary, the data from the Guttman Scale in this study only partially supported the predictions of the Olmsted theory. The predictions that were upheld by the current data would seem to indicate that ease of perception is a definite factor in correct phonological production.

Olmsted's theory was not supported in those instances where his theory failed to describe adequately all the possible phonological errors that can be present in children's patterns.

#### Ease of Articulation and Scale

Locke (1972) offered evidence that ease of articulation is an important factor in determining the sequence of acquisition of phonology in young children. He used motor ease subjective judgment scores by adults to rate the phonemes. The following ranking based on motor ease, from easy to difficult was found:

Word	Motor
Initial	Ease
<u>Phoneme</u>	<u>Rank</u>
/d/	1.0
/s/	2.0
/h/	3.0
/n/	4.0
/ʃ/	5.0
/t/	6.0
/p/	7.5
/l/	7.5
/m/	9.0
/f/	10.0
/j/	11.0
/r/	12.0
/b/	13.0

Word	Motor
Initial	Ease
<u>Phoneme</u>	<u>Rank</u>
/k/	14.5
/g/	14.5
/v/	16.0
/z/	17.0
/w/	18.0
/dʒ/	19.5
/tʃ/	19.5

Few comparisons could be made between Locke's results and the results in this study since the phonemic stimuli were approached from different views. Locke only tested word-initial position phonemes and omitted /θ/ and /ʒ/. This study focused on process usage which involved two to six phonemes per process. However, the following trends could be observed. Locke predicted that labial assimilation would be eliminated early in young children since it involved phonemes ranked below 7.0 /t, s, n/. On the other hand, alveolar assimilation would be eliminated late since it affected phonemes with rankings above 10.0 /k, g, tʃ/.

In the present study labial assimilation had a rank of nine and alveolar assimilation had a rank of 14 (see Table 1). This meant that both processes would be eliminated early with alveolar assimilation being lost before labial assimilation. Thus the phonological process usage data did not support the trend predictions of ease of articulation.

The remaining fourteen phonological processes contained phonemes of both high and low ranking according to Locke's system. Therefore comparisons could not be made. It was interesting to note, however, that the processes of stopping and fronting would be considered late elimination processes in Locke's model if it were not for his rating on the sibilants /s/ and /ʃ/. Locke gave these sibilants low ratings and so early acquisition times.

The results of this study support the concept that sibilants should be acquired late in the acquisition sequence since stopping, which affects sibilants, is a prevalent process. Late sibilant acquisition times are predicted by Jakobson's (1968) theory of phoneme acquisition. The next review of his theory indicates where it supports the results of this study.

The overall comparison between Locke's results and results from this study show an overwhelming lack of agreement. One of the main reasons is the fact that Locke listed the ordering in terms of single phonemes. The Guttman Scale is listed according to processes that involve several phonemes per process. Another reason for the lack of agreement between results was that he considered the sibilants /s/ and /ʃ/ easy to produce phonemes. Child developmental data by Templin (1957) and the prevalence of lisps in the school age population both counter that finding. It might be hypothesized that if Locke had based his data on child motor ease judgments, the data from the present study might

have supported those results. Motor ease should be a factor in accuracy of phoneme. Thus more research is needed in this area.

### Distinctive Features and Scale

Phoneme acquisition has been described by Jakobson as development of the phoneme system based on growth in feature contrast mastery. The contrastive features were described as universal distinctive features. The distinctive features of an individual phoneme would be those aspects of the process of articulation and their acoustic consequences that serve to contrast one phone with others. Children acquire the phonemic system of a language by gradually making finer and finer contrasts as they proceed through the stages of development.

Menyuk (1968) proposed the following order of distinctive feature development in young children:

1. Nasal
2. Grave
3. Voice
4. Diffuse
5. Continuent
6. Strident

A set of predictions can be made with respect to phonological processes based on the distinctive feature theory. The early phonological processes should be denasalization, fronting, pre-vocalic voicing, final consonant devoicing, and vocalization. Since the aforementioned processes involve phoneme changes that violate the correct usage of

the features: nasal, grave, voice, and diffuse, these processes should be eliminated early in the developmental sequence. Thus Menyuk's theory would predict that these processes should not be prevalent in the present study since most children should have eliminated their use early in speech development. On the other hand, gliding and stopping would be eliminated late in speech development, and thus are prevalent in this usage study since they violate the correct usage of the features of continuance and stridency which are late developing features in Menyuk's sequence.

The results of the Guttman Scale in the present study would support Menyuk's prediction that gliding of liquids and stopping would be late processes. The hierarchy of phonological processes also would support the early elimination of denasalization, assimilation, pre-vocalic voicing, and final consonant devoicing. Therefore, most of Menyuk's predictions were supported by the hierarchy of phonological processes established in this study. Since some of the phonological processes contain feature contrasts which form the basis for distinctive feature analysis, it would be expected that Menyuk's development scale would be upheld in some cases. The fact that the Guttman Scale results did not support Menyuk's scale with respect to fronting and vocalization, which are feature contrast processes, another reason must be found. It might be hypothesized that the sound changes involved in these processes

are place, manner, and duration changes not adequately described in the Menyuk scale.

Another criticism of the Menyuk order of development is that her scale did not permit inclusion of the remaining five phonological processes due to the distinctive feature structure of the scale. Menyuk only offered six features for the sequence which is only a partial list of the distinctive feature categories. This would restrict the comparison between the scale and the phonological processes. Finally, more accurate comparison of the results of this study and Menyuk's predictions could not be made because she did not specify which of the six were early and which were late features. She just enumerated the features in the above stated order with no specific time table given for appearance.

#### Markedness Theory and the Scale

The markedness theory of phonology, as described by Cairns et al. (1974), employs features to describe phoneme complexity based on ease of articulation, perceptual saliency, and frequency of phonemes in the language. This theory has also been used to predict the direction of phoneme changes in young children. It has not been used to predict which phonemes would be acquired first, but only which phonemes would be the likely substitutions for the adult target phonemes. The markedness model was useful in a discussion of the phoneme changes possible within the

phonological process hierarchy, but not in a discussion of the order of the elimination of the processes in phoneme development and acquisition.

The markedness model assigns values to the distinctive features of phonemes (see Table 3). The assignment of a marked value to a feature reflects the relative articulatory or perceptual complexity. The total number of marked values assigned to a particular phoneme yields a complexity score for the phoneme. Sound changes, according to the markedness model, are always supposed to be from a complex to a less complex phoneme.

The system of markedness is a weak system with basic flaws in its structure. Since it is based on a binary distinctive feature system with no scale of values, it lacks the full expression of variability. It also fails to account for the surrounding linguistic context in assigning the values. However, since the markedness theory includes the three factors of perceptual ease, articulatory ease, and frequency of phonemes in the language in determining complexity value, it is worthwhile to use it for discussion of the results in this study.

When the possible phoneme changes that result from the application of a phonological process are considered, only six processes can be analyzed with respect to the markedness model. The other processes cannot be examined in the markedness system since they involve sound changes caused by contextual influences and deletions of sounds. These types

TABLE 3  
 MARKEDNESS VALUES AND COMPLEXITY INDEX

Features	Phonemes																	
	z	s	ʃ	θ	d	t	v	f	b	p	ʒ	dʒ	tʃ	g	k	w	l	r
Consonantal	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Initial	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Final	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Vocalic	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	M	M	M
Anterior	U	U	U	U	U	U	U	U	U	U	M	U	U	U	M	U	U	U
Coronal	U	U	M	M	U	U	U	U	M	M	M	M	M	U	U	U	U	U
Continuant	M	M	M	M	U	U	M	M	U	U	M	U	U	U	U	U	U	U
Strident	U	U	M	M	U	U	M	M	U	U	U	U	U	U	U	U	U	U
Voiced	M	U	M	U	M	U	M	U	M	U	M	U	M	U	M	U	U	U
Lateral	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	M	U
Complexity Score	2	1	4	3	1	0	3	2	2	1	3	3	2	2	1	1	2	1

U=Unmarked  
 M=Marked

of sound changes are not accounted for in the markedness model. Therefore, only pre-vocalic voicing, final consonant devoicing, stopping, affrication, fronting, and gliding of liquids could be interpreted with respect to the markedness theory.

In the case of pre-vocalic voicing all sound changes were made to more complex sounds which is contrary to the theory of markedness (i.e.  $|p \rightarrow b|, k \rightarrow g|, t \rightarrow d|$ ). In affrication, fronting, and gliding of liquids some sounds were substituted for more complex sounds while others were replaced by less complex sounds. In affrication,  $|s \rightarrow tʃ|$  was a change to a less complex phoneme but  $|z \rightarrow dʒ, ʃ \rightarrow tʃ|$  were increases in complexity. Fronting contained four substitutions that changed the sound to a less complex member,  $|k \rightarrow t, g \rightarrow d, ʃ \rightarrow s, θ \rightarrow f|$  and one with an increase in complexity  $|s \rightarrow θ|$ . On the other hand, gliding of liquids, final consonant devoicing and stopping each contained substitutions for the target sound which showed a decrease in complexity (i.e.  $|l \rightarrow w, d \rightarrow t, s \rightarrow t|$ ).

As is evident from the examples cited, the markedness system often failed to predict the sound changes that resulted from the use of the phonological processes. Phoneme changes in the processes under interpretation contained some examples that adhered to the predictions of the markedness theory, but also many sound changes that did not. The process of stopping was the only one that contained sound changes that conformed without exception to predic-

tions based on markedness theory.

The reason that the markedness system often failed to predict the sound changes in phonological processes can only be conjectured. Perhaps, the system failed because binary scores were not appropriate for the task. It could be the case that a graduated scale of values might have improved its predictability accuracy.

#### Developmental Studies and the Scale

Developmental data from longitudinal studies of phoneme acquisition in young children provide another useful comparison with the phonological process hierarchy. Data from Sander's (1961) study were used to compile Table 4. The table represented the age ranges of acquisition of English consonants. For any consonant, the range started from the median age of customary articulation until the age where 90% of all the children in the study were producing the sound according to the adult standard model.

Examination of the phoneme changes usually associated with the phonological processes yielded certain predictions from the developmental data. The following processes would be eliminated early in acquisition:

1. Pre-vocalic voicing
2. Fronting
3. Denasalization

These predictions are based on the notion that these three processes involve phoneme changes that affect

TABLE 4

## SANDER'S DEVELOPMENTAL SOUND CHART

Sounds	Median Age of Customary Usage	90% Criterion Age
p m h n w	1.6	3.0
b	1.6	4.0
k g d	2.0	4.0
t d	2.0	6.0
f j	2.6	4.0
r l	3.0	6.0
s	3.0	8.0
ʃ	3.6	7.0
z	4.0	7.0
n d	4.0	7.0
ʒ	4.0	8.0
w	4.6	7.0
ʒ	5.0	8.0
ʒ	6.0	8.6

[p m n b k g d t ŋ] Sander identified these phonemes as the sounds that are mastered between the ages of 1.6 and 2.0 years. Thus, since these phonemes are located at the early end of the developmental scale, few children should be using processes that cause phonological errors on them since all the children were older than 2.0 years of age.

The following processes should be eliminated later in the acquisition sequence and thus be more prevalent among the speakers in this study. They include:

1. Stopping
2. Affrication
3. Gliding of Liquids
4. Vocalizations
5. Gliding of Fricatives except for /f/

These processes should be more prevalent because they affect the sounds [r l s tʃ z d ʒ v θ ʒ ʒ] which are phonemes found on the Sander's developmental chart between the ages of 3.0 and 6.0 years.

The remaining processes would not be included in the developmental sequence predictions since those processes involve sound clusters and word changes not accounted for in a single phoneme system.

The results of the present study supported some of the predictions based on Sander's developmental data. Pre-vocalic voicing and denasalization were high in the phonological process hierarchy and so would be eliminated early. Fronting was a process used by 34 out of the 40 children and so was low in the hierarchy, which would result in a later elimin-

ation.

The developmental data suggested that stopping, vocalization, and gliding of liquids would be late in the acquisition sequence. This study revealed these processes to be low in the hierarchy, which would result in late acquisition. Affrication and gliding of fricatives were also predicted as late processes. However, the results of this study did not support the prediction. The reason might be that these processes were rarely found in the profiles of the children. Thus, the high place in the phonological hierarchy might be the results of low frequency usage, rather than just a process that was usually eliminated early in sound development. Affrication involves sound changes on /ʃ/ and /ʒ/. Gliding of fricatives involves sound changes on /s, f, v, θ/. Since stopping could be applied to all these phonemes, the factor of process exclusion could be the cause of the low frequency usage. Stopping may be precluding the use of affrication and of gliding of fricatives, since two processes cannot usually operate on the same phonemes.

Let us turn finally to review two sound developmental schemes assembled through the analysis of cross sectional and longitudinal studies. Shriberg and Kwiatkowski (1980) examined the data from the following studies: Leopold (1947), Renfrew (1966), Jakobson (1968), Ferguson and Garnica (1975), and Ingram (1976). Shriberg and Kwiatkowski reorganized the information in these studies to reveal phonological process usage. They identified the following developmental sequence:

1.0 - 1.6 years: During the phonology of the first 50 words, multi-syllable words are reduced to monosyllables (i.e.: apple → [æp]) : final consonants are deleted (i.e. (dog → [dɔ] ) : reduplication is used (i.e. ball → [baba] ).

1.6 - 4.0 years: The following processes are used

1. Reduplication
2. Deletion of Final Consonants
3. Final Consonant Devoicing
4. Weak Syllable Deletion
5. Cluster Reduction
6. Assimilations
7. Fronting
8. Gliding of Liquids and Fricatives
9. Stopping of Fricatives and Affricates
10. Vocalization

4.0 - 7.0 years: Fricatives and affricates are still subject to process usage.

Since the Shriberg and Kwiatkowski developmental scheme contains process overlap in the three stages, and since the scheme has only a three step division, it was difficult to assess the scheme fully with respect to the hierarchy found in the present study.

Shriberg and Kwiatkowski found final consonant deletion to be a process used by the youngest children in the studies. However, it was also a process retained by some children up to 4.0 years of age. In the present study, final consonant deletion was still being used by 29 out of the 40 pre-schoolers examined. Thus, this study would have predicted that this process would be one of those eliminated toward the end of the developmental period.

Shriberg and Kwiatkowski also noted that processes affecting fricatives and affricates would be retained late in the developmental sequence. The results from this study generally supported those findings. Stopping, fronting, and cluster reduction were lowest in the hierarchy of phonological process. This would suggest that these processes were the most difficult for the children to eliminate from their speech patterns. These three processes are all involved in the classes of sounds labeled fricative and affricate.

The only other processes that directly affected fricatives and affricates were gliding of fricatives and affrication. These two processes were high in the hierarchy. Gliding of fricatives might have been high in the hierarchy because stopping and fronting precluded its appearance. In other words, if the child stopped or fronted a fricative he/she could not also glide it at the same time. The same conflict of process usage probably occurred for the

process of affrication. Again the fricatives were being affected in an exclusive manner, which negated the use of affrication.

According to the diary studies, final consonant devoicing, gliding of liquids, weak syllable deletion, assimilation and vocalization occurred during the middle years of the development. These processes were also located in the middle of the phonological process hierarchy of this study.

Denasalization, glottal replacement, and pre-vocalic voicing were not mentioned in the data scheme. It should be noted, however, that few children were included in the diary studies. A larger subject sample might have revealed a more widespread use of the processes.

Ingram (1976) also compiled a developmental pattern scheme from his review of the literature involving longitudinal studies of phonological acquisition. Ingram's developmental scheme was compiled after examining the data from Velton (1943), Leopold (1947) and Menn (1971):

Stage One: First 50 words to 3.5 years of age

1. Pre-vocalic Voicing
2. Final Consonant Deletion
3. Reduplication
4. Assimilation
5. Fronting
6. Denasalization
7. Gliding of Liquids

Stage Two: 3.0 to 4.0 years of age

1. Weak Syllable Deletion
2. Cluster Reduction
3. Devoicing of Final Consonants

It should be noted that there was an overlap of age groups for the two stages which would result in an overlap of process usage. However, Ingram did distinguish the two stages as noted in the above list.

The present study supported some of Ingram's findings but not all. Pre-vocalic voicing, assimilation, and denasalization were all high in the hierarchy, and so had probably been eliminated by most of the students in the study. However, final consonant deletion, fronting, and gliding of liquids were prevalent processes in the present study. This would seem to indicate that they would be among those retained during the later period of phonological development. Therefore, there was a conflict of results between this study and Ingram's findings.

Ingram's stage two contained cluster reduction. This process was low in the hierarchy which resulted in a concurrence in the findings. However, Ingram also noted weak syllable deletion and final consonant devoicing as late developmental processes. These two processes were in the middle of the hierarchy in the present study. Therefore, it was not possible to say whether the results of the two schemes concurred for these processes.

Phonological Process Frequency Analysis

Introduction

Sum structure scores can be found in Table 5. These scores represented the total number of times a subject used the phonological processes. The scores to the left of the sum structure score showed the breakdown of the sum structure scores into the frequency scores for each of the syllabic structures tapped in the sampling tool. The case number represented subject identification with respect to experimental group. Single digit numbers represent the subjects in the retarded group; numbers prefaced with an H denote communication handicapped members; numbers preceded by an N are subjects in the normal speaking group. A single horizontal entry contained the process usage by one subject in the study. For example, case 7 is a retarded subject who used processes with the recorded frequency in the seven syllabic categories:

		Process Frequency Scores
CV	- consonant-vowel words	0
CVC	- consonant-vowel-consonant words	47
SYL 2	- two syllable words	58
SYL 3	- three syllable words	10
CCV	- consonant-consonant-vowel words	7
CCVC	- consonant-consonant-vowel- consonant words	26
CVCC	- consonant-vowel-consonant- consonant words	32

PHONOLOGICAL PROCESS FREQUENCY SCORES  
PER SYLLABIC STRUCTURE

CASE	CV	CVC	SYL2	SYL3	CCV	CCVC	CCVCC	Sum Structures
R7	0	47	58	10	7	26	32	180
R8	0	52	80	15	6	38	23	214
R9	0	36	60	10	8	34	25	173
R17	2	57	68	6	8	34	31	206
R4	8	50	71	8	7	36	22	202
R12	0	24	100	15	7	21	18	185
R13	0	38	41	15	8	40	21	163
H2	2	77	104	16	8	52	24	283
H7	3	61	108	10	6	54	22	262
H9	1	31	76	11	8	58	21	206
R2	2	65	74	18	6	62	30	257
R5	2	58	70	10	8	53	26	227
R6	0	39	63	8	4	23	23	160
R19	0	15	33	5	3	16	12	84
H1	2	46	125	14	10	45	23	265
H0	2	22	45	11	4	23	7	114
R1	0	26	84	9	4	23	9	155
R3	0	29	100	9	6	29	23	196
R14	0	21	30	4	6	30	25	116
H4	0	9	35	6	2	3	7	62
H5	0	27	58	7	7	24	11	134
H8	0	32	49	19	4	34	23	161
H3	2	22	80	12	9	41	12	178
N2	0	19	34	5	4	23	0	85
R10	0	19	34	3	2	21	15	94
R11	0	8	12	6	4	4	15	49
R18	0	28	28	9	6	13	15	99
R20	2	33	41	8	6	40	24	154
H6	0	25	33	10	4	24	17	113
R15	0	11	12	5	3	22	2	55
R16	0	5	4	2	0	2	8	21
N3	0	12	15	4	4	4	0	39
N6	0	12	17	2	4	6	0	41
N8	0	4	10	1	2	0	2	19
N0	0	6	7	2	4	0	4	23
N5	0	0	2	2	2	0	0	6
N7	0	4	2	2	0	0	0	8
N9	1	2	4	0	0	0	0	7
N1	0	2	1	0	0	1	0	4
N4	0	1	0	0	0	0	0	1

R=Retarded  
H=Handicapped  
N=Normal

## Retarded Group

The sum structure scores were high for the retarded. They ranged from 21 to 257. Eighty percent of the retarded children used the phonological processes more than 93 times. Two of the retarded children had total frequency scores that would easily put them in the score range of the normal speaking children. These two children were obviously not typical of the retarded group as a whole, and so highlighted the exceptions that could occur to most general rules. The two retarded children who had sum scores of 21 and 49 were girls in the upper age and I.Q. range of the group, and who had mean length of utterance scores of 5.0 morphemes. These positive features may have helped them to achieve low scores as opposed to the rest of the retarded population.

The frequency profiles for each phonological process revealed some intragroup variations for the retarded children. The mean and mode scores found in Table 6 demonstrated that final consonant deletion, cluster reduction, stopping, fronting, gliding of liquids, and vocalization were all high frequency processes for most of the retarded children. However, the broad range of scores, 0-93, also indicated that a few students did not use these high frequency processes at all. Weak syllable deletion, assimilation, glottal replacement, and pre-vocalic voicing showed low frequency usage by most children. The low range

TABLE 6

## PHONOLOGICAL PROCESS FREQUENCY SCORES FOR MENTALLY RETARDED SUBJECTS

Statistics	Denasalization	Glottal Replace- ment	Alveolar Assimi- lation	Velar Assimi- lation	Gliding Frica- tives	Pre-vocalic Voicing
Mean	.8	.9	1.6	2.0	4.2	1.4
Mode	0	0	0	0	0	0
Range	0-12	0-8	0-18	0-15	0-38	0-7
Standard Deviation	2.7	2.1	4.2	4.2	10.3	2.1
Total Possible Occurrences	62	54	26	26	128	82
Statistics	Final Consonant Devoicing	Weak Syl- lable Deletion	Gliding Liquids	Final Consonant	Cluster Reduction	Fronting
Mean	7.0	3.6	11.2	25.6	39.0	15.4
Mode	2	4	13	21	43	8
Range	0-30	0-10	0-23	0-93	1-86	4-55
Standard Deviation	7.9	3.2	7.0	22.1	23.5	12.4
Total Possible Occurrences	50	12	92	220	98	112
Statistics	Affrication	Labial Assimi- lation	Vocali- zation	Stopping	Sum Structures	
Mean	1.8	2.8	12.7	17.7	149.5	
Mode	0	2	8	14	155	
Range	0-18	0-10	0-33	1-35	21-257	
Standard Deviation	4.1	2.7	17.1	9.0		
Total Possible Occurrences	36	24	42	128		

of scores and low standard deviations also indicated the cohesiveness of usage among the members of the group. The remaining processes of gliding of fricatives, affrication, and denasalization showed some intragroup variation and less frequent usage than the above-mentioned processes. Few children used gliding of fricatives, affrication, and denasalization but those who did used it at a high rate.

#### Communication Handicapped Group

The high sum structure scores for the handicapped group (Table 7) were similar to those of the retarded group. The sums ranged from 62 to 283. Ninety percent of the group had frequency scores greater than 113.

The frequency profiles revealed slight intragroup variations. Those processes that contained high frequency scores were used by most members of the group, and those with low frequency scores were used by few members of the group.

Final consonant deletion, cluster reduction, stopping, fronting, gliding of liquids and vocalization were the high frequency processes. Final consonant deletion appeared to show two distinct groups within the handicapped population. Fifty percent of the students used the process more than 20 times, and forty percent used it less than 8 times. One student was distinctly different, by using the process 104 times. Cluster reduction showed less intragroup variation, with seventy percent using the process more than 37 times, and everyone using it at least 12 times.

TABLE 7  
 PHONOLOGICAL PROCESS FREQUENCY SCORES  
 FOR COMMUNICATION HANDICAPPED SUBJECTS

Statistics	Denasalization	Glottal Replace- ment	Alveolar Assimi- lation	Velar Assimi- lation	Gliding Frica- tives	Pre- Vocalic Voicing	Affri- cation
Mean	.1	4.3	2.1	.1	3.6	3.3	1.2
Mode	0	0	0	0	0	0	0
Range	0-1	0-42	0-8	0-1	0-23	0-26	0-4
Standard Deviation	.3	13.2	2.5	.3	7.0	8.0	1.6
Total Possible Occurrences	62	54	26	26	128	82	36
Statistics	Labial Assimi- lation	Final Conson- ant Devoicing	Weak Syllable Deletion	Vocali- zation	Gliding Liquids	Final Conson- ant Deletion	Cluster Reduction
Mean	1.2	1.2	5.3	21.4	16.7	27.4	48
Mode	0	2	4	20	4	27	62
Range	0-4	0-4	2-10	3-63	2-47	2-104	12-73
Standard Deviation	1.3	1.3	2.4	17.5	15.4	29.7	24.9
Total Possible Occurrences	24	50	12	42	92	220	98
Statistics	Fronting	Stopping	Sum Structures				
Mean	18.5	23.4	177.8				
Mode	12	15	113				
Range	0-46	5-45	62-283				
Standard Deviation	15.0	16.3					
Total Possible Occurrences	112	128					

Stopping was also a high frequency process with every child using it more than 5 times, and eighty percent using it more than 12 times. Fronting showed a similar pattern with ninety percent of the children using the process, and only one child not using it at all. Gliding of liquids and vocalization were similar in process profiles, with rather consistent scores at 11 and 12 times.

Weak syllable deletion, labial and alveolar assimilation, final consonant devoicing and affrication were used by the children at low frequency levels. Glottal replacement, pre-vocalic voicing, and gliding of fricatives were also low frequency processes among the handicapped, except for a few isolated cases. In those instances, high frequencies were recorded. For example, one child used glottal replacement 42 times while the rest of the group used it 0 or 1 time.

Denasalization and velar assimilation were distinguished by the fact that only one child, a different one in each case, used denasalization and velar assimilation once. All of the other members of the group did not use the processes at all.

The communication handicapped group profile was very homogeneous. High consistent usage of the processes characterized the patterns of this cohesive group.

## Normal Speaking Group

The sum structure scores for the normal group (Table 8) showed low frequency scores for most of the children. The sums ranged from one to 85. Ninety percent of the normal speaking children had scores under 42. One child had an exceptionally high score. This boy was the youngest member of the group with a chronological age of 3.0. Perhaps his immaturity was the major factor in making his speech pattern resemble that of a communication handicapped child.

Frequency profiles for the normal speaking subjects revealed low scores in most of the processes. None of the subjects used velar assimilation, pre-vocalic voicing, final consonant devoicing, gliding of fricatives and denasalization. Glottal replacement, alveolar assimilation, affrication, weak syllable deletion, and vocalization had only isolated instances by a few subjects. Cluster reduction, final consonant deletion, and labial assimilation showed consistent usage by a few subjects.

The three remaining processes in the PPA sample contained the highest frequency scores for the group. Stopping was consistently used by all the normal speaking subjects except for two students. Fronting was used on a consistent basis by half the group. Finally, gliding of liquids contained high frequency rates for two subjects.

TABLE 8  
 PHONOLOGICAL PROCESS FREQUENCY SCORES  
 FOR NORMAL SPEAKING SUBJECTS

Statistics	Denasalization	Glottal Replace- ment	Alveolar Assimi- lation	Velar Assimi- lation	Gliding Frica- tives	Pre-vocalic Voicing	Affri- cation
Mean	0	.2	.4	0	0	0	.3
Mode	0	0	0	0	0	0	0
Range	0	0-2	0-2	0	0	0	0-2
Standard Deviation	0	.6	.8	0	0	0	.6
Total Possible							
Occurrences	62	54	26	26	128	82	36

Statistics	Labial Assimi- lation	Final Conson- ant Devoicing	Weak Syl- lable Deletion	Vocali- zation	Gliding Liquids	Final Conson- ant Deletion
Mean	.4	0	.6	.1	7.6	1.4
Mode	0	0	0	0	0	0
Range	0-4	0	0-2	0-1	0-47	0-4
Standard Deviation	1.2	0	.9	.3	16.0	1.3
Total Possible						
Occurrences	24	50	12	42	92	220

Statistics	Cluster Reduction	Fronting	Stopping	Sum Structures
Mean	1	3.5	7.8	23.3
Mode	0	5	6	6
Range	0.4	0-9	0-19	1-85
Standard Deviation	1.6	3.8	6.1	
Total Possible				
Occurrences	98	112	128	

### Between Group Analysis

The Mann-Whitney U Test revealed there were significant differences in the sum structure scores between the normal speaking children and the retarded at the .0001 level of significance, and the normal speaking versus communication handicapped at the .001 level. No significant difference was found between the retarded group and the communication handicapped group. These tests of statistical difference were based on total frequency scores of all the processes taken as a sum.

Statistical significance in frequency of processes was computed for individual processes, using the Mann-Whitney Test to compare groups (see Table 9). The retarded group could be separated from the handicapped group only on one process. The retarded used final consonant devoicing more frequently than the handicapped group. The retarded could also be separated from the normal speaking group in the previous process plus pre-vocalic voicing, labial assimilation, weak syllable deletion, vocalization, gliding of liquids, final consonant deletion, cluster reduction, fronting and stopping. The retarded used these processes more frequently than the normal speaking children in every case at a level of significance of at least .05 level for each process. The communication handicapped group could be separated from the normal speaking group on ten processes. The handicapped group used the processes of glottal replace-

TABLE 9  
 BETWEEN GROUP DIFFERENCES  
 BASED ON PHONOLOGICAL PROCESS  
 FREQUENCY SCORES

Process	Retarded vs Handicapped	Retarded vs Normal	Handicapped vs Normal
Denasalization	N.S.	NS	NS
Glottal Replacement	N.S.	NS	NS
Alveolar Assimilation	N.S.	NS	*
Velar Assimilation	N.S.	NS	NS
Gliding Fricatives	N.S.	NS	**
Pre-vocalic Voicing	N.S.	*	NS
Affrication	N.S.	NS	NS
Labial Assimilation	N.S.	*	NS
Final Consonant Devoicing	*	***	*
Weak Syllable Deletion	N.S.	**	***
Vocalization	N.S.	***	***
Gliding Liquids	N.S.	*	*
Final Consonant Deletion	N.S.	**	***
Cluster Reduction	N.S.	***	****
Fronting	N.S.	**	**
Stopping	N.S.	***	*
Sum Structures	N.S.	***	***

N.S. not Significant \* .05 Level of  
 Significance  
 \*\* .01 Level of Significance  
 \*\*\* .001 Level of Significance  
 \*\*\*\* .0001 Level of Significance

ment, gliding of fricatives, final consonant devoicing, weak syllable deletion, vocalization, gliding of liquids, final consonant deletion, cluster reduction, fronting and stopping more frequently than the normal group. Finally, table 7 also shows that nine processes reached significant levels to separate both the retarded and the communication handicapped groups from the normal speaking group.

#### Discussion of Frequency Analysis

Results from this study supported the basic conclusions of the previous studies completed with similar populations. Panagos (1974) who examined language delayed, and Hodson and Paden (1981) who examined unintelligible speakers, found that their speakers used the same phonological processes as normal speakers. However, both authors did note frequent usage of glottal replacement by the handicapped speakers, a process that was rarely used by the normal speakers. Panagos, Hodson and Paden feel that this might be a process which separates the two experimental groups. The results from this study do not support this theory. Glottal replacement was used by only one communication handicapped child on a consistent basis. Thus, glottal replacement could not be distinguished as a process that separated the two groups in the current study, but only as a process that is used when the child has a high number of different processes in his/her pattern.

Syllabic Context and Phonological Process Usage

## Results

Phonological process frequency scores were arranged with respect to the syllabic structures tapped by the PPA sampling tool. The same order of syllabic structure process frequency based on mean percent of usage was noted for the retarded and communication handicapped groups (Table 10). The three syllable structures that contained the highest percentage rate of phonological process usage were consonant-consonant-vowel (CCV), consonant-consonant-vowel-consonant (CCVC), and consonant-vowel-consonant-consonant (CVCC), with CVCC having the highest percent of process usage. Thus most sound changes occurred in words that contained consonant clusters.

Examination of the normal speaking children's process usage exposed a more random pattern than the other two groups. Phonological processes were used on all types of syllabic structures with a low percent rate for all structures.

Between group analysis based on Mann-Whitney U Tests showed that process frequency on different syllabic structures could separate the normal speaking children from the other two experimental groups. The retarded and communication handicapped used more processes on each of the syllabic structures except for consonant-vowel, than the normal speaking group. Table 11 offers significant levels for differences between groups. Consonant-vowel was the only

TABLE 10

## SYLLABLE STRUCTURE PROCESS FREQUENCY SCORES

Scores	CV	CVC	Two Syllable	Three Syllable	CCVC	CCV	CVCC
Retarded Group							
Mean	.8	33	53.1	8.7	28.3	5.4	19.9
Mode	0	26	41	9	34	6	15
Range	0-8	5-65	4-100	2-18	2-62	0-8	2-32
Possible Occurrences	20	310	464	74	204	38	76
Mean Percent of Usage	4	10.6	11.4	11.7	13.8	14.2	26.1
Communication Handicapped Group							
Mean	1.2	35	71.3	11.6	35	6.2	16.5
Mode	0	22	45	11	24	4	23
Range	0-3	9-77	33-125	6-19	3-58	4-10	7-24
Possible Occurrences	20	310	464	74	204	38	76
Mean Percent of Usage	6	11.2	15.3	15.6	17.1	16.3	21.7
Normal Speaking Group							
Mean	.1	6.2	9.2	1.8	3.4	2.0	.6
Mode	0	4	2	2	0	4	0
Range	0-1	0-19	0-34	0-5	0-23	0-4	0-4
Possible Occurrences	20	310	464	74	204	38	76
Mean Percent of Usage	.5	2	1.9	2.4	1.6	5.2	.7

TABLE 11

## SYLLABLE STRUCTURE FREQUENCY SCORES

Variable	Mean Retarded	Standard Deviation Retarded	Mean Handicapped	Standard Deviation Handicapped	Mean Normal	Standard Deviation Normal
CV	.8	1.8	1.2	1.1	.1	.3
CVC	33.0	17.5	35.2	20.4	6.2	6.1
Two Syllable	53.1	28.5	71.3	32.5	9.2	10.5
Three Syllable	8.7	4.3	11.6	3.9	1.8	1.6
CCV	5.4	2.2	6.2	2.6	2.0	1.8
CCVC	28.3	14.7	35.8	17.3	3.4	7.1
CVCC	19.9	8.0	16.5	6.7	.6	1.3

## GROUP COMPARISONS

Variable	Retarded vs Handicapped	Retarded vs Normal	Handicapped vs Normal
CV	N.S.	N.S.	N.S.
CVC	NS	****	**
Two Syllable	NS	****	***
Three Syllable	*	****	****
CCV	NS	***	**
CCVC	NS	****	**
CVCC	NS	****	****

\*significant at .05 level N.S. not significant

\*\*significant at .01 level

\*\*\*significant at .001 level

\*\*\*\*significant at .0001 level

syllabic structure that did not separate the groups. This structure contained a low frequency of process usage for all the groups. Finally, the retarded group scores and the handicapped group scores did not separate these two groups on a statistically significant basis. Both groups showed the same pattern of frequency.

Additional between group analysis was completed on the basis of consistent phonological process usage. The entire subject population was separated into two groups. The first group contained all those children who were consistent process users of a particular process, and the second group, those who were not consistent users of a particular process. Each phonological process was analyzed with respect to frequency of usage of a process on a particular syllabic structure. Table 12 shows significant differences between consistent process users and non-consistent users that were obtained for certain syllabic structures on individual phonological processes using the Mann-Whitney U Test.

The following discussion specifies these significant differences.

1. The scores on denasalization and labial assimilation showed that consistent users of these processes used them more frequently than non-consistent users in CVCC syllables.
2. Glottal replacement and alveolar assimilation scores showed that the process users used these processes more frequently than

TABLE 12

DIFFERENCE BETWEEN PROCESS/NON-CONSISTENT PROCESS USERS  
IN SYLLABLE STRUCTURE FREQUENCY SCORES

Process	CV	CVC	Two Syllable Words	Three Syllable Words	CCV	CCVC	CVCC
Denasalization	NS	NS	NS	NS	NS	NS	*
Glottal Replacement	NS	**	*	**	NS	*	**
Alveolar Assimilation	***	*	*	NS	*	*	NS
Velar Assimilation	NS	NS	NS	*	NS	NS	NS
Gliding of Fricatives	*	**	**	*	**	*	*
Pre-vocalic Voicing	*	**	*	NS	**	*	**
Affrication	NS	NS	NS	NS	NS	NS	NS
Labial Assimilation	NS	NS	NS	NS	NS	NS	*
Final Consonant Devoicing	NS	*	*	NS	*	NS	**
Weak Syllable Deletion	NS	****	****	****	**	***	**
Vocalization	NS	****	****	****	***	****	***
Gliding of Liquids	NS	****	****	***	***	****	***
Final Consonant Deletion	NS	****	****	****	***	****	****
Cluster Reduction	NS	****	****	****	***	****	****
Fronting	NS	**	**	**	*	*	**
Stopping	NS	*	*	*	*	*	NS

\*Significant at .05 level N.S. Not Significant

\*\*Significant at .01 level

\*\*\*Significant at .001 level

\*\*\*\*Significant at .0001 level

non-process users on five of the seven syllabic structures.

3. The processes that were consistently used by the majority of children revealed significant differences between the process users and the non-consistent users on six of the seven structures. The process users used weak syllable deletion, vocalization, gliding of liquids, final consonant deletion, cluster reduction, and fronting more frequently on all syllabic structures, except for CV, than those who were non-consistent users.
4. Stopping, which was used by 37 of the 40 subjects on a consistent basis, revealed significant differences on five of the seven syllabic structures when process users versus non-consistent process users were compared.
5. The phonological processes which were used consistently by six to 12 children revealed a varied pattern of occurrence among the syllabic structure types. Gliding of fricatives, pre-vocalic voicing, final consonant devoicing showed higher rates of process usage by consistent users on four to seven of the syllabic structure types, than by non-consistent users.

6. Finally, affrication revealed no significant difference in the process frequency scores of process users versus non-consistent process users with respect to syllabic structure. The reason might be that this was a process used by few children with low frequency scores, with a few instances in several syllabic structures.

#### Discussion of Process Usage

Limited research has been completed in the examination of syllabic structure of words that contain phonological errors. A review of the literature showed that some studies do, while others do not, support the findings of the present study.

Klein (1981) examined the speech skills of a small group of normal speech developing children and found that multi-syllabic words were often the targets for phoneme and syllable deviations from the adult model. Because of the complexity of the structures, children often employed simplification procedures. Panagos et al. (1979) further defined the syllabic/phonological error relationship by concluding that an increase in lexical complexity resulted in an increase in phonological errors. In a study with 17 functional phonologically disordered children, they found that phonological errors increased from monosyllables to disyllables.

The results of the present study do not support the conclusion of Panagos et al. Multi-syllable words did not contain the highest frequency phonological process usage. Monosyllable word types composed of consonant clusters showed the highest percent of process usage for all the children. Fewer processes may have occurred because the multi-syllable words contained individual syllables less phonemically complex than the monosyllable words. Eighty percent of the multi-syllable words were composed of two simple monosyllable structures (i.e. CV + VC, CVC + CVC). Only eight multi-syllable words contained a consonant cluster syllable. Thus multi-syllable words were really less complex than monosyllabic words containing consonant clusters. As a result more phonological processes usage occurred in monosyllable words than multi-syllable words.

The remaining previous research that will be reviewed in this section include studies that involve phoneme errors. Since phonological process usage can often result in phoneme changes as well as syllable changes, the results of the present study can also be compared to this research.

Menyuk and Looney (1972) examined the speech of language delayed and normal children. They found that more phoneme errors occurred in final consonant clusters than in initial consonant clusters in words.

Kiparsky and Menn (1977) also maintained that most children make more phoneme errors at the ends of words

than at the beginnings of words. They hypothesized that perceptual representations underlie productive realizations. In order to reproduce difficult syllable structures, children will often adopt the strategy of paying particular attention to the beginning phoneme segments and so reproduce the initial segments with fewer phoneme errors than final segments.

Kiparsky and Menn's theory and Menyuk and Looney's results were partially upheld in the present study. The retarded and communication handicapped children in this study used phonological processes at the highest rate of percent for final consonant clusters. However, the normal speaking children had the highest percent of process usage in the initial consonant cluster category. Therefore, only part of the population in this study used the strategies predicted by previous research.

Another factor that might have influenced the rate of syllabic process usage is the language-specific frequency of occurrence of syllable types. The frequency of occurrence of the different types of syllable structures in English has been investigated by French et al. (1930). After sampling telephone conversations, they observed the following percentages of occurrence of the syllables in everyday conversation:

CV	21.8%
CVC	33.5%
CCV	.8%
CVCC	7.8%
CCVC	2.8%
CCVCC	.5%
VC	20.3%
V	9.7%
VCC	2.8%

Since the PPA tool did not sample the processes in initial vowel syllables, only the initial consonant syllables can be used in analyzing the results in this study with respect to French's findings.

One analysis of French's results would have predicted a low rate of errors in CV and CVC syllables since these structures are most frequent in English. The high frequency rate provides many opportunities for practice to perfect phonological skills. On the other hand, the infrequent CCV, CVCC, and CCVC and multi-syllable structures would limit practice opportunities and thus be potential targets for errors. These syllabic predictions were generally upheld in the results for the retarded, communication handicapped, and normal speaking children. The retarded and communication handicapped children had the highest error rates on the CCV, CVCC, and CCVC syllables. The normal speaking children had the highest percent of

error in CCV syllables and multi-syllable words. Therefore, all the children had the highest error rates in the infrequent syllable structures. However, it must be noted that the normal speaking children had low rates of errors in all the syllable structures with very little disparity between scores.

Another analysis of the frequency of structures in our language results would have predicted that many errors would be found in CV and CVC since these structures are frequent in English and thus provide many opportunities for making errors. As a result the error pattern would be strengthened by the repeated exposure to the errant structures. The infrequent structures would provide few opportunities for the errors to be reinforced. Therefore, according to this argument the highest error rates should be in CV and CVC structures. This was not the case in the present research. The mean percent of error rate was not the highest in CV and CVC for the retarded, communication handicapped, and normal speaking groups.

## CHAPTER V

## SUMMARY AND CONCLUSIONS

Summary

This study was undertaken to examine the speech production skills of young educable mentally retarded children and pre-school children of normal intelligence. The hypotheses tested were that: (1) educable mentally retarded children will differ significantly from the normal I.Q. children in the frequency of use of the phonological processes examined; (2) those phonological processes that are used by both the retarded and normal I.Q. children will be more frequently used by the retarded than the normal I.Q. children; (3) educable mentally retarded children will differ in their pattern of use of the phonological processes examined.

Forty children between the ages of three and seven years two months from local schools served as subjects. The experimental group contained 20 educable mentally retarded children with I.Q. scores between 50 and 75. The first control group contained ten children of normal intelligence who demonstrated a communication handicap. The second control group contained ten children of normal intelligence who had no communication handicap, The research

population was matched on the basis of mean length of utterance since all the children produced spontaneous utterances of between three and five morphemes.

The following protocol was observed for each child who participated in the study:

1. A speech sample was obtained by having the child respond to the Weiner Phonological Analysis (PPA) as specified in the manual (Weiner, 1979). The tool was designed to elicit speech for the purpose of determining phonological process usage.
2. A peripheral speech examination was performed on each child.
3. The Peabody Picture Vocabulary Test was administered to each child.

### Conclusions

It can be concluded from this investigation that educable mentally retarded children use a significantly greater number of phonological processes than children with normal I.Q. and no communication handicap use. The first hypothesis is thus accepted, as is the second, since it was found that retarded children make more frequent use of those processes than the normal speaking children. Finally, retarded children do not significantly differ from the normal speaking children in their pattern of usage of the phonological processes. Thus, a hierarchy of process usage is evident, with a decrease in process

usage resulting in a rather orderly elimination of processes from denasalization to stopping for all the children. Therefore the third hypothesis is rejected.

These conclusions support the speech development theories of Lenneberg et al. (1962) and Schlinger (1953) that retarded children demonstrate the same types of speech problems, but with greater frequency, than normal I.Q. children with no communication handicap. The conclusions also support the notion that since the retarded children and the normal speaking children demonstrate the the same pattern of phonological process usage, the techniques for remediation of both groups can be the same. Therefore, the therapy suggestions that have been made by Ingram (1976) and Hodson (1980) can be applied to the retarded population. However, caution must be observed in the exact duplication of techniques for both groups. The intellectual limitations of the retarded group will require that modifications in procedures be made. The need for modifications is also highlighted in this study by the results of the syllabic structure analysis of the processes. The retarded children used the processes most often on consonant-vowel-consonant-consonant structures (CVCC). The normal speaking children used the processes most often in the consonant-consonant-vowel structures (CCV). This difference should be an important consideration when designing a therapy program. The need for tailoring

speech therapy programs to the specific problems of the retarded was also supported by the results of the comparison between the retarded and the normal I.Q. communication handicapped group.

Comparison of phonological process usage by the retarded with normal I.Q. communication handicapped children revealed that there was no significant difference in the number of processes used or the frequency of 15 of the processes examined between these two groups. The retarded and communication handicapped also showed the same pattern of phonological process usage. However, the communication handicapped had a lower reliability score than the retarded in the pattern of usage analysis. This suggests that, although retarded and communication handicapped children both use phonological processes, they do not show the same prevalence of types. Those communication handicapped children who used a large number of processes did not always use the same processes as the high frequency process users in the retarded population. Therefore, it can be claimed that retarded children differ from the communication handicapped population. More research is needed to further explore the difference(s) between these two groups.

Finally, we may note there was considerable intra-group variability for each of the three populations. The broad ranges of frequency scores found within each group indicate that different children use a given process with

different frequencies. The low frequency rate or non-use of various processes by the children insures, and perhaps explains why each of the children displays at least a minimal level of communicable ability; some portion of every child's phonological performance approximated that of an adult speaker.

#### Limitations

The Phonological Process Analysis Tool by Frederick Weiner lacks established norms. Therefore, the results of this study could not be compared to a standardized process profile. The tool also failed to sample each of the processes an equal number of times. This necessitated separate totals for possible process usage, rather than one consistent total for each process, in order to calculate rates of processes that were comparable to one another.

#### Recommendations

This study should be replicated on a larger sample of subjects so that more powerful statistics might reveal broader differences between the groups in the use of phonological processes. The sample of subjects should also encompass a broader range of language development skills. Younger children from the normal speaking group might reveal developmental trends in the data. These data could then be compared to those of expanded mentally retarded

and communication handicapped groups. More children are needed in the upper developmental range in the latter groups to reveal developmental trends in phonological process usage.

Another suggestion is to replicate the study by eliciting spontaneous speech responses as primary data. However, since spontaneous speech is difficult to obtain from many mentally retarded children in a test situation, such a replication should be carried out with a small experimental group.

**APPENDIX A PHONOLOGICAL PROCESS PROFILE  
PROCESS PROFILE**

Name \_\_\_\_\_ Age \_\_\_\_\_

Birthdate \_\_\_\_\_

Date \_\_\_\_\_

Phonetic Inventory	
<u>Present</u>	<u>Absent</u>
h w j l r	
p b t d k g	
tʃ dʒ	
f v θ ð s z ʃ ʒ	
m n ŋ	

Syllable Structure Processes

Deletion of final consonants (1)

Cluster reduction (4)

Weak syllable deletion (3)

Glottal replacement (2)

Harmony Processes

Labial assimilation (4)

Alveolar assimilation (5)

Velar assimilation (3)

Prevocalic voicing (1)

Final consonant devoicing (2)

Feature Contrast Processes

Stopping (1)

Gliding of fricatives (3)

Affrication (2)

Fronting (4)

Denasalization (5)

Gliding of liquids (6)

Vocalization (7)

	Proportion of test processes	Frequency of nontest processes	Process decision
Deletion of final consonants (1)	8		
Cluster reduction (4)	28		
Weak syllable deletion (3)	6		
Glottal replacement (2)	8		
<b>Harmony Processes</b>			
Labial assimilation (4)	8		
Alveolar assimilation (5)	6		
Velar assimilation (3)	8		
Prevocalic voicing (1)	8		
Final consonant devoicing (2)	8		
<b>Feature Contrast Processes</b>			
Stopping (1)	8		
Gliding of fricatives (3)	6		
Affrication (2)	8		
Fronting (4)	8		
Denasalization (5)	8		
Gliding of liquids (6)	8		
Vocalization (7)	8		

Descriptions of other processes, e.g., manner assimilation, nonfinal devoicing, neutralization, etc.

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APPENDIX B  
 SPEARMAN CORRELATIONS  
 OF  
 TEST SCORES WITH OTHER SCORES  
 ON  
 PHONOLOGICAL PROCESSES

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Denasalization	.82***
Glottal Replacement	.66***
Alveolar Assimilation	.36**
Velar Assimilation	.83***
Gliding Fricatives	.51***
Pre-vocalic Voicing	.38**
Affrication	.42**
Labial Assimilation	.27*
Final Consonant Devoicing	.52***
Weak Syllable Deletion	No correlation score
Vocalization	.68***
Gliding Liquids	.69***
Final Consonant	.68***
Cluster Reduction	.93***
Fronting	.64***
Stopping	.60***

\*Significant at .05 level  
 \*\*Significant at .01 level  
 \*\*\*Significant at .001 level

APPENDIX C

SPEARMAN CORRELATIONS BETWEEN SUM STRUCTURE SCORES

AND SUM PROCESS SCORES

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	All Experimental Groups	Retarded group	Communication Handicapped Group	Normal Speaking Group
Sum Structures with Sum Processes	.86	.71	.67	.97

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