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THE COMPREHENSION OF RATE CONTROLLED SPEECH
BY SECOND-GRADE CHILDREN WITH
FUNCTIONAL MISARTICULATIONS

DISSERTATION
Presented in Partial Fulfillment of the Requirement for
the Doctor of Philosophy Degree in the Graduate
School of the Ohio State University

By
Robert Vernon Stroud, B.A., M.S.

* * * * * * * *

The Ohio State University
1967

Approved by

[Signature]
Advisor
Department of Speech
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VITA

June 25, 1929  
Born--Dayton, Ohio

1954 ........  
B.A., Bowling Green State University, 
Bowling Green, Ohio

1956 ........  
M.S., Bowling Green State University, 
Bowling Green, Ohio

1956-1965. . .  
Supervisor Speech Rehabilitation 
Hearing and Speech Center of 
Dayton and Montgomery County

1965-1967. . .  
Fellow, Speech and Hearing Science, 
The Ohio State University, Columbus, 
Ohio

FIELD OF STUDY

Speech and Hearing Science
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CHAPTER I

INTRODUCTION

Considerable material has been written on the etiology of functional articulatory problems. Much has also been written describing the nature of these aberrations. Search for causality has lead numerous investigators through tedious tasks in an attempt to find positive relationships which would allow them to make statements pertinent to functional misarticulations. But still the present information concerning the etiology of functional misarticulations is inconclusive.

The oneness of speech and hearing has inspired many scholars to search for the causality of articulatory disorders in the auditory process. "Every aspect of audition--basic acuity for pure tones, acuity for the higher frequencies, pitch discrimination, auditory memory span, perception for complex auditory patterns--has received attention," according to Powers (1957, p. 738). Still, there are no consistencies in the findings relating the relationships of speech to
hearing. Concern over whether the child, with functional misarticulations, is able to process or hear speech as well as the normal-speaking child has often entered the mind of the speech pathologist.

Casual observation has lead this investigator to feel that some of these children may miss part of the oral message or phonemic differences of spoken language as a function of the rate of talking. Unfortunately, search for literature in which this observation is quantified has been unrevealing. Some investigators, whose works are presented in the following chapter, have substantiated that children with functional misarticulations have difficulty hearing certain phonetic elements in words and the same has been reported with reference to the child's ability to hear phonemic differences and similarities in words. However, to this investigator's knowledge, no study in which the objective was to observe the perceptual abilities of children with misarticulations in relationship to rapid and slow speech has been reported.

That the individual hears what he has been conditioned to hear has been demonstrated by Guberina (1963). In reporting an observation of the foreign student's adjustment to a new language, he contends that the basis of linguistic structure lies in specific external stimuli which are
integrated by the brain according to certain optimal elements. Thus, the speech signal is received normally by the ear; the decoding occurs at a cortical level on the basis of previous linguistic experiences. This implies that when these optimal elements are disregarded, a person with normal hearing may perceive speech as one who has a hearing loss. Testing this postulate further, Black (1964) found that foreign students with normal hearing made lower scores on intelligibility tests than did native students who had mild hearing losses. Reporting a similar finding, Lane (1963) indicates that articulation scores of Yugoslavian, Indian, and Japanese speakers were consistently below those of English speakers.

The ability to comprehend messages even though significant amounts of the original message had been removed by periodic interruptions was quantified by Miller and Licklider (1950). They report that when the speech was interrupted ten or more times a second, the listener was still able to discriminate monosyllabic words. As the duration of the speech decreased, the intelligibility score dropped off in value. Later, Licklider (1951) reports that "...acoustic power alone does not activate the auditory mechanism. That power must be expended for some length of time: it takes energy to produce effects (p. 1020)."
Discussing the manner in which speech conveys information, Miller (1951) reports that "...the amount of information in a speech wave is proportioned to the duration of the speech, to the range of frequency components involved, and to the logarithm of the number of discriminable steps in amplitude (p. 70)." In discussing information, however, one cannot generalize from intelligibility, since Miller (1951) reports that duration of the signal does not enter into the formula when one is calculating intelligibility because it was assumed that all the test items lasted equally as long. Thus information as defined above cannot be taken as a direct measure of the amount of information in a speech message.

The relevance of these reports to the study presented here lies in the fact that they demonstrate that in the process of perceiving speech from an external source, certain acoustical attributes such as frequency, duration, and intensity must be present before the listener can comprehend the message. If it is true that these acoustical attributes affect the comprehension and perception of speech of normal speakers, would it not be true to a greater extent of persons with misarticulations?

Purpose

The purpose of the study was to ascertain if rate of speaking affected the comprehension of speech by second-grade
children with functional misarticulations. It was also the purpose of the study to ascertain the effects of sex, severity of misarticulation, therapy, socioeconomic status, size of family, and race on the ability to comprehend speech altered by various degrees of speaking rates.

The specific questions proposed for this study were:

1. Do children with normal speech display a greater ability in comprehending varying rates of speaking than do children with functional misarticulations?

2. Do boys differ from girls in their ability to comprehend speech spoken at varying rates?

3. Is there a difference in the ability to comprehend varied rates of speech between second-grade boys and girls who have functional misarticulations?

4. Does speech therapy affect the proficiency with which children with misarticulations can comprehend speech spoken at varying rates?

5. Does severity of the misarticulation problem affect the ability to comprehend speech spoken at varying rates?

6. Do children with normal and defective speech from various socioeconomic levels differ in ability to comprehend varying speech rates?

7. What is the relationship of the number of siblings and the child's ability to perceive varying rates of speech?
8. Are there differences between Negro and Caucasian children in ability to comprehend various speaking rates?

Definition of Terms

Specific terms used in this study are defined as follows:

**Functional Misarticulation.** Van Riper's definition of this term was used for this study: "A disorder with no organic basis characterized by substitutions, omissions, additions and distortions of speech sounds" (1963, p. 19).

**Degrees of Severity of Misarticulations.** The descriptions presented below are those used by the State Board of Education, Columbus, Ohio, (1964).

- **Mild Misarticulation** indicates slight variation of phonation, language structure, rhythm or inconsistent substitutions of one or more sounds which would be expected to be used correctly by the child at his level of mental maturity. These defects interfere little with communication, may cause little or no psychological maladjustment and have the possibility of improving with maturation or the help of the classroom teacher.

- **Moderate Misarticulation** indicates noticeable defects of phonation, language structure, rhythm, or misarticulation of several sounds expected to be correctly articulated at the child's level of mental maturity. These defects may not seriously impede communication, but may cause the child to be maladjusted. Amelioration will be dependent upon speech therapy and assistance from other disciplines as needed.
Severe Misarticulation indicates consistent misarticulation of many sounds normally expected at the child's level of mental maturity, noticeable defects of phonation, language structure of rhythm patterns which seriously impair the child's ability to communicate. These symptoms may be indicative of organic impairments, and/or severe emotional disturbances. (Ohio Department of Education, 1964).

Stanine Scores refer to single digit standard scores based on the California Mental Maturity Test in which the mean is five and the standard deviation is two (Thorndike and Hagen, 1961). The relationships of stanine scores to percentile and to the normal curve is presented in the Appendix A.

Social Class Distinctions. The information concerning social classes below was taken from the Social Profile of Dayton, Ohio, Metropolitan Area, with reference to the Dayton Public Schools (1960 Census). Characteristics of three socioeconomic groups used in the study are as follows:

Upper Class. Children in this group came from residential communities which reported that less than one per cent of the dwellings and buildings were deteriorated and run down; persons receiving annual incomes of $3,000 or less were under one per cent and less than one per cent of the residents were relief recipients.

Middle Class. Children in this group came from residential communities which reported that less than fifteen per cent of the dwellings and buildings were deteriorated and run down, persons receiving annual incomes of $3,000 were less than fifteen per cent and less than five per cent of the residents were relief recipients.
Lower Class. Children in this group came from residential communities which reported that forty per cent of the dwellings and buildings were deteriorated and run down, persons receiving annual incomes of $3,000 or less were forty per cent and thirty-five per cent of the residents were relief recipients.

A Speech Signal refers to a spoken linguistic message transmitted from an individual or source to another.

Rate. The amount of speech which is produced in a given period of time.

Speech Compression refers to the process of adjusting the temporal parameter of a recorded speech signal, electronically, so that the original signal is played back at a rate which is less (faster) than the one at which it was recorded, and is accomplished by the sampling method (Foulke, 1966).

Speech Expansion refers to the process of adjusting the temporal parameter of a recorded speech signal, electronically, so that the original signal is played back at a rate which is greater (slower) than the one at which it was recorded; and is accomplished by repetition of the speech signal.
**Sampling Method** refers to the removal of parts of a speech signal on a periodic basis; this removal may occur within a phoneme, syllable, word, or between words.

**Organization of the Study**

In this chapter, the basis for this study, the purpose, and a definition of terms have been presented. In Chapter II, the literature relevant to the problem will be reviewed. The procedures will be considered in Chapter III. Chapter IV will consist of the statistical analysis and results of the analysis. In Chapter V the complete study will be summarized and discussed.
CHAPTER II

REVIEW OF THE LITERATURE

Information relative to comprehension of compressed and expanded speech by individuals with functional misarticulations was not found by this investigator. Pertinent information, however, is reported concerning (1) duration of stimuli, (2) speech perception, (3) hearing, (4) rate of speaking, (5) information processing, and (6) comprehension of compressed and expanded speech by normal speakers. Although these topics were not directly related to the present study, the investigator felt that they were essential to the understanding of the results of this experiment.

Duration of Stimuli

"The ear is an integrative system," according to Osgood (1959), "in the sense that energies distributed in time summate." That is, auditory stimuli of reasonable duration are summed into meaning by the listener on the basis of previous experiences. Tones of short duration are experienced as clicks, having little or no pitch quality. These
clicks are due to the rapid series of transient frequencies produced as the ear overcomes its inertia. With durations of 10-15 milliseconds, the click becomes more tonal. Licklider, as stated in the previous chapter, found that acoustic power alone does not activate the auditory mechanism. He states, "The power must be expended for some length of time: it takes energy to produce effects (p. 1020)." It has been reported, however, by Doughty and Garner (1957) that shorter durations of stimuli can be compensated to some extent by increasing intensity.

In discussing requirements for the duration of a phonetic unit, Gemelli and Black (1957) report that this has been an area of controversy and experimentation both in the context of the word and in isolation. Gemelli speculated that "...unless the oscillograph record of a vowel contained a pair of similar, typical waves, the observer of the photograph of the physical vowel could not be positive that he had secured a representative sample of the sound (Gemelli and Black, 1957, p. 108)."

Through the use of a pendulum-activated pair of mercury switches, Gray (1964) controlled the time that a sustained vowel was allowed to "pass a panel of listeners." He varied the duration of the vowels from 0.0052 seconds to
0.0003 seconds. The listeners displayed individual differences in their ability to recognize the short segments of the sounds and were unable to recognize uniformly equal segments of the different vowels.

When comparing the recognition of sections of vowels of 0.08, 0.2, 0.5, 0.8 seconds, Tiffany (1953) noted that the added duration beyond a natural duration for a vowel in speech does not aid recognition. Similar findings are reported by Siegenthaler (1950) stating that ten long sustained vowels were scarcely more than fifty per cent recognizable.

Investigating the effects demonstrated in perception subsequent to the removal of different segments from the initial part of consonant vowel (CV) syllables, Grimm (1965) found that from the 50 millisecond cut point, the percentage of correct responses increased rapidly. Maximum intelligibility was reached at 170 milliseconds.

An excellent summary with reference to duration was presented by French (1957):

It appears that speech sounds are rather elastic as regards to duration. At one extreme, set by the properties of the nervous system, is an average duration of roughly 0.05 second. At the other extreme, in slow speech, is an average duration of about 0.15 second with individual sounds ranging from 0.02 to 0.3 second, or possibly higher. Thus, it seems rather significant that the integration properties of the auditory system are rather strong up to durations of the order of 0.2 second.
In addition to being short, speech sounds are highly complex as regards the distribution of intensity along the frequency scale. With consonants, this distribution tends to be continuous. With vowel sounds the distribution is discontinuous but, as noted previously, the spacings between components are generally within the range which permits considerable interference between the overlapping patterns of the individual components. With both vowels and consonants the result is at least a partial fusing of sensations along the frequency scale.

Thus with speech sounds, like the other short sounds mentioned earlier, the combined effect of integration or fusing of sensations along both the time and frequency scales is to produce subjective impressions which are closely akin to single, coherent sensations. To understand the desirability of this result and something of the processes which give rise to it, is to go a long way toward an understanding of the peculiar nature and limitations of many auditory sensations. (French, 1957, p. 91).

Speech Perception

The articulation index of French and Steinberg (1947) has been the paragon for many studies in speech perception. The notion presented in this index is that "...any narrow band of speech frequencies of a given intensity, carries a contribution to the total index which is independent to the other bands with which it is associated, and that the total contribution of all bands is the sum of the contributions of separate bands (p. 93)." In establishing this concept, French and Steinberg used different band widths ranging from 250 Hz to 7000 Hz. This resulted in
twenty bands being identified, each contributing .05 to the index. Those bands above and below 1900 Hz made equal contributions to the articulation scores. Black (1959) and Kryter (1956) made similar observations and concluded that it was feasible to accept the concept of the articulation index.

Some writers have noted that familiarity of words augment their intelligibility under adverse conditions. Black (1952) reports that the intelligibility of a word is dependent upon the fact that it is a familiar one and that it has more than one syllable with the accent on the second syllable. Savin (1963), another investigator, reports that frequently used words are more often perceived correctly at lower signal to noise ratios than uncommon ones. Using particular words under varied signal to noise ratios, Miller, Heise and Lichten (1951) demonstrated that context enhanced perception. Key words were used in sentences and the same words were used in isolation. Subjects made more correct responses to the words in context than they did under the isolated condition.

**Hearing and Discrimination**

The question of hearing has perpetually puzzled the investigator who attempted to establish a relationship
between auditory acuity and discrimination. The works of Guberina (1963) and Black (1964) previously mentioned demonstrate the auditory phenomena which exists when scores obtained on intelligibility tests by native English speakers and those of foreign students were compared. In the normal range of hearing, Mange (1960) reports that individuals with defective speech displayed less acuity. In an earlier study reported by Hall (1938), cases with better than average auditory acuity showed no superiority to cases below average in acuity in the mean number of errors on the three auditory perceptual tests used in the study. According to Haller (1964), a child's speech defect may be due to a hearing loss not severe enough in degree to interfere materially with a normal adjustment in other respects.

Evidence purporting that a kind of hearing loss may exist within the realm of normal hearing is reported by Tidwell (1965). He notes that the time needed to identify a stimulus word was vital to the comprehension of the word. As an example, he found that an average student reacted in .1 seconds to a given stimulus, where students operating at a grade of "C" or "D" relative to classroom performance required .4 or more seconds to respond to the same stimuli. Also he reports that slow learners used in the study performed at levels below the average student. In that
intelligence is implied here, Wepman (1960) would differ since he feels that there is little or no relationship between intelligence and auditory discriminative ability. Those differences that do exist are explained by Wepman who states that..."Children with high intelligence attend to their tasks better and consequently score better on tests (p. 331)." That auditory perception of speech is more closely related to intelligence than to hearing acuity is also upheld by Hall (1938).

A rather interesting theory on the perception of speech, of paramount significance to this study, is the one presented by Liberman (1961). The perception of speech according to Liberman does not depend solely on the acoustical characteristics of the stimulus; instead it is perceived in reference to articulation. Liberman postulates that the articulatory movements and their sensory effects mediate between the acoustic stimulus and the event which is called perception. Thus, the listener mimics the incoming message and responds to proprioceptive and tactile stimuli that are produced by his own articulatory movements. From this, one can infer that if a listener is unable to perform these processes as a function of the rate of utterance he will be incapable of comprehending the message.
Rate of Speaking

Attention has been devoted to the rates at which various articulatory movements can be made. Using "tat tat tat" as a means of measuring the speed of tongue-tip movements, Hudgins and Stetson (1937) found that 8.2 syllables per second could be produced with the tip of the tongue, 7.3 seconds with the jaw, 7.1 with the back of the tongue, 6.7 with the velum, and 6.7 with the lower lip.

Demonstrating that speakers talk at different rates, Brigance (1952) reports that speakers whose rates varied from 80 words per minute to 215 words per minute. The rate of 148 words per minute was considered as being average. A talking rate of 2.5 syllables per second and 120 words per minute is reported by Crandell and Meader (1957) as being a reliable estimate of deliberate speech. The rate of 270 words per minute and 5.5 syllables per second was considered an adequate description of conversational speech. Speech at this latter rate, according to French (1957), applies to brief bursts and lasts for only a few seconds.

Information Processing

The question of a child's ability to process information becomes important when one discusses responses to rapid and prolonged speech. Individual differences in cognitive behavior in children of normal intelligence was questioned by Kagan, Moss and Sigel (1963). They found that children
with equal ability and equal mediational structures might arrive at different results in a problem situation as a result of the manner in which they processed the initial information. Analytical and nonanalytical children differed, according to Lee, Kagan and Rabson (1963), in the kinds of stimuli that were initially selected for labeling. They studied the influence of categorizations upon acquisition of concepts. Three groups of phonemes were used and it was found that the analytical children saw differences more often than the nonanalytical. Children and adults displayed clear and stable preferences with reference to the speed when they offer solutions to problem situations, according to Kagan (1964).

In cognition, there are methods in which the individual handles the stimulus. One author, Holzman (1953), feels that, in some instances, individuals tend to minimize differences between a stimulus and context. This is referred to as "leveling." In another instance, there is a tendency to maintain the independence and discreteness of the stimulus and the surrounding field, which is referred to by Holzman as "sharpening."

Responses to Compressed and Expanded Speech

Comprehension relative to the rate of utterance has been studied by many investigators. The impetus for much
of this work was based on the findings of Miller and Licklider (1950) who capitalized on the redundancy of the speech signal and demonstrated that they could eliminate segments of a message and retain a high degree of intelligibility. Going a step further Garvey and Henneman (1952) deleted segments from a tape, they spliced the remaining tape and attained significant results from their listeners. They were able to remove more than sixty per cent of the signal before intelligibility dropped to eighty per cent.

A method in which segments of the original recorded message were discarded periodically was described by Fairbanks, Everill and Jaeger (1954); this method resulted in the message being played back in less than the recording time with no shift in the frequency spectrum. At a later date, Fairbanks, Guttman, and Marion (1957) studied the effects of time on comprehension of connected speech and report that "...the curve of comprehension as a function of message time was characteristically sigmoid. Response was approximately 50 per cent of maximum when message time was 40 per cent, 60% compression, 353 wpm. When the message was 50%, 282 wpm, the response was slightly less than 90% and efficiency, response per time, was maximal (p. 47)."

Later the same authors (1957) investigated the effect of
the listener's aptitude and message effectiveness; they report that the listener's aptitude and the structure of the message affected comprehension. Studying intelligibility as a function of compression, Fairbanks and Kodman (1957) note that as the discard interval increased from 0.01 to 0.24 second, there was a reduction in intelligibility.

Using a Tempo Regulator which utilizes the sampling method, Foulke, Amster, Noland and Bixler (1962) studied the possibility of compressed speech with blind children as a means of shortening their listening time to academic material. They used 291 blind children from Grades Six, Seven, and Eight. Literary and scientific materials were chosen as stimuli. The stimuli were presented at rates from 175 words per minute to 375 words per minute. The results revealed that the subjects did nearly as well at 275 as they did at 175.

Using live voice, varying the rate from 80 to 230 words per minute, Fergen (1954) studied the comprehension of fourth-, fifth- and sixth-grade subjects. Comprehension was quantified by a written examination. The results revealed that at all grade levels, the best scores were obtained at material read at 130 words a minute. Eighty words per minute was better than 180 and the children scored higher on 180 words per minute than on 230.
Using a Tempo Regulator as a means of controlling rate and imperative sentences as stimuli, Wood (1965) presented fifty sentences at the following rates: 175, 200, 225, 275, 300, 325, 350, 375, and 400 words per minute to ninety pupils in the elementary school. The subjects represented three grades: thirty from Grade One; thirty from Grade Three; and thirty from Grade Five. He reported significance at the .05 level with reference to rate of presentation, grade, practice, rate by grade-level interaction, and rate-by-practice interaction. No significance was reported relative to intelligence. Children exceeded ninety per cent comprehension at 350 words per minute. At no rate was the comprehension less than seventy-five per cent. Scores in comprehension were in relation to grade: for first-grade children, 84.2 per cent; for third-grade children, 92.2; and fifth-grade children, 93.9 per cent.

Using thirty-six male college freshman and sophomores, Orr, Friedman, and Williams (1965) investigated the effects of training on comprehension of speeded discourse and found that "...under the impact of practice their experimental group was able to build a greater skill in listening comprehension at higher levels of speed than the control group was able to develop (p. 151)."
In studying "Temporal Effects in Speech Analysis and Synthesis," Scott (1965) used two methods of compressing speech. One method was linear where the time was compressed and expanded by a constant factor. In the second method, a nonlinear method was employed where the time factor of the speech signal was varied in accordance with the integral of the rate of change of the spectrum. Subjects responded better to the latter method.

Possibilities for expanded speech have been discussed in the literature but investigative results have not been noted by this investigator. Tiffany and Bennett (1961) studied the intelligibility of slow speech. They used two male and two female readers and reported that intelligibility scores decreased under the slow condition, but the female voice was less affected by distortion.

Related Factors Affecting Comprehension and Measurement

Sentence Length. Studying aural reception in relation to sentence length, Black (1961) reports that on the basis of his stimuli which were sentences of 3, 5, 7, 9, 11, 13, 15 and 17 words, the longer sentences yielded the least comprehension. Normal eight-year-old children, according to Templin (1964) displayed a mean sentence length of 7.6 words.
Sociological Factors. "The young Negro comes into the school system from an immigrant background, in which non-standard American English is the primary (if not only) means of verbal communication, and then he is denied the opportunity to acquire the socially approved dialect through adequate contact with indigenous white speakers of it" reports Pederson (1964, p. 17). The term "condition inattention" was used by Brooks (1964) in describing the culturally deprived child who has learned to turn himself off as a means of rejecting noises of the slum community, and fails to turn himself on in the classroom. Since little is known about the morphological abilities of the Negro culturally disadvantaged child, Shriner and Miner (1966) have undertaken an investigation to see if these children display differences between receptive and expressive aspects of English morphology.

Speech development in Negro children was studied by Osser (1966) with emphasis on the development of syntax in urban children who spoke a nonstandard dialect. The results demonstrated discrepancies in speech comprehension between the group's responses on the imitation and comprehension task to the same structure, which could be understood by referring to the child's dialect. Possessives, for example, were poorly imitated but apparently well understood.
Methods for Measuring Rate. The manner in which vocal utterances are measured has frequently concerned those who investigated rate. Presenting suggestions for research, Templin (1957) states that the study of sounds in syllables may provide a more acceptable unit of measurement than sounds in words. The syllable is recommended by Carroll (1966) as the unit of speech output in measuring speech rate. He states that,

"If very small time units are used, data must be reported to sufficient precision to permit projection to larger units. A measurement reported as 3 syllables per second is probably imprecise, unless it is actually 3.000 syllables per second, from which one could reliably translate to 180.0 syllables per minute (p. 89)."

The inadequacies of the words per minute as accurate measurement of actual articulation time gave rise to a new concept of rate according to Cotton (1936). The value of syllabic rate lies in the fact that it takes into consideration the length of time taken to articulate the units and the pause between the units reports Cotton.

Rejecting the syllable as a unit of measurement, Drushal (1938) points out that problems often arise when a syllable is defined or limited in some manner. Evidently, as a result of feeling that syllables were not an adequate
means of expressing rate, Kelly and Steer (1949) used words per minute as a means of expressing rate in their study of extempore speech.

Summary

In this chapter, many factors affecting the perception of speech have been presented. Duration of stimuli was discussed. Tones must be of sufficient length, 10-15 milliseconds, before they are recognized as tones. This is due to the fact that activation of the auditory mechanism requires a definite period of time. This period of time may vary slightly in individuals. In addition to duration, the frequency of the message has effects on the perception of speech. Given bands of speech frequencies are summated by the listener, thus allowing the message to become intelligible.

The individual's ability to hear and discriminate, apparently in part, depends upon what he is accustomed to hearing. Native students respond better to English intelligibility tests than do foreign students. Subjects who do poorly on discrimination tests are discussed as having hearing losses which are not severe enough to interfere with normal adjustment in other respects. Mediation between acoustical stimuli, articulatory movements, and their
sensory effects, would appear to enhance perception. In processing information, children with equal ability and equal mediational structures were found to arrive at different results in problem situations. This was due to the manner in which they processed the information. Analytical and nonanalytical children differ in the kinds of stimuli they select for labeling.

Due to the redundancy of speech, the time parameter can endure considerable changes before intelligibility is seriously hampered. Elementary school children have demonstrated that they can exceed ninety per cent comprehension when speech has been compressed to yield 350 words per minute. Intelligibility is impaired under slow conditions but female voices are affected less by this situation. The perception of speech is affected by sentence length. Longer sentences are more difficult to comprehend. As for speech production, normal eight-year-old children generate sentences with a mean length of 7.6 words.

Sociological factors also contribute to the manner in which speech is perceived. Children from substandard milieus will frequently develop the linguistic patterns peculiar to that community. When placed in situations where standard patterns are spoken they will display
difficulties in comprehension due either to reason described by Black (1964) and Guberina (1963) or "conditioned inattention" as described by Brooks (1964).

Measurement of rate of utterance has vacillated from words per minute to syllables per minute. Presently, syllables per minute are considered by many to be the most informative unit.
CHAPTER III

PROCEDURE

The purpose of this study was to investigate the relationships between the rate of utterance and speech comprehension in second-grade children with normal speech and second-grade children with functional misarticulations.

Seven steps were used to collect the data presented in this study: (1) selection of subjects, (2) selection of words used as stimuli, (3) construction of the sentences, (4) recording of the sentences, (5) compression and expansion of the sentences, (6) presentation of the sentences to the subjects, and (7) processing the data.

Selection of the Subjects

Ninety-eight second-grade children from seven Dayton, Ohio, public schools served as subjects in this investigation. In that it is felt by the Dayton school system that children will have overcome developmental speech deficiencies by the second grade, the experimental subjects were
selected from Grade Two. They were selected from schools which had speech and hearing clinicians on their faculties. Fifty-two of these children were reported by the speech and hearing clinician in their respective schools as having normal speech. That is, none of these children during kindergarten, first grade, or second grade displayed symptoms which would result in their being referred to the speech clinician. Forty-six of these ninety-eight children had been diagnosed by the speech clinician, in his respective school, as having a functional misarticulation. The degree of severity varied in these subjects and will be discussed later in this chapter.

A table of random numbers was used to select those children who comprised the population of normal speakers. The second-grade teachers of the schools used in this study were instructed to submit to the clinician in her school the names of children in her class who were normal speakers, had normal hearing, and were operating intellectually at a normal or higher level. Confirmation that these children were normal speakers was made by the school clinician. Prior to the test situation, verification of normal hearing was made by the examiner through the use of a Maico Model 12B audiometer calibrated in accordance to the I.S.O. 1964 standards. All children were required to respond to a 25 dB
pure tone at 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz in order to qualify as a subject. Children were considered as having normal or above intelligence if they had obtained a stanine score\* of 4 or better.

Similar conditions, with reference to randomization, stanine scores, and hearing tests, were used for the selection of those children who comprised the experimental group with the following exceptions: (1) they were selected by the speech clinician in lieu of the classroom teacher, (2) all had to be diagnosed as having functional misarticulations and were either enrolled in therapy or were awaiting placement in therapy.

Forty-seven of the total number of subjects (ninety-eight were female and fifty-one were males. Of the forty-six children with articulatory disorders, the range of severity varied from mild to moderate. None of the children with severe misarticulations was able to meet the requirement, which was a stanine score of 4 or higher. There were sixteen in the moderate category and thirty in the mild. Thirty-seven of the children in the experimental group were receiving therapy at the time of this investigation. Nine, though labeled

\* In this instance, the stanines are normalized scores obtained on the California Test of Mental Maturity. In Appendix A, stanine scores in relation to norm, curve, and percentile scores are demonstrated.
as having speech defects, were not receiving therapy. Seventy-four of the subjects came from families with three or more siblings. Distribution, according to social class was as follows: twenty-nine in the upper class, forty-nine in the middle class, and twenty in the lower class. There were sixty-two Caucasian subjects and thirty-six Negro subjects. Description of experimental subjects will be found in Table 1.

**Selection of Words for Construction of Sentences Used as Stimuli**

A number of words assumed to be at a second-grade level were selected from Thorndike (1944) and Schoolfield (1951). Lists were made from these words and were presented to nine second-grade teachers in the Dayton (Ohio) Public School System, to be judged relative to their familiarity to all of the children in their classrooms. Words found to be questionable by any one of the nine teachers were discarded from the lists. The end product was a list of words which these teachers felt could be understood by all of the children in their respective classes.

None of the classes was designated as special education classes; however, intelligence did vary in all of the situations. The schools were representative of the three
Table 1. Composition of experimental population as to race, sex, socioeconomic status, size of family, and degree of severity of misarticulations.

<table>
<thead>
<tr>
<th>POPULATION</th>
<th>NORMAL</th>
<th>MISARTICULATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negro</td>
<td>21</td>
<td>15</td>
</tr>
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<td></td>
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<td>20</td>
</tr>
<tr>
<td>Male</td>
<td>25</td>
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<td>Socioeconomic Status</td>
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<td></td>
</tr>
<tr>
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<td>14</td>
</tr>
<tr>
<td>Middle</td>
<td>27</td>
<td>22</td>
</tr>
<tr>
<td>*Lower</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Size of Family</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two or fewer Siblings</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>Three or more Siblings</td>
<td>40</td>
<td>34</td>
</tr>
<tr>
<td>Degree of Severity of Misarticulations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate with Therapy</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>Moderate without Therapy</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Mild with Therapy</td>
<td></td>
<td>24</td>
</tr>
<tr>
<td>Mild without Therapy</td>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

* All subjects in this class were Negro.
socioeconomic classes as defined in Chapter I. There were three schools from the upper class, three from the middle class, and three from the lower class.

Construction of Sentences Used as Stimuli

Those words which were not discarded were made into interrogative and imperative sentences. There was a total of 170 with a mean sentence length of 5.8 words. They were designed to be culture free. Neither reading and writing skills nor special materials were required to indicate comprehension of the sentences. Appendix B presents a complete list of the sentences. These sentences were presented to the same nine teachers for judging; they were instructed to indicate those sentences assumed to be incomprehensible to the children in their classrooms. After judging, the sentences were returned to the examiner; those found acceptable were incorporated into the test. The sentences were then recorded on magnetic tape and presented to ten first-grade children. Since all of the sentences were understood by these children, they were accepted as the final stimuli to be used in the investigation.

Recording Sentences Used as Stimuli

Two hundred sentences were recorded at the Ohio State University Speech and Hearing Science Laboratory with the
assistance of the Electronic Technical Supervisor. One hundred of these sentences were to be compressed and 100 were to be expanded in relation to their original time of approximately 225 words per minute and 280 syllables per minute. The sentences were divided into units of ten so that time alterations could be made to the individual units. Each unit of ten sentences was prefaced with a statement concerning the amount of compression or expansion that followed.

A male speaker was used to record the sentences, which were recorded at approximately 225 words per minute and 280 syllables per minute, in an I.A.C. sound-treated room. An Altec Model 61B Microphone, with a neck rest, was suspended around the speaker's neck with the microphone placed six inches from the mouth. The speech signal was picked up and transmitted outside the sound treated room to a Magnecord Model PT6V tape recorder where it was recorded full track at fifteen inches per second.

**Compression and Expansion of Stimuli**

The compression and expansion of the stimuli was done at the Center for Rate Controlled Recordings, located at the University of Louisville in Louisville, Kentucky. The Tempo Regulator, manufactured by Telefonbau and Normalzeit,
Frankfurt-am-Main, Germany, was used for the purpose of compressing and expanding the tape recordings. A technician employed by the Center for Rate Controlled Recordings was in charge of processing the tapes. The technician was informed that the beginning of each unit of ten sentences he would hear the speaker's voice announcing the amount of alteration that should be applied to the following sentences. A list of sentences including the amount of alteration was presented to the technician to clarify the task.

The original sentences were recorded at 225 words per minute (wpm) and 280 syllables per minute (spm). The first ten sentences that passed through the Tempo Regulator were unaltered and were referred to as the reference point or zero compression. The second ten sentences were compressed by ten per cent of the original signal and yielded an output of 249 wpm and 310 spm, the third ten sentences were incremented by twenty per cent of the original signal yielded an output of 281 wpm and 350 spm, and so forth, until seventy per cent or 749 wpm and 933 spm compression was reached. Contrary to the original design, this point (seventy per cent) was maximum compression capacity for the Tempo Regulator used in this study; thus, only seventy
sentences were used under compressed conditions. They ranged from zero compression through seventy per cent compression. The process for expanding the speech signals on the tape was basically the same except the objective was to create a prolonged speech signal instead of a reduced one. The expanded sentences had the same zero reference point as the compressed ones and proceeded in ten per cent decrements of the original signal of 225 wpm and 280 spm until 100 per cent expansion, 112 wpm and 140 spm had been reached.

Time changes were accomplished in the following manner as described by Foulke (1964). Alteration of the duration of the speech signal was acquired by a sampling method; that is, as the tape was processed certain bits of the original recordings were retained and others were discarded electronically. The tape passed on a curved surface of a cylinder on the Tempo Regulator and wrapped around the circumference of the cylinder. While the cylinder was stationary, the tape moved at fifteen inches per second, the original recording speed; the tape made contact with only one of the reproducing heads, the signal was reproduced as recorded; and the tape was then fed to a Crown Model 800 Tape Recorder where the master tape was recorded at 7.5 inches per second.
When the Tempo Regulator was adjusted for a given amount of compression, through a correction made by the tachometer, the speed of the tape increased and the cylinder began to rotate in the direction of the tape movement. When the tape speed increased, the rotational speed of the cylinder was increased allowing the tape speed in relationship to the surface of the cylinder to be held constant at fifteen inches per second. This permitted each of the four heads in turn to make and then lose contact with the tape. Each head reproduced, as recorded, the material on that portion of the tape with which it made contact. When the cylinder was positioned so that one head was losing contact with the tape while the preceding head was making contact with the tape, that part of the tape which was wrapped around the cylinder between these two heads never made contact with a reproducing head and was not reproduced. That portion of the tape which was eliminated from the reproduction, as described, was always one-fourth of the circumference of the cylinder. The amount of speech compression depended upon the number of speech segments eliminated over a period of time. This elimination of segments depended upon the tape and cylinder speed.

The expanded speech was accomplished by reversing the direction of the cylinder and the tape moved across
the cylinder at a speed slower than that used during the original recording. Under this condition, the redundancy of the speech signal was increased 200 per cent.

Presentation of the Stimuli

Ninety-eight second-grade children listened to the compressed and expanded speech recordings. Fifty-two of these subjects were children with normal speech; and forty-two had been diagnosed as having functional misarticulations. None of the subjects, as far as the investigator could determine had ever heard compressed or expanded speech. They listened to eighteen units consisting of ten sentences which were imperative and interrogative in nature. The rate of seventeen of these sentence units had been altered as a function of time. One unit was unaltered and was referred to as the zero point. From this zero point the rate of speech was compressed by ten per cent, thus making the second unit of ten sentences presented in a time period which was ten per cent faster than the zero point, which was presented at 225 wpm (words per minute) and 280 spm (syllables per minute). This procedure continued at increments of twenty per cent, thirty per cent, forty per cent, fifty per cent, sixty per cent through seventy per cent compression which was 749 wpm and 933 spm. From the
zero point through seventy per cent compression, each subject listened to seventy sentences. Upon completion of this task, the expansion phase of the test was introduced and the administrative procedure was the same. Under this condition the subjects were exposed to ten time alterations instead of seven since the equipment was able to reproduce 100 per cent expansion.

In every instance, the testing was done in the room which was designated as the speech clinic. Ambient noise was measured in all of the testing rooms by a General Radio Sound Level Meter, Model 1551B using the C scale. In no instance did the level exceed 55 dB re. .0002 dynes. All of the test rooms were equipped with small chairs and long, low tables, which allowed the examiner to sit at eye level with each subject. At the end of the table was an Electro-Voice Speaker, Model SP8B which was connected to a Wollensac Tape Recorder, Model T1500. The distance between these two instruments was approximately two feet. The test situation is represented by diagram in Figure 1.

The subjects were brought individually to the test situation by the examiner and requested to sit on the chair at the head of the table three feet from the loud-speaker. This spot, with reference to distance from the loud-speaker, was marked on the floor.
Figure 1. Representation of test situation.
A pure tone screening test was administered by the examiner using a Maico Portable Audiometer, model 12B, at 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz at 25 dB re. I.S.O. 1964 calibration standards. If the subject passed the screening test, he was told that the examiner wanted him to hear some recordings and was instructed in the following manner:

You are going to hear a voice coming from this tape recorder. It will ask you to do things. You will be able to do many of these things while sitting in your chair and you will have to stand to do some of the things. Also the voice will ask you questions. You are to do what the voice tells you and answer the questions as quickly as you can. Let's see how well you understand what you are to do.

Using a practice tape, which was presented at a rate of approximately 200 wpm, the child was exposed to a fifteen second segment containing the five following sentences:

- Put your hands over your ears.
- Touch the bottom of your shoe.
- Show me how you sweep with a broom.
- Who is the principal of your school?
- Do you have a fish bowl in your classroom?

Each sentence was prefaced with, "Listen." Also after each presentation the recorder was stopped to allow time for completion of the task. The children were requested to
repeat those questions which required a "Yes" or "No" answer. That is, if the question were, "Do you like apples?" and the child answered, "Yes, I like apples." In some instances the subject would answer questions requiring a "Yes" or "No" answer with a statement, "Yes, I like apples." All of the children demonstrated the ability to comprehend the task.

The next step provided the subject with an opportunity to hear samples of compressed speech. It was felt that this would reduce the humorous effect which is often associated with distorted speech. For this purpose, five ten-second segments of connected discourse at ten per cent, twenty per cent, thirty per cent, forty per cent and fifty per cent compression were presented to the children. The samples on the demonstration tape were made available to the examiner by the Ohio State School for Blind, Columbus, Ohio.

The final step in testing procedure was the presentation of the experimental stimuli to the subject. The child who was seated three feet from the speaker was again told to do what the voice on the tape told him as quickly as he could. The tape recorder was turned on; the voice on the tape said, "First you are going to hear me count to twenty."
This allowed the examiner time to adjust amplitude to 85 dB at ear level in both ears with each subject. A General Radio Sound Level Meter, Model 1551B, was used for this purpose. After this adjustment was made the recorder was stopped and the examiner would say, "O.K. let's start." The recorder was again turned on and the voice would say, "Zero compression", and then the first sentence was presented. At the end of the sentence the recorder was stopped to allow time to complete the task. After the task was completed, the examiner would say, "Listen", and the recorder was again started and the second sentence was presented. This procedure continued throughout presentation of the first ten sentences. At the onset of the second unit of ten sentences which was at a ten per cent rate increment of the first unit, the voice on the tape said, "Ten per cent compression", and the sentences were presented. From this point on, the procedure was the same as mentioned above with compression increments of twenty per cent, thirty per cent, forty per cent, fifty per cent, sixty per cent and seventy per cent until the entire compressed part of the examination had been given.

The expanded portion was then presented and the method was the same. Since a response to zero compression
was already obtained, the expanded test started at ten per cent expansion and was continued through 100 per cent expansion. The quality of the expanded recording was not as good as the compressed, but subjects' responses to the stimuli suggest that intelligibility was not seriously hampered. The entire test of both compressed and expanded speech took fifty minutes.

Errors were recorded on a response sheet when the child failed to complete the task as a function of being unable to comprehend the speech. Failure to repeat any of the task sentences, requiring a "Yes" or "No" answer as stated on the tape, was counted an error.

Processing the Data

Each child had an individual data sheet which consisted of two parts: (1) a face sheet which contained identifying information which was used for forming the hypotheses, and (2) the sentences which were used for the compressed and expanded conditions. Errors were scored on this data sheet during the process of the examination (Appendix B).

Summary

In this chapter the process used in selecting the subjects has been discussed. Selection of the words which
formed the sentences used as stimuli has been presented. The process of preparing the recordings and the method of presenting the stimuli have been described. In the next chapter, the analysis of the investigation will be presented.
CHAPTER IV

STATISTICAL ANALYSIS AND RESULTS

The purpose of this study was to ascertain the effect of rate of utterance on speech comprehension by second-grade children with normal speech and second-grade children with functional misarticulations. It was also the purpose of this study to ascertain the effects of sex, severity of misarticulation, therapy, socioeconomic status, size of family, and race on the ability to comprehend speech altered by various degrees of expansion and compression.

Null Hypotheses

Nine null hypotheses were formulated for testing purposes:

1. There is no difference between second-grade children with normal speech and second-grade children with misarticulations in the comprehension of compressed and expanded speech.
2. There is no difference between second-grade girls with misarticulations and second-grade boys with misarticulations in the comprehension of compressed and expanded speech.

3. There is no difference between second-grade boys and girls who are normal speakers in their abilities to comprehend compressed and expanded speech.

4. There is no difference in the ability to comprehend compressed and expanded speech between those children with misarticulations who are presently receiving therapy and those with misarticulations not receiving therapy.

5. There is no relationship between the degree of severity of misarticulations and the ability to comprehend compressed and expanded speech.

6. There is no difference among second-grade children with misarticulations from various social classes and their abilities to comprehend compressed and expanded speech.

7. There is no difference among second-grade normal speakers of various social classes and their ability to comprehend compressed and expanded speech.
8. There is no relationship in the ability to comprehend compressed and expanded speech between those children who come from families with three or more siblings and those of two or less.

9. There is no difference between the Negro and Caucasian children in their ability to comprehend compressed and expanded speech.

**Statistical Analysis**

The data were compiled by finding the sum of all correct responses made by each subject at eighteen temporal levels. Eight levels consisted of varied degrees of speech compression\(^1\) and ten levels comprised the expanded speech portion of the investigation. These data were then analyzed in relationship to specific hypotheses.

In analyzing the data, it was noted that the responses made by the normal speakers and subjects with misarticulations to Levels 1, 2, 3, and 4 of the compressed stimuli and Levels 10 through 18 of the expanded stimuli were almost identical, thus were not treated in the critical statistical analysis (Table 2). An exception occurred at Level 4 which

\(^1\) In the original design, it was planned to use ten levels of compressed speech, but this was not accomplished due to limitation of the Tempo Regulator used in this study.
Table 2. Mean scores for responses made by normal and defective speakers to the eighteen levels of compressed and expanded speech.

<table>
<thead>
<tr>
<th>Level</th>
<th>Compression</th>
<th>Words per Minute</th>
<th>Syllables per Minute</th>
<th>N=56 Normal</th>
<th>N=42 Defective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>225</td>
<td>280</td>
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<td>70</td>
<td>749</td>
<td>933</td>
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Expansion

<table>
<thead>
<tr>
<th>Level</th>
<th>Compression</th>
<th>Words per Minute</th>
<th>Syllables per Minute</th>
<th>N=56 Normal</th>
<th>N=42 Defective</th>
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<td>100</td>
<td>112</td>
<td>140</td>
<td>10.0</td>
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</tr>
</tbody>
</table>

Mean of Means 9.45 9.32
was treated individually and is discussed later in this chapter. Figure 2 illustrates the responses of the subjects at all eighteen levels.

Since these similarities did occur at the levels previously mentioned, the testing of the hypotheses was done on the responses made at Levels 5, 6, 7, and 8 of the compressed stimuli and Level 9 of the expanded stimuli. Levels 5 and 9 served as boundaries confining the levels at which consistent differences were recorded.

To insure that this treatment would not distort the results, a Pearson Product-Moment Correlation was run to support the decision to use only five levels (5, 6, 7, 8, 9) of temporal change as representative of the performances of the subjects under eighteen levels of change. The relationship of mean scores of eighteen levels to the mean scores of five levels in both the normal and the defective speaking groups were investigated. The results of this inquiry yielded positive correlations: means of eighteen levels compared to the means of five levels for the children with normal speech yielded a correlation of 0.97; correlation of means for eighteen levels compared to the means of five levels for the defective speakers was 0.94. In that these relationships existed, it was concluded that
Figure 2. Response of the normal and defective speakers to compressed and expanded speech.
five levels could be used. A summary of mean scores for responses made by all subjects to the eighteen levels of compressed and expanded speech is shown in Table 2.

**Compression and Speech Production**

**Hypothesis One.** The first hypothesis, that there is no difference in the comprehension of compressed and expanded speech between second-grade children with normal speech and second-grade children with misarticulations was treated statistically. In that responses were almost identical at all but five levels, the statistics were computed using those levels at which the greatest differences occurred. These levels were 5, 6, 7, and 8 of the compressed speech and Level 9 of the expanded speech. Levels 5 and 9 served as cut-off points for the compressed and expanded speech. Differences above and below these points did not reveal significance.

A summary of the mean scores made by the subjects of the two groups to the eighteen levels of speech compression and expansion is presented in Table 2. As shown in Figure 2, the responses of the two groups were similar at several levels. A Lindquist (1953) Type I mixed design analysis of variance was computed for the correct responses at Levels 5, 6, 7, and 8 of the compressed speech and Level 9 of the
expanded speech. As shown in Table 3 the F-ratio of 4.66 with 1 and 96 degrees of freedom was significant beyond the .05 level and the F-ratio of 1442.76 with 4 and 384 degrees of freedom was significant beyond the .01 level. On the basis of this analysis the subjects with normal speech performed better than those with functional misarticulations.

To further confirm these results a t-test for unrelated measures was employed to assess the difference between the means of the normal speakers and the defective speakers at all eighteen levels. The results revealed that they differed significantly beyond the .01 level and that the normal speakers performed better in response to compressed and expanded speech. On the basis of these findings, Hypothesis One is rejected since the normal speakers demonstrated that they possess a better ability in comprehending compressed and expanded speech.

Comprehension and Sex of Subjects

The second and third hypotheses were concerned with ascertaining the differences between the sexes and their abilities to comprehend compressed and expanded speech. In order to investigate the results with reference to sex, the
Table 3. Summary of the analysis of variance for five levels of compressed and expanded speech for normal versus defective speakers.

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td>97</td>
<td>181.4</td>
<td>8.4</td>
<td>4.66*</td>
</tr>
<tr>
<td>B (Normal Defective)</td>
<td>1</td>
<td>8.4</td>
<td>8.4</td>
<td></td>
</tr>
<tr>
<td>Error (b)</td>
<td>96</td>
<td>173.0</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>Within Subjects</td>
<td>392</td>
<td>3992.6</td>
<td>934.7</td>
<td>1442.76**</td>
</tr>
<tr>
<td>A (Levels)</td>
<td>4</td>
<td>3738.8</td>
<td>934.7</td>
<td></td>
</tr>
<tr>
<td>AB (Interaction)</td>
<td>4</td>
<td>6.0</td>
<td>1.50</td>
<td></td>
</tr>
<tr>
<td>Error (w)</td>
<td>384</td>
<td>247.8</td>
<td>.65</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>489</td>
<td>4174.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Significant at the .05 level 3.24 (df 1,96).
** Significant at the .01 level 3.36 (df 4,384).
responses of the males with misarticulation were paired with the females of the same group. Scores attained by the normal speakers were paired on the basis of sex. There were twenty-six males and twenty females in the group with misarticulations. Twenty-five males and twenty-seven females were in the group of normal speakers.

**Hypothesis Two.** There is no difference in the comprehension of compressed and expanded speech between second-grade girls with misarticulations and second-grade boys with misarticulations.

The data relevant to this hypothesis were compiled and the means were computed. Inspection of the mean scores for responses to all eighteen levels were unrevealing. The mean of means of the two groups was identical, 9.3 for responses at eighteen levels. The data are presented in Table 4.

Responses of the two groups at five levels were submitted to a $t$-test for unrelated measures for purposes of assessing the differences between the means of defective-male speakers and defective-female speakers. The results of this test were not significant thus prohibiting the rejection of Hypothesis Two.
Hypothesis Three. There is no difference between second-grade boys and girls who are normal speakers in their abilities to comprehend compressed and expanded speech.

The data relevant to this hypothesis were compiled and the means were computed. The mean of mean scores were the same (9.4) for the males and females. This is shown in Table 4. Inspection, however, indicates a difference at Levels 5, 6, 7, 8 and 9, suggesting that the boys performed better. This indication lead to further statistical investigation where a t-test for unrelated measures was employed to assess the differences between the means of the normal male and female speakers. The results of this test revealed that there was a significant difference between these two groups which was beyond the .05 level, thus permitting rejection of this hypothesis and revealing that the males performed better than the females. The mean scores for the normal-speaking boys and girls are presented in Table 4.

Comprehension and Therapy

Hypothesis Four. This hypothesis was concerned with differences between those children with misarticulations receiving therapy and those with misarticulations not
Table 4. Mean scores of responses of normal and defective subjects to compressed and expanded speech in relation to sex.

<table>
<thead>
<tr>
<th>_LEVEL</th>
<th>COMPRESSION</th>
<th>WORDS PER SYLLABLES</th>
<th>MEAN OF MEANS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>MINUTE PER MINUTE</td>
<td>NORMAL (N=25)</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>225</td>
<td>10.0</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>254</td>
<td>10.0</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>281</td>
<td>10.0</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
<td>321</td>
<td>9.9</td>
</tr>
<tr>
<td>5</td>
<td>40</td>
<td>374</td>
<td>10.0</td>
</tr>
<tr>
<td>6</td>
<td>50</td>
<td>450</td>
<td>9.4</td>
</tr>
<tr>
<td>7</td>
<td>60</td>
<td>562</td>
<td>8.2</td>
</tr>
<tr>
<td>8</td>
<td>70</td>
<td>749</td>
<td>3.6</td>
</tr>
</tbody>
</table>

|_|_|_|_|

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>COMPRESSION</th>
<th>WORDS PER SYLLABLES</th>
<th>MEAN OF MEANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>10</td>
<td>204</td>
<td>9.9</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>187</td>
<td>10.0</td>
</tr>
<tr>
<td>11</td>
<td>30</td>
<td>173</td>
<td>10.0</td>
</tr>
<tr>
<td>12</td>
<td>40</td>
<td>160</td>
<td>9.9</td>
</tr>
<tr>
<td>13</td>
<td>50</td>
<td>149</td>
<td>10.0</td>
</tr>
<tr>
<td>14</td>
<td>60</td>
<td>140</td>
<td>10.0</td>
</tr>
<tr>
<td>15</td>
<td>70</td>
<td>132</td>
<td>10.0</td>
</tr>
<tr>
<td>16</td>
<td>80</td>
<td>124</td>
<td>10.0</td>
</tr>
<tr>
<td>17</td>
<td>90</td>
<td>118</td>
<td>10.0</td>
</tr>
<tr>
<td>18</td>
<td>100</td>
<td>112</td>
<td>10.0</td>
</tr>
</tbody>
</table>

MEAN OF MEANS

9.49      9.40      9.32      9.32
receiving therapy. Thirty-seven of these children were receiving therapy and nine were not. Inspection of the data (Table 5) reveals that the scores are practically the same at all eighteen levels. The greatest difference between the two groups (.3) occurred at Level 4. The mean of means of the two groups differed by .01. Tests for critical differences at Levels 5, 6, 7, 8, and 9 were not significant; therefore, this hypothesis cannot be rejected. A summary of the mean scores of those subjects with misarticulations receiving therapy and those subjects with misarticulations not receiving therapy is presented in Table 5.

Comprehension and Severity

Hypothesis Five. This hypothesis was concerned with the relationship between severity of misarticulations and the ability of the subject to comprehend compressed and expanded speech. Mean scores were compiled to show the responses of the children, relative to degrees of severity, to compressed and expanded speech. Since no child with a severe problem attained a stanine score of $\frac{4}{2}$ or better on the California Mental Maturity Test, only two levels of

\[2\text{ In complying with the criteria for selection of subjects, children with stanine scores less than } \frac{4}{2} \text{ were excluded from the study.}\]
Table 5. Mean scores for those subjects with misarticulations and receiving speech therapy and those subjects with misarticulations and not receiving therapy.

<table>
<thead>
<tr>
<th>Level</th>
<th>Compression</th>
<th>Words per Minute</th>
<th>Syllables per Minute</th>
<th>Therapy (N=37)</th>
<th>No Therapy (N=9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>225</td>
<td>280</td>
<td>10.0</td>
<td>9.9</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>249</td>
<td>310</td>
<td>9.9</td>
<td>9.8</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>281</td>
<td>350</td>
<td>10.0</td>
<td>9.9</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
<td>321</td>
<td>400</td>
<td>9.5</td>
<td>9.2</td>
</tr>
<tr>
<td>5</td>
<td>40</td>
<td>374</td>
<td>466</td>
<td>9.9</td>
<td>10.0</td>
</tr>
<tr>
<td>6</td>
<td>50</td>
<td>450</td>
<td>560</td>
<td>9.1</td>
<td>9.3</td>
</tr>
<tr>
<td>7</td>
<td>60</td>
<td>562</td>
<td>700</td>
<td>7.5</td>
<td>7.6</td>
</tr>
<tr>
<td>8</td>
<td>70</td>
<td>749</td>
<td>933</td>
<td>2.5</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Expansion

<table>
<thead>
<tr>
<th>Level</th>
<th>Compression</th>
<th>Words per Minute</th>
<th>Syllables per Minute</th>
<th>Therapy (N=37)</th>
<th>No Therapy (N=9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>10</td>
<td>204</td>
<td>255</td>
<td>9.9</td>
<td>10.0</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>187</td>
<td>231</td>
<td>9.8</td>
<td>9.9</td>
</tr>
<tr>
<td>11</td>
<td>30</td>
<td>173</td>
<td>215</td>
<td>9.9</td>
<td>10.0</td>
</tr>
<tr>
<td>12</td>
<td>40</td>
<td>160</td>
<td>194</td>
<td>9.9</td>
<td>10.0</td>
</tr>
<tr>
<td>13</td>
<td>50</td>
<td>149</td>
<td>186</td>
<td>9.9</td>
<td>10.0</td>
</tr>
<tr>
<td>14</td>
<td>60</td>
<td>140</td>
<td>175</td>
<td>10.0</td>
<td>9.9</td>
</tr>
<tr>
<td>15</td>
<td>70</td>
<td>132</td>
<td>164</td>
<td>9.9</td>
<td>9.7</td>
</tr>
<tr>
<td>16</td>
<td>80</td>
<td>124</td>
<td>155</td>
<td>9.9</td>
<td>9.9</td>
</tr>
<tr>
<td>17</td>
<td>90</td>
<td>118</td>
<td>147</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>18</td>
<td>100</td>
<td>112</td>
<td>140</td>
<td>10.0</td>
<td>10.0</td>
</tr>
</tbody>
</table>

Mean of Means 9.31 9.30
severity, mild and moderate, were used in this study. There were thirty subjects who displayed a mild degree of severity and sixteen in the moderate class. The paired mean scores for all eighteen levels of compression and expansion are almost indistinguishable as may be observed in Table 6. It will also be noted that the mean of means 9.2 for the two groups is the same.

Investigation for a critical difference at Levels 5, 6, 7, 8, and 9 was done through the use of the $t$-test for unrelated measures. The results were unrevealing; thus, Hypothesis Five, concerned with relationship of severity of misarticulations to comprehension cannot be rejected. The mean scores of the two groups of subjects according to severity of misarticulation are presented in Table 6.

Comprehension and Social Class

An investigation concerning the relationships of the comprehension to social class was made. The population was divided into three social classes: upper, middle and lower. The three social classes were further divided into children with normal speech and those with misarticulations. In the upper social class, there were fifteen normal speakers and fourteen with misarticulations. The middle-class group
Table 6. Mean scores of responses to compressed and expanded speech in relation to severity of problem.

<table>
<thead>
<tr>
<th>PERCENTAGE</th>
<th>RATES</th>
<th>MEANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>Level</td>
<td>Compression</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>225</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>249</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>281</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
<td>321</td>
</tr>
<tr>
<td>5</td>
<td>40</td>
<td>374</td>
</tr>
<tr>
<td>6</td>
<td>50</td>
<td>450</td>
</tr>
<tr>
<td>7</td>
<td>60</td>
<td>562</td>
</tr>
<tr>
<td>8</td>
<td>70</td>
<td>749</td>
</tr>
</tbody>
</table>

Expansion

<table>
<thead>
<tr>
<th>Level</th>
<th>Compression</th>
<th>Words per Minute</th>
<th>Syllables per Minute</th>
<th>Mild (N=30)</th>
<th>Moderate (N=16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>10</td>
<td>204</td>
<td>255</td>
<td>9.9</td>
<td>9.9</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>187</td>
<td>231</td>
<td>9.3</td>
<td>9.8</td>
</tr>
<tr>
<td>11</td>
<td>30</td>
<td>173</td>
<td>215</td>
<td>9.9</td>
<td>9.9</td>
</tr>
<tr>
<td>12</td>
<td>40</td>
<td>160</td>
<td>194</td>
<td>9.9</td>
<td>9.9</td>
</tr>
<tr>
<td>13</td>
<td>50</td>
<td>149</td>
<td>196</td>
<td>9.9</td>
<td>9.9</td>
</tr>
<tr>
<td>14</td>
<td>60</td>
<td>140</td>
<td>175</td>
<td>9.9</td>
<td>10.0</td>
</tr>
<tr>
<td>15</td>
<td>70</td>
<td>132</td>
<td>164</td>
<td>9.9</td>
<td>9.8</td>
</tr>
<tr>
<td>16</td>
<td>80</td>
<td>124</td>
<td>155</td>
<td>9.9</td>
<td>9.8</td>
</tr>
<tr>
<td>17</td>
<td>90</td>
<td>118</td>
<td>147</td>
<td>10.0</td>
<td>9.9</td>
</tr>
<tr>
<td>18</td>
<td>100</td>
<td>112</td>
<td>140</td>
<td>10.0</td>
<td>9.9</td>
</tr>
</tbody>
</table>

MEAN OF MEANS 9.27 9.25
consisted of twenty-seven normal speakers and twenty-two speakers with misarticulations. There were ten normal speakers and ten defective speakers in the lower-class group.

**Hypothesis Six.** There is no difference among children with misarticulations of various social classes and their abilities to comprehend compressed and expanded speech.

**Hypothesis Seven.** There is no difference among second-grade normal speakers of various social classes and their abilities to comprehend compressed and expanded speech.

In order to investigate the responses relative to Hypotheses Six and Seven, the data were pooled and are presented in Table 7, which demonstrates the number of subjects in each class and the means of the classes. These data were further subjected to a single classification analysis of variance to ascertain the difference between three social classes subdivided into normal and defective speakers. Temporal Levels 5, 6, 7, 8, and 9 were used to compute this analysis. The results of the analysis of variance are presented in Table 8. An $F$-ratio of 4.63 with 5 and 92 degrees of freedom was significant.
Table 7. Summary of the number of subjects in each social class and the mean scores of the classes for five levels of compressed and expanded speech.

<table>
<thead>
<tr>
<th></th>
<th>1 Normal Lower Class</th>
<th>2 Defective Lower Class</th>
<th>3 Normal Middle Class</th>
<th>4 Defective Middle Class</th>
<th>5 Normal Upper Class</th>
<th>6 Defective Upper Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>10</td>
<td>10</td>
<td>27</td>
<td>22</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>$\bar{x}$</td>
<td>81.0</td>
<td>76.0</td>
<td>224.0</td>
<td>172.8</td>
<td>113.8</td>
<td>110.0</td>
</tr>
<tr>
<td>$\bar{x}^2$</td>
<td>658.28</td>
<td>578.80</td>
<td>1866.08</td>
<td>1368.16</td>
<td>862.96</td>
<td>870.40</td>
</tr>
<tr>
<td>Mean</td>
<td>8.10</td>
<td>7.60</td>
<td>8.29</td>
<td>7.85</td>
<td>7.59</td>
<td>7.86</td>
</tr>
</tbody>
</table>
Table 8. Summary of the analysis of variance to assess the degree of difference in comprehension of compressed and expanded speech between the three social classes subdivided into normal and defective speakers.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups</td>
<td>5</td>
<td>6.97</td>
<td>1.39</td>
<td>4.63*</td>
</tr>
<tr>
<td>Remainder</td>
<td>92</td>
<td>27.69</td>
<td>.30</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>97</td>
<td>34.66</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Significant at .01 level > 3.20 (df 5, 92).
beyond the .01 level which substantiates a difference among the normal and defective speakers of the various groups. The middle-class subjects performed better than the upper- and lower-class subjects.

In attempting to locate where the differences existed, it was necessary to regroup the subjects into three groups on the basis of social class with no regard to the speech characteristics of the subjects. The mean scores and the number of subjects for this classification are presented in Table 9. A single classification analysis of variance was employed to locate the differences among the groups. The results of this analysis (Table 10) reveal that there was a significant difference among the three groups at the .05 level. The middle-class population performed better and was different from the upper- and lower-class groups; however, the upper- and lower-classes did not differ significantly between themselves. The nature of these results allow, in part, rejection of Hypotheses Six and Seven. The mean scores for Hypotheses Six and Seven at all eighteen levels are given in Table 11.

Comprehension and the Number of Siblings

The question of the effect of family size on comprehension was investigated in Hypothesis Eight. Both normal and
Table 9. Summary of mean scores at five levels for all subjects subdivided into three social classes, based on comprehension of compressed and expanded speech at five levels.

<table>
<thead>
<tr>
<th></th>
<th>Lower Class</th>
<th>Middle Class</th>
<th>Upper Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>20</td>
<td>49</td>
<td>29</td>
</tr>
<tr>
<td>$\bar{x}$</td>
<td>157.0</td>
<td>396.8</td>
<td>223.8</td>
</tr>
<tr>
<td>$\bar{x}^2$</td>
<td>1237.08</td>
<td>3234.24</td>
<td>1733.36</td>
</tr>
<tr>
<td>Mean</td>
<td>7.85</td>
<td>8.09</td>
<td>7.72</td>
</tr>
</tbody>
</table>
Table 10. Summary of the analysis of variance to assess the degree of difference among the three social classes on the basis of comprehension of compressed and expanded speech at five levels.

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups</td>
<td>2</td>
<td>2.82</td>
<td>1.41</td>
<td>4.27*</td>
</tr>
<tr>
<td>Remainder</td>
<td>95</td>
<td>31.84</td>
<td>.33</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>97</td>
<td>34.66</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Significant at .05 level > 3.09 (df 2,95).
Table 11. Mean response scores for the three social classes at all eighteen levels of compressed and expanded speech.

<table>
<thead>
<tr>
<th>Level</th>
<th>Compression</th>
<th>Words per Minute</th>
<th>Syllables per Minute</th>
<th>Upper Normal (N=15)</th>
<th>Upper Defective (N=14)</th>
<th>Middle Normal (N=27)</th>
<th>Middle Defective (N=22)</th>
<th>Lower Normal (N=10)</th>
<th>Lower Defective (N=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>225</td>
<td>280</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
<td>9.8</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>249</td>
<td>310</td>
<td>10.0</td>
<td>10.0</td>
<td>9.9</td>
<td>9.9</td>
<td>10.0</td>
<td>9.6</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>281</td>
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Expansion

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<th>Lower Defective (N=10)</th>
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Mean of Means

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<th>Lower Mean</th>
</tr>
</thead>
<tbody>
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<table>
<thead>
<tr>
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<table>
<thead>
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<table>
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<th>Lower Mean</th>
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<tbody>
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</table>
defective children were studied in relation to the number of siblings and responses to compressed and expanded speech. There were sixteen normal-speaking subjects who came from families where there were two or fewer children in the family. Forty of the normal children came from families of three or more children. In the defective-speech group, there were eight children from families of two or less children. Thirty-four of the children with defective speech came from families of three or more children.

**Hypothesis Eight.** There is no relationship between the ability to comprehend compressed and expanded speech between those children who come from families with three or more siblings and those of two or fewer. From Table 12, it may be observed that the mean scores between those children from the normal speakers with two or fewer siblings differ little at the eighteen levels of compression and expansion from those with three or more siblings. The total means for the two groups are 9.5 for the two or fewer siblings group and 9.4 for those children who have three or more siblings.

The responses made by those children with misarticulations in relationship to size of family was less revealing than the former condition where the subjects were normal
Table 12. Summary of mean scores of normal and defective speakers based on comprehension of eighteen levels of compressed and expanded speech in relation to family size.

<table>
<thead>
<tr>
<th>Level</th>
<th>Compression</th>
<th>Words per Minute</th>
<th>Syllables per Minute</th>
<th>Normal 2 Siblings (N=16)</th>
<th>3 or more Siblings (N=40)</th>
<th>Defective 2 Siblings (N=8)</th>
<th>3 or more Siblings (N=34)</th>
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<tr>
<td>1</td>
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<td>466</td>
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<tr>
<td>6</td>
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<td>560</td>
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<td>2.2</td>
<td>2.8</td>
<td>2.4</td>
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**Expansion**

<table>
<thead>
<tr>
<th>Level</th>
<th>Compression</th>
<th>Words per Minute</th>
<th>Syllables per Minute</th>
<th>Normal 2 Siblings (N=16)</th>
<th>3 or more Siblings (N=40)</th>
<th>Defective 2 Siblings (N=8)</th>
<th>3 or more Siblings (N=34)</th>
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**MEAN OF MEANS**

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<tr>
<td>9.2</td>
<td>9.3</td>
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</table>
speakers. The means for the children from families with two or fewer siblings and three or more siblings were the same, 9.3 and 9.3. Further statistical investigation of these two groups through the use of a t-test for unrelated measures was uninformative, thus this hypothesis cannot be rejected.

Comprehension and Race

Concern over differences related to race lead to Hypothesis Nine: that there is no difference between Negro and Caucasian children in their abilities to comprehend compressed and expanded speech. In investigating this relationship, it was necessary to separate the normal speakers from those with misarticulations. Once this had been done, the Negro children in the defective group could be paired with those Caucasian children who comprised the defective speakers. There were fifteen defective Negro speakers and thirty-one Caucasian children with speech defects. Secondly, the Negro children who were normal speakers were paired against those Caucasian children who were normal speakers. There were twenty-one Negro and thirty-one Caucasian normal speakers. Observation of the means (Table 13) revealed the possibility of a significant
Table 13. Summary of mean scores for eighteen levels in relation to race of subject.

<table>
<thead>
<tr>
<th>PERCENTAGES</th>
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<tr>
<td></td>
<td>Words per Minute</td>
<td>Syllables per Minute</td>
</tr>
<tr>
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<tr>
<td>Expansion</td>
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<tr>
<td>9</td>
<td>10</td>
<td>204</td>
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<tr>
<td>10</td>
<td>20</td>
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<tr>
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<td>30</td>
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<td>112</td>
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<td>MEAN OF MEANS</td>
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</tbody>
</table>
difference occurring between Levels 5 and 9. (Levels 5, 6, 7, and 8 represented compressed speech and Level 9 referred to expanded speech.)

These observations suggested that significant differences might occur between Levels 5 and 9 lead to further statistical analysis. A Lindquist (1953) Type I mixed design analysis of variance was used and the results are shown in Table 14. The $F$ ratios for 3 and 94 degrees of freedom was 3.19, which was significant at the .05 level. The $F$ ratio for 4 and 12 degrees of freedom was 510.25 which was significant beyond the .01 level. To investigate further the difference between these two groups a critical difference test was employed. The critical differences between the groups were significant in two instances at the .01 level, and in one instance at the .05 level. A summary of these differences is presented in Table 15. The dip in the curve, Figure 3, which occurred at Level 4 resulted from the poor response of the Negro subjects with misarticulations. In that the Caucasian subjects made fewer errors in comprehending compressed and expanded speech, this hypothesis is rejected.
Table 14. A summary of the analysis of variance to assess the degree of difference between the Negro and Caucasian subjects based on their abilities to comprehend five levels of compressed and expanded speech.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
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<tr>
<td>Between Subjects</td>
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<td>184</td>
<td>5.67</td>
<td>3.19*</td>
</tr>
<tr>
<td>B (Groups)</td>
<td>3</td>
<td>17</td>
<td>1.78</td>
<td></td>
</tr>
<tr>
<td>Error (b)</td>
<td>94</td>
<td>167</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within Subjects</td>
<td>392</td>
<td>4162</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A (Levels)</td>
<td>4</td>
<td>3735</td>
<td>933.75</td>
<td>510.25**</td>
</tr>
<tr>
<td>AB</td>
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<td>22</td>
<td>1.83</td>
<td></td>
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<tr>
<td>Error (w)</td>
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<td>405</td>
<td>1.08</td>
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<tr>
<td>TOTAL</td>
<td>489</td>
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</table>

* Significant at .05 level > 2.70 (df 3, 94).
** Significant at .01 level > 2.23 (df 4, 12).
Table 15. Summary of Critical differences between the Negro and Caucasian subjects in relation to speech characteristics and comprehension of five levels of compressed and expanded speech.

<table>
<thead>
<tr>
<th></th>
<th>Negro Normal</th>
<th>Caucasian Defective</th>
<th>Caucasian Normal</th>
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<td>.51**</td>
<td>.55**</td>
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<tr>
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<td>.04</td>
</tr>
<tr>
<td>Caucasian Defective</td>
<td>7.92</td>
<td>.11</td>
<td>.15</td>
</tr>
</tbody>
</table>

* A difference between any two means in the above table which exceeds .278 is significant at the .05 level.

** A difference which exceeds .465 is significant at the .01 level.
Figure 3. Response of the subjects to compressed and expanded speech on the basis of race.
Summary

In this chapter, the hypotheses were stated and the analysis of the data was presented. The following chapter is concerned with the results, discussion, and conclusions from the study. Also, implications for further research will be made.
CHAPTER V

SUMMARY AND CONCLUSIONS

The main objective of this study was to ascertain the relationships between the rate of utterance and speech comprehension by second-grade children with normal speech and second-grade children with functional misarticulations. Also, secondary purposes of this study were to investigate the effects of sex, severity of misarticulations, therapy, socioeconomic status, size of family, and race on the ability to comprehend speech altered by various degrees of compression and expansion.

Summary

Ninety-eight second-grade children from the Dayton (Ohio) Public School System served as subjects. Fifty-two of these children were normal speakers and forty-eight were diagnosed by the public school speech clinician as having functional misarticulations. All of the subjects
possessed normal hearing and were of average or above intelligence. In order to investigate the secondary purposes of this investigation, six subgroups of the original ninety-eight subjects were formed. There were fifty-one male subjects, twenty-six of whom had functional misarticulations and twenty-five were normal speakers; forty-seven subjects were females, twenty with misarticulations and twenty-seven with normal speech. Since no subject with severe misarticulations was able to meet the criteria of intelligence established for the study, only two degrees of severity, mild and moderate, were investigated. Thirty subjects were classified as mild and sixteen as moderate. Of the forty-six subjects with misarticulations, thirty-seven were receiving therapy and nine were not. The division of subjects on the basis of socioeconomic classes was: upper class, twenty-nine; middle class, forty-nine; and lower class, twenty. Twenty-four subjects came from families of two or fewer children, and seventy-four came from families where there were three or more children. Of the total population, thirty-six of the subjects were Negro and sixty-two were Caucasian.

All of these subjects were requested to listen to speech which had its temporal parameter changed through the
use of a Tempo Regulator. Speech was presented in the form of imperative and interrogative sentences at rates ranging from 112 words per minute (wpm) and 140 syllables per minute (spm) to 749 wpm and 933 spm. Eighteen different rates were presented to each subject. Responses were scored on the basis of correct items.

**Null Hypotheses**

1. There is no difference between second-grade children with normal speech and second-grade children with misarticulations in the comprehension of compressed and expanded speech.

2. There is no difference between second-grade girls with misarticulations and second-grade boys with misarticulations in the comprehension of compressed and expanded speech.

3. There is no difference between second-grade boys and girls who are normal speakers in their abilities to comprehend compressed and expanded speech.

4. There is no difference in the ability to comprehend compressed and expanded speech between those children with misarticulations who are presently receiving therapy and those with misarticulations not receiving therapy.
5. There is no relationship between the degree of severity of misarticulations and the ability to comprehend compressed and expanded speech.

6. There is no difference among second-grade children with misarticulations from various social classes and their abilities to comprehend compressed and expanded speech.

7. There is no difference among second-grade normal speakers of various social classes and their ability to comprehend compressed and expanded speech.

8. There is no relationship between the ability to comprehend compressed and expanded speech between those children who come from families with three or more siblings and those of two or less.

9. There is no difference between the Negro and Caucasian children in their ability to comprehend compressed and expanded speech.

Results
In analyzing the data, it was observed that the responses made by subjects at thirteen of the eighteen levels
of compression and expansion were almost identical. Rather than analyze these similarities statistically, it was decided to analyze those levels where differences occurred consistently. Inspection revealed that the areas at which differences occurred consistently were Levels 5, 6, 7, and 8 of the compressed stimuli and Level 9 of the expanded stimuli. To insure that these five levels adequately represented those responses which were made at all eighteen levels, the data was subjected to a Pearson Product Moment Correlation. The relationship of the mean scores of eighteen levels of temporal change to the mean scores of five levels of temporal change in the normal and defective groups was investigated. In the case of the normal speakers, a correlation of 0.97 was obtained, displaying a highly positive relationship between performance on five levels and eighteen levels of temporal change. The subjects with misarticulations attained a correlation of 0.94 which also demonstrated a positive relationship between performance of five levels and eighteen levels of temporal change.

Significant difference obtained through the use of analysis of variance, critical difference tests, and the \( t \)-test for unrelated measures permitted rejection of three
of the hypotheses. These hypotheses were concerned with the subject's ability to comprehend compressed and expanded speech in relation to speech proficiency, sex, or race. The defective speakers displayed greater difficulty in comprehending compressed and expanded speech than did the normal speakers. The males with normal speech made fewer errors than did the females with normal speech. Negro subjects with misarticulations had greater difficulty in comprehending compressed and expanded speech than did the Caucasian subjects with misarticulations.

The results relative to social class were not as definitive as the above results. Significant difference did exist among the social classes, but only when the characteristics of the subject's speech were disregarded. The middle class responded significantly better than the upper or lower classes. The upper and lower classes did not differ significantly, although the lower class did respond better than the upper class.

No significant differences were observed to exist between the boys and girls with misarticulations. Significant differences in comprehension did not exist in relation to severity, misarticulations, or size of family. Nor did significance exist among subjects who were receiving therapy and those with defective speech who were not receiving therapy.
Discussion

The results of this study imply that children with functional misarticulations have greater difficulty in comprehending rapid speech than children with normal speech. The responses of the two groups were equal through the third level of compressed speech. At Level 4, where the stimuli were presented at 321 wpm and 400 spm, the defective speakers made their first excursion from the normal speakers. From this point on through 749 wpm and 933 spm, the defective speakers never equalled the normal speakers.

The fact that the males performed better than the females is surprising since girls at this age tend to exceed boys in the acquisition of language skills. The Negro subjects with normal speech did not differ significantly from the Caucasians in relation to responses to the stimuli. The Negro subjects with defective speech, however, differed significantly from the Negro and Caucasian subjects with normal speech and the Caucasian subjects with misarticulations. At this time, no apparent reason can be given for this poor response.

Differences did not exist among the defective-speaking population in relation to sex. Both groups attained identical mean of means. Comprehension in relation
to severity of misarticulations revealed no significant information. This may be due, in part, to the fact that no children with severe misarticulations were included in this study.

The number of siblings had no bearing on comprehension. In the population of normal speakers, the subjects from families of two or fewer children had a higher total mean score than those children from larger families, but no statistical significance was established. Children from the defective population showed no difference in relation to family size. Both groups attained the same mean of means and were almost identical at Levels 5 through 9.

The effect of therapy did not enhance the subject's ability to comprehend compressed and expanded speech, according to the results of this study. The five levels, 5, 6, 7a, 8, and 9, did not reveal any significance and the mean of means was identical.

Conclusion

In that the subjects with normal speech made significantly fewer errors in the comprehending of compressed and expanded speech than those children with functional misarticulations, it would appear that children
with defective articulation may have greater difficulty processing information than do normal speakers. It is apparent that, on the basis of the speaking rates used in this study, these children need a slower presentation of information before they can decode the intended oral message. The poor responses of the Negro subjects with misarticulations cannot be accounted for in a systematic manner. It was noted, however, during the investigation that many of the subjects displayed the kind of speech which is frequently referred to as being substandard.

Even though the various rates of presentation used in this investigation were not always realistic, the results of the study may have implications for further study concerning the rate at which second-grade children can process information. The expanded speech as used in this study provided little or no information with reference to the individual with defective articulation and his ability to comprehend.

Implications for Therapy and Further Research

The following are recommendations for further study:

1. The effects of expanded speech on children with functional misarticulations.
2. The effects of expanded speech on children with normal hearing who display receptive disorders.
3. The effects of expanded speech on adults with receptive aphasia as the predominant symptom.
4. Relationships among individuals with normal hearing, neurological insult, and the ability to comprehend compressed and expanded speech.
5. The effectiveness of expanded speech in the presentation of verbal stimuli to hyperactive children.
APPENDIX A
RELATIONSHIP OF STANINES TO PERCENTILE AND NORMAL CURVE

PERCENTILE SCORES

STANINE SCORES
APPENDIX B
GENERAL INFORMATION SHEET

Name_________________________  Number_______________________
School________________________  Age: ___yrs. ___mos.
Sex: M__ F ___  Grade________________________
Speech: Normal__ Defective__  Socioeconomic Class____
Speech Rating___________________  Number of Siblings____
Intelligence Test_______________  Therapy: Yes____ No____
Race: Caucasian____ Negro____  Hearing Test____________

Notes:
ZERO COMPRESSION

Put your hands over your eyes.
Point to the window.
Which is bigger, an elephant or a cow?
Wiggle your nose.
Put your hands in your lap.
Did you wear a coat today?
Show me how you brush your teeth.
Can a dog climb a tree?
Is it hot outside when Christmas comes?
How many brothers and sisters do you have?

TEN PERCENT COMPRESSION

Where does your grandmother live?
What kind of ice cream do you like best?
Put your hand on the table.
Open your mouth.
Pick up the chair on which you are sitting.
What color do you like best?
Do you have a brother?
How many fingers do you have?
Do you know how to tell time?
Put your elbows on the table.

TWENTY PERCENT COMPRESSION

Cross your legs.
When is your birthday?
Where do you eat lunch?
Are there more girls in your room than boys?
Tell me the name of your best friend.
Do you have a pet at home?
Point to the door.
What do you use for sweeping the floor?
Have you ever been on a farm?
Are you afraid of dogs?
THIRTY PERCENT COMPRESSION

Cover your eyes.
Is a car bigger than a bike?
Can you stand on your head?
Would you rather have a cat or a dog?
What color are apples?
Do you have a swimming pool in your yard?
Scratch your head.
Show me how to throw a ball.
Put your hands on your hips.
Can boys run faster than girls?

FORTY PERCENT COMPRESSION

Blink your eyes.
Do you know how to swim?
Show me your left hand.
Have you ever ridden on a school bus?
What color is your hair?
How old are you?
What is your name?
Do you have a brother?
Wipe your face.
Stand up and turn around.

FIFTY PERCENT COMPRESSION

Show me your sock.
What is your telephone number?
What does a elephant look like?
What grade are you in?
Do you know a poem about Mary had a little lamb?
Is it day or night when you go to bed?
Name an animal you would see at the zoo.
Is cotton hard or soft?
How many eyes do you have?
SIXTY PERCENT COMPRESSION

What is your last name?
Show me ten fingers.
What color are your shoes?
What do you like to eat best?
Is the sun bright?
Do you like to draw?
Touch your toes.
What would you like to have, a doll, or a ball glove?
Do you have a bird house in your yard?
Have you ever been on an airplane?

SEVENTY PERCENT COMPRESSION

Put your hands on your legs.
Do you like carrots?
Is Santa Claus skinny or fat?
What does a snake look like?
Have you ever read the story about the cat and the hat?
What color is the sky?
Do you have a bicycle?
Please count to five for me.
Do you have a puppy?
Is your teacher tall or short?
EXPANDED SENTENCES

ZERO EXPANSION (Same as zero compression)

TEN PERCENT EXPANSION

Who brings toys at Christmas?
What color are your socks?
Do you have a baby in your family?
What time do you go to bed?
What does a squirrel look like?
Put your hand on your shoulder.
Do you like to read?
Why does it rain?
Show me how you eat with a spoon.
What does a Christmas tree look like?

TWENTY PERCENT EXPANSION

What does a rabbit look like?
When does it snow, in the winter or in the summer?
What color is our flag?
What number comes after nine?
Point to your cheek.
Show me how you wash your face.
Clap your hands for me.
What would you rather play with, a doll or a toy truck?
What is a robin?
Did you walk to school today?

THIRTY PERCENT EXPANSION

What is the name of your school?
What is your first name?
Scratch your nose.
What is today?
Close your eyes.
What do you like to watch best on TV?
Stand up and turn around.
What color is grass?
Place your hands on top of your head.
What kind of noise does a cat make?
FORTY PERCENT EXPANSION

What is your teacher's name?
Show me your teeth.
Hit the table with your hand.
Show me how you walk.
Name an animal you would see at a zoo.
What do kittens like to drink?
Point to my arm.
Put your hand on my arm.
Where do you eat lunch?
Did you wear a coat today?

FIFTY PERCENT EXPANSION

Why does it rain?
Can a dog climb a tree?
Show me how you tie your shoe.
Put your hands on your knees.
Show me how you throw a ball.
What does an elephant look like?
What color is the sky?
Do you have a bird house in your yard?
Tell me the name of your best friend.
Have you ever ridden on a school bus?

SIXTY PERCENT EXPANSION

Which is bigger an elephant or a dog?
Where do you eat lunch?
Have you ever seen a snake?
Do you ride a bus to school?
What number comes after four?
How many fingers do you have?
Scratch your nose.
Show me your sock.
Is a car bigger than a bike?
Can you stand on your head?
SEVENTY PERCENT EXPANSION

What color do you like best, red or blue?
Put your finger on your lip.
How many feet does a dog have?
Does a lion have wings?
Do you have a swimming pool in your yard?
What color is your hair?
Is it day or night when you go to bed?
Is your teacher tall or short?
Pretend that you are combing your hair.
Put your hands under your chair.

EIGHTY PERCENT EXPANSION

Stand on one foot.
Shake your head.
Put your hands over your ears.
What does your teacher use for writing on the board?
Scratch your head.
Wiggle your nose.
Point to the floor.
What is the name of your school?
What kind of noise does a cat make?
Do you have a bird house in your yard?

NINETY PERCENT EXPANSION

Are there more boys than girls in your room?
What is your name?
Do you like to read?
Show me how you wash your face.
When does it snow, in the winter or in the summer?
Did you walk to school today?
Show me how you eat with a spoon.
What color are your shoes?
Is cotton hard or soft?
Show me your little finger.
ONE HUNDRED PERCENT EXPANSION

Touch your toes.
Can a dog climb a tree?
Point to the window.
Stand up and turn around.
What do rabbits eat?
What does a Christmas tree look like?
Do you have a pet at home?
Is sugar sweet or sour?
Do you know a poem about Mary had a little lamb?
Have you read a story about the cat and the hat?
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