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THE INFLUENCE OF LANGUAGE ABILITY, AGE, SPEAKING RATE AND LINGUISTIC COMPLEXITY ON LANGUAGE COMPREHENSION

A Thesis

by

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ABSTRACT

THE INFLUENCE OF LANGUAGE ABILITY, AGE, SPEAKING RATE AND LINGUISTIC COMPLEXITY ON LANGUAGE COMPREHENSION (May 1982)

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Efficient auditory processing skills are essential for social and educational growth. Because the attainment of information through listening is necessary for school success, it is important to learn how disruptions affect the processing system.

The purpose of this study was to measure the singular and interacting effects of speaking rate, sentence difficulty and listener age upon sentence comprehension by language-normal and language-impaired children between the ages of six and eight.

Language comprehension was measured with a pictured sentence comprehension test. The test consisted of forty sentences divided into four syntactically matched groups, each containing different versions of the same sentence types arranged in order of increasing difficulty. The first five sentences of each group comprised the "less difficult" group, the second five the "more difficult" group. The sentences were presented at four speaking rates expressed in

syllables per second (sps) including: fast (4.9 sps), moderately fast (4.0 sps), moderately slow (3.3 sps) and slow (2.5 sps).

The influence of language ability, age, speaking rate and linguistic complexity on language comprehension was measured using an analysis of variance for repeated measures. The influence of linguistic complexity on comprehension was never resolved due to interactions which occurred when the "less difficult" and "more difficult" sentences were combined and also when the "less difficult" sentences were examined alone. Therefore, conclusions were drawn only on the "more difficult" sentences.

The influence of language ability showed the performance of the language-normal group to be significantly superior to that of the language-impaired group on comprehension of sentences. Differences between the language-normal and the language-impaired groups at each of the three age levels was also significant.

Listener age had a significant effect on comprehension for both the language-normal and the language-impaired groups, with comprehension increasing with age. The comprehension skills tested developed by age seven in the language-normal group, but development was not complete within the language-impaired group until age eight.

The overall effect of rate on comprehension was significant for both the language-normal and language-impaired groups. The optimal speaking rate for comprehension by the language-normal group was moderately fast while the optimal speaking rate for comprehension by the language-impaired group was either slow or moderately fast.

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CHAPTER 1

INTRODUCTION

Significance of the Study

The primary avenues of learning in school are reading and listening. For many years an extensive number of studies have been conducted on reading but recently attention has been focused on the problems involved in learning through listening, with 90 percent of the investigations on listening being conducted since 1952 (Taylor, 1964). It appears that listening skills have received far less attention from researchers than reading skills, even though more than 50 percent of the time spent by students in school learning situations is devoted to listening (Markgraf, 1966; Wilt, 1966).

Teachers frequently complain that even bright children learn little by listening. Apparently, the attainment of information through listening at normal speaking rates of 150 to 175 words per minute tends to be a tedious process for some children (Woodcock & Clark, 1968). Yet, all children are expected to spend much of their school learning time in this manner. Nichols and Stevens (1957) described the inefficiency of learning through listening as a problem in which the brain, capable of processing messages at rates much faster than it receives them, fills in time between messages with other thoughts. For the most efficient processing then, information should be presented at a rate nearer the listener's processing capabilities.

Clinical reports (Eisenson, 1968; Hardy, 1965) of language-impaired children have emphasized an impairment in the ability to process acoustic information at a normal rate of speech. For these children, the normal speaking/processing rate of 150 to 175 words per minute may be so fast that they are not able to comprehend the material they hear. At one level or another, there is a disruption in the children's auditory processing system (Sanders, 1977), which is frequently identified when they enter school and more sophisticated aspects of processing are required. In particular, success in the classroom is dependent upon the comprehension of complex verbal instructions and the mastery of phonics skills in learning to read.

As the language-impaired child progresses through the early grades, the demands for processing and interpreting spoken language, for the formulation and production of language in oral presentations, and for the recall of verbal materials increases significantly. At the same time, less classroom time is spent on manipulative materials necessitating the acquisition of new information from the teacher's verbal presentations alone (Wiig & Semel, 1980).

When children enter the middle and upper grades, the auditory processing demands on them change greatly. Now, deficits in language processing may influence reading comprehension in the content areas as well as mathematics skills, affecting achievement in all academic areas and adjustment to many social situations. To provide the most effective learning situation for language-impaired children, additional information about how they process auditory messages at various rates of presentation is needed.

The technology of time compressed and expanded recording makes possible the reproduction of recorded materials at faster and slower rates of recording without the usual accompanying audio distortions. Rates on the order of 300 to 400 words per minute can easily be obtained through the process of compression while rates slower than normal, 75 words per minute, can also be achieved. Although compression and expansion of recorded materials requires laboratory equipment, the technology has advanced to the point where applications to education are now feasible and worthy of further exploration.

Before specific applications can be prepared and developed, however, more research needs to be conducted. The few studies available are difficult to compare due to their diversity of subjects, materials and procedures. Moreover, most of these investigations have involved normal children's performance across a wide range of listening rates, both expanded and compressed. Similar studies need to be conducted on the effectiveness of this method of auditory learning with language-impaired children of various ages. This renewed interest in processing disruptions as a correlate of child language disorders warrants further examination. The results of such studies would provide a basis upon which teachers and clinicians could make decisions regarding practical applications of compressed and expanded speech in school learning situations and speech and language therapy.

Statement of the Problem

The problem of this investigation was to measure the singular and interacting effects of speaking rate, sentence difficulty and listener age upon sentence comprehension by language-normal and language-impaired children between the ages of six and eight. More specifically, answers to the following questions were sought:

1. Does age affect the ability to comprehend sentences presented at various speaking rates?

2. Does sentence complexity affect ease of comprehension when sentences are presented at various speaking rates?

3. Is there a difference in the comprehension of sentences presented at various speaking rates between language-normal and language-impaired children?

Delimitations

1. The study was confined to a language-normal and a language-impaired group, with 10 subjects per age level in each group.

2. Subjects were selected from the kindergarten, first-, second- and third-grade populations of the Scotland County school systems in Laurinburg, North Carolina according to the following criteria:

a. They demonstrated normal intellectual functioning (Age Deviation Score = 88 to 111) on the Columbia Mental Maturity Scale (Burgemeister, Blum, & Lorge, 1972).

b. They were judged to be language-impaired or language-normal on the basis of performance on the "Processing Word and Sentence Structure" subtest of the Clinical Evaluation of Language

Function (Semel & Wiig, 1980) and the clinical opinion of a speech, language and hearing clinician.

c. They were native speakers of English from monolingual homes who did not exhibit any gross peripheral defects of audition or vision.

Limitations

1. To the extent that pretesting sensitized the subjects to the testing procedure, results will not be generalizable to unpretested groups.

2. To the extent that subjects selected were not representative of the language-normal or language-impaired population at large, results will not be generalizable beyond the sample investigated.

3. To the extent that knowledge of subject status affected the objectivity of the researcher's observations and judgements, or caused her to influence the children's reactions to the tasks, results might be biased in favor of one group or the other.

4. To the extent that the subjects were aware of the participation in a research study, results might not be generalizable beyond the experimentally accessible population.

5. To the extent that results of this study were affected by the partial counterbalancing of the four speaking rates, the data may not be directly comparable to Nelson's (1976) work.

Assumptions

The following assumptions were made in this study:

1. That the groups of language-normal and language-impaired children were matched on relevant variables affecting language comprehension: age and intellectual ability.

2. That the researcher, being a practiced speech, language and hearing clinician, was qualified to administer, score and interpret all testing procedures used in this study.

3. That the sentences used in this study were in fact representative of a "less difficult" and a "more difficult" group.

CHAPTER 2

REVIEW OF RELATED LITERATURE

Auditory Processing

Auditory Processing Model

Auditory processing, a complex network of skills involving the comprehension of heard information (Semel, 1976), plays an important role in the development of communication, cognition and reading. A child with an auditory processing problem may find it difficult to localize the source of sound, comprehend the meaning of environmental noises, discriminate among sounds and words, distinguish and select significant from background sounds, or in speech, to combine syllables to form words and words to make sentences (Barr, 1972, 1976).

A major thrust of recent writings in the area of perceptual processing and child language disorders has been to compile and define an integrated system of auditory processes. Different facets of this complex system have been emphasized by major professionals working in this area and a summary of these auditory processing components is in Table 1.

Sanders' (1977) auditory processing model seemed particularly well-suited to the present investigation. In this system, processes should be treated as highly interdependent, and overlapping rather than as discrete or step-like occurrences. A balanced

TABLE 1

PERCEPTUAL PROCESSING STAGES

(Aram & Nation, 1982)

Bangs (1968)
Avenues of learning
1. Sensation
2. Perception
3. Memory-retrieval
4. Attention
5. Integration

Chalfant & Scheffelin (1969)
Auditory processing tasks
1. Attention to auditory stimuli
2. Sound vs. no sound
3. Sound localization
4. Discriminating sounds varying on one acoustic dimension
5. Discriminating sound sequences varying on several acoustic dimensions
6. Auditory figure-ground
7. Associating sounds with sound sources

Eisenson (1972)
Perceptual functions underlying language acquisition
1. Selectivity
2. Discrimination
3. Categorization
4. Perceptual defense
5. Proximal/distance reception
6. Sequencing

Weener (1974)
Basic components and measurement procedures of auditory processing
1. Echoic memory
    a. Duration
2. Discrimination
    a. Selective attention
    b. Phoneme and word discrimination
3. Structural analyzer
    a. Utilization of linguistic structure

TABLE 1 <u>continued</u>

Butler (1975)
Subcomponents of auditory perception
1. Auditory vigilance
2. Figure-ground
3. Auditory analysis
4. Auditory discrimination
5. Auditory sequencing
6. Sequencing unrelated sounds
7. Intonation patterns
8. Auditory closure
9. Auditory synthesis
10. Auditory memory
11. Auditory association

Wiig & Semel (1976)
Auditory-perceptual processing
1. Attention
2. Localization
3. Figure-ground
4. Discrimination of nonverbal stimuli
5. Discrimination of verbal stimuli
6. Sequencing
7. Synthesis
8. Segmentation and Syllabication

Sanders (1977)
Aspects of auditory processing
1. Awareness of acoustic stimuli
2. Localization
3. Attention
4. Differentiation between speech and nonspeech
5. Auditory discrimination
   a. Suprasegmental
   b. Segmental
6. Auditory memory
7. Sequencing
8. Auditory synthesis

integration of all processing skills is required for efficient comprehension and interpretation of spoken language.

Awareness of acoustic stimuli. Awareness of the presence or absence of sound energy is the base level of all auditory processing (Sanders, 1977), providing the impetus for the auditory system to initiate sound processing. One of the first skills acquired, awareness of environmental sounds is present at birth (Barr, 1972, 1976; Semel, 1976; Wiig & Semel, 1980) and by one month of age, awareness of speech sounds is apparent (Barr, 1972, 1976; Wiig & Semel, 1980).

Localization. The next perceptual processing state is localization of non-speech and speech stimuli (Sanders, 1977). At approximately four months, infants begin to localize sound by searching with their eyes for sounds of a bell or a rattle (Barr, 1972, 1976; Wiig & Semel, 1980). By seven months, they begin to localize their mother's voices, searching for the sound source with head movements (Barr, 1972, 1976). Normal infants turn their heads toward sudden noise, interrupting their play activities and staring attentively, as if trying to place the direction of particular sounds (Semel, 1976).

Sanders (1977) believes that the acquisition of spoken language requires the child to associate a particular pattern of acoustic stimuli, generated vocally by a speaker, first with concrete values (persons, things or events) and later with abstract values (ideas). This skill grows out of the ability to localize the sound generating source and to link the properties of the acoustic event to the properties of the object giving rise to the event (Sanders, 1971).

Attention. Auditory attention, the ability to direct and sustain attention to sounds (Semel, 1976), includes the ability to select a relevant stimulus from a background of irrelevant stimuli and to continue to attend selectively to this stimulus for an appropriate length of time (Sanders, 1977). The normal system is protected from being overwhelmed through the mechanism of selective processing. In order for children to perceive a given message, they must be able to follow its developing pattern over time against a background of ongoing activity in the same medium. The maintenance of the desired figure-ground relationship involves both the selective process of focusing attention and sustaining that focus for as long as it is necessary to identify and evaluate the stimulus (Sanders, 1977). Attention must be focused and then held.

The development of auditory attention takes place in the form of increasing active participation by the child in the attention process (Hagen & Hal; cited in Sanders, 1977). As children increase in age so do their attending skills. Those children who do not develop adequate attention strategies may show some cognitive problems.

Differentiation between speech and nonspeech. In the next stage, the differentiation between speech and nonspeech takes place. An early and critical decision to be made in processing the auditory stimulus is whether it is to be analyzed in a speech or nonspeech mode. The interrelationship between the various stages of processing is illustrated by the fact that, while speech perception is dependent upon the initial speech/nonspeech decision, that decision itself rests on the ability to process the signal as speech. Once the mode of processing has been chosen in favor of speech, the figure-ground relationship of speech versus nonspeech sounds can be maintained.

Auditory discrimination. The task of differentiating between auditory patterns, commonly referred to as auditory discrimination is the next stage in Sanders' (1977) processing schema. Sanders (1977) stated that discrimination between auditory patterns is made on the basis of one or more perceptual variants. At the phonological level, sound patterns of various lengths and complexity differ initially in the acoustic information they yield, but even more importantly in their structural, linguistic nature (Sanders, 1977). To differentiate between patterns necessitates awareness, focal attention, storage and sequencing competency. The actual discrimination can occur only after the pattern has been internally synthesized, and then compared with the internal model and categorized.

The ability to discriminate perceptually emerges very early. Sanders (1977) reported Moffitt's (1971) study as the first important study in the history of infant speech perception. Moffitt (1971) showed that infants as young as six weeks, could discriminate auditorily /ba/ versus /ga/ when the only acoustic difference was in the second formant transition of each.

Sanders (1977) categorizes discrimination into suprasegmental and segmental discrimination. Suprasegmental information includes intonation, stress and juncture patterns. Children learn to use the suprasegmental information as cues to the syntactical structure of the language.

Discrimination of the segmental components of speech, like that of the suprasegmental elements, calls for analysis of variations in patterns. Such differential discriminations may be made at the syntactic level, at the morphological level, or at times at the phonemic level (Sanders, 1977). Most of the time, processing shifts between levels, varying as a function of internal redundancy. Therefore, the concept of auditory discrimination of speech should not be limited to the differentiation and identification of phonemes.

Speech is a continuum. Perception involves the ability to identify patterns within that continuum. Auditory discrimination of meaningful speech must be predicted by familiarity with those rules in operation. It must involve suprasegmental and segmental discrimination and it requires the differentiation between syntactic and semantic patterns (Sanders, 1977).

Auditory memory. Auditory memory is the ability to store and retrieve heard information (Sanders, 1977; Semel, 1976). Because speech involves the spatiotemporal encoding of information, at no time do children have the total pattern before them. The time factor necessitates that in receptive processing the internal representation of the acoustic event be held in storage as it is progressively resynthesized. Because the retention capacity of long-term memory appears to be limited to between five and nine units, "chunking" of components into larger, meaningful units is necessary (Sanders, 1977). These phonetic chunks can then be restructured into other chunks of a higher linguistic order, turning patterns of phonemes into morphemes, patterns of morphemes into words and words into sentence components.

Sequencing. Auditory sequencing is the ability to recognize the order in which sounds and words are heard (Sanders, 1977). Sounds, words, phrases and sentences are not generally heard or learned in isolation. Accurate auditory sequencing requires that the child analyze a series of sounds and words or a rhythmic pattern and synthesize the sounds or pattern into the correct order (Semel, 1976). The order of the units comprises an important constraint in determining meaning.

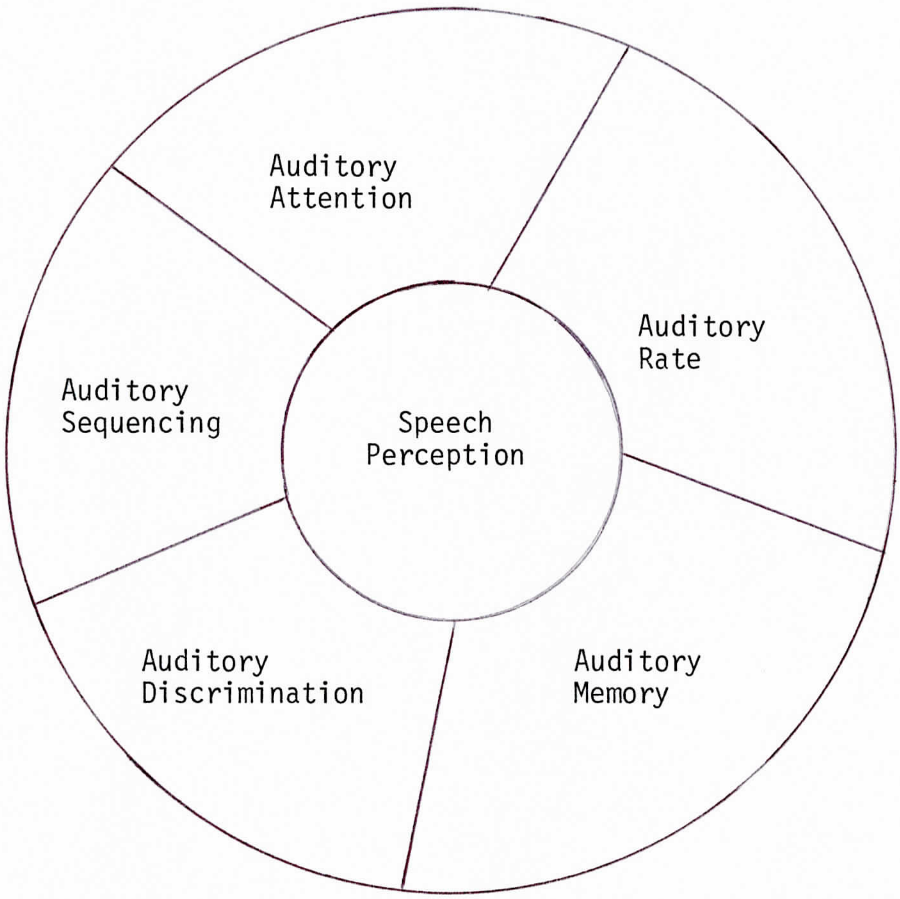
Auditory synthesis. Sanders' (1977) final stage of perceptual processing is auditory synthesis. Because the acoustic signal generates a continuous stream of information, it is necessary for the auditory system to restructure the data into segmental units. This analysis of the components of the speech pattern is followed by synthesis of the segments into larger, more meaningful units at a higher level until the semantic whole has finally been restructured into the various sized chunks which permit the identification of the total pattern (Sanders, 1977).

All the stages of auditory processing are constantly shifting and blending so that children may arrive at an understanding of the heard sentence, including its connotations and subtleties (Semel, 1976). In order to achieve comprehension, it is necessary to consider context, to redefine words with multiple meanings and to abstract the pertinent parts from the whole, as well as to understand individual words and their syntactical relationships.

Factors Which Affect Processing

Aram and Nation (1982) have singled out five auditory operations which may contribute to auditory processing disruptions and to child language disorders. The five operations, auditory attention, auditory discrimination, auditory sequencing and auditory rate, are represented in Figure 1 as a circle to discourage viewing them as hierarchical stages (Aram & Nation, 1982). More than likely, these are simultaneous operations, interrelated in a complex and continuous manner. It is not the writer's intention to imply that one operation supercedes the others in importance but, for the purposes of the present investigation, the operation of auditory rate as it relates to syntactic comprehension has been singled out for study.

Auditory attention. Attention as an auditory phenomenon usually incorporates such concepts as selective attention, the ability to ignore irrelevant auditory stimuli and to separate figure ground relationships (Aram & Nation, 1982). When listening to speech, children must learn to separate the important auditory speech signals from any ambient, interfering background stimuli. It has been noted that many children with language problems exhibit difficulty with selective listening. These children may function acceptably in ideal listening conditions, but they manifest



Figures 1. Auditory Operations (Aram & Nation, 1982)

difficulty in conditions of acoustic distortion, visual distraction and other kinds of confusion.

Sanders (1977) indicated that environmental noise levels in normal classrooms are surprisingly high, particularly in the early grades. Language-impaired children with auditory attention problems may exhibit unusual levels of distractability in response to competing environmental noise. They may show behavioral symptoms which include apparent unawareness that they have been spoken to, or failure to persevere with a listening task for more than a few minutes (Sanders, 1977).

Sanders (1977) concluded that when normal control of the focus is impaired, or when the span is inadequate, the perception of speech and the processing of both receptive and expressive forms of language may be affected.

Auditory discrimination. That children with language disorders present discrimination difficulties has been a long standing assumption based on the clinical impressions of the writers who have addressed child language disorders (Eisenson, 1972; Johnson & Myklebust, 1967; Wiig & Semel, 1976). Models of speech and language processing have assumed that auditory discrimination must be intact for the normal development and processing of language (Aram & Nation, 1982). In such models, hierarchical auditory stages are proposed. Information must first traverse a discrimination process before feeding information forward for language processing. Thus, errors in auditory discrimination would be passed on to language processes and be reflected in language usage.

Therefore, a disruption in auditory discrimination may be associated with the phonemic level and/or the semantic/syntactic levels of processing. Children with discrimination problems appear to have difficulty forming and distinguishing between perceptual categories (Aram & Nation, 1982).

Auditory memory. The production of a speech sound takes time. The time factor necessitates that in receptive processing the internal representation of the acoustic event be held in storage as it is progressively resynthesized (Sanders, 1977). Deprived of the ability to "chunk" words into larger grammatical units, language-impaired children are faced with an overload situation. Therefore, instead of being able to process a limited number of logical auditory language units, these children have to attempt to retain a long string of single sounds or words, a task beyond the capacity of their short-term memory system. For this reason, some language-impaired children exhibit no difficulty in processing single words or two-word phrases, but may be unable to retain the earlier components of longer phrases for sufficient duration to be able to determine the whole pattern. Thus, language-impaired children with symptoms of auditory memory dysfunction may be unable to repeat orally or motorically an event involving more than two or three components. At a more advanced level, they may be unable to follow directions involving more than one component.

Auditory sequencing. A disorder in the perception of temporal sequence has long been suggested as a causal basis for developmental language disorders (Aram & Nation, 1982). Some children can recall the components of a pattern, but are unable to remember the order. The order of the units comprises an important constraint in determining meaning. For language-impaired children, sequencing difficulties may take the form of sound reversals or reordering, and may occur in compound words, or in combinations of words. Although some of these patterns may be acceptable at early stages of language development, their persistence beyond these stages is indicative of language processing difficulty.

Auditory rate. There are those children whose chief perceptual problem is adapting to the rate at which speech stimuli are presented (Aram & Nation, 1982). Some language-impaired children are unable to adequately process rapidly incoming acoustic information, though they may be able to deal with slower auditory signals (Lubert, 1981). Those working with language-impaired children and adults have long noted that the rate of presentation of auditory information seems to be a variable which contributes to the client's ability to understand what is said. Therefore, if language-impaired children are characterized by an impaired rate of processing for rapidly changing acoustic information, it appears that an obvious treatment implication would be to slow down the signal to facilitate its perception. A procedure that is widely used in research but is not yet prevalent in clinical practice is the electromechanical method of producing time-altered speech.

Time-Altered Speech

Techniques Used For Time-Altering Speech

Time-altered speech may take one of two forms. Recorded speech that is reproduced in less time than the time required for its original production can be regarded as having been compressed in time (Foulke, 1970) and is often called time-compressed speech, or simply compressed speech. Since reproducing recorded speech in less time than the time required for its original production results in an increase in word rate, it is sometimes called accelerated speech (Foulke, 1970). When recorded speech is slowed down, the recording time is increased or expanded resulting in speech called time-expanded speech.

There are several methods for increasing or decreasing the word rate of recorded speech. Each method imposes its own characteristic distortions.

Speaking rapidly. Increasing word rate by speaking rapidly does not require a recording apparatus like the other methods which will be presented. However, if the increased word rate that results from speaking rapidly is to be well-controlled, the speaker must be trained, and provided with feedback to regulate speaking rate (Foulke, 1970; Harwood, 1955; Nelson, 1948). When speakers attempt to operate their speech machinery at a rate that is much faster than normal, it begins to malfunction. The muscles involved in the articulation of speech sounds are made to respond too rapidly, therefore the coordination of their actions begin to deteriorate, with resulting errors in articulation. As speakers produce connected speech, the vocal intensity, vocal pitch and the amount and distribution of pause time is varied.

The speed changing method. The word rate of recorded speech may be changed simply by reproducing a tape or record at a different speed than the one used during recording. This procedure is called the speed changing method (Foulke, 1966, 1970) and has been examined in several experiments (Garvey, 1953; Kurtzrock, 1957). If the playback speed is slower than the recording speed, word rate is decreased and the speech is expanded in time. If the playback speed is increased, the word rate is increased, and the speech is compressed in time. When speech is accelerated in this manner, the frequency will be doubled, and vocal pitch raised one octave. This method only withstands moderate compression or expansion before intelligibility and comprehension are lost (Foulke, 1970).

The sampling method. In 1950, Miller and Licklider (cited in Foulke, 1970), demonstrated the signal redundacy in spoken words by deleting brief segments of the speech signal. This was accomplished by a switching arrangement which permitted a recorded speech signal to be turned off periodically during its reproduction. As long as these interruptions occurred at a frequency of ten times per second or more, the interrupted speech was easily understood. The intelligibility of monosyllabic words did not drop below 90 percent until 50 percent of the speech signal had been discarded. Thus, it appeared that a large portion of the speech signal could be discarded without serious disruption of communication. However, in Miller and Lickliders' (cited in Foulke, 1970) electronic chopping technique, the gaps in the speech record were not closed after chopping, therefore no acceleration was achieved. With these findings, it appeared possible that some means could be devised for removing the silent spaces, thus leaving an abbreviated speech record and an increased speech rate with no great losses in intelligibility (Garvey, 1953).

Garvey (1953) incorporated Miller and Lickliders' (cited in Foulke, 1970) findings in his chop-splice method. He reasoned that if the samples of a speech signal remaining after periodic interruption could be abutted in time, the result would be time-compressed intelligible speech without distortion in vocal pitch.

The chop-splice technique involved recording on a plastic base tape with a magnetic recorder. The standard pulling mechanism on the recorder was replaced with a larger capstan so that approximately 40 centimeters (standard is 19.5 centimeters) of tape per second passed the magnetic recording head, thus creating greater lengths of tape for the chopping technique (Garvey, 1953). The position of the words on the tape was determined by slowly passing the tape over the magnetic playback head of the recorder. The beginning and ending of each word was marked on the tape, and then the sections to be removed were marked and cut out. The ends of the remaining segments were then spliced together to form a new abbreviated speech pattern.

Garvey (1953) was able to obtain an acceleration of twice the original speed by removing every other centimeter of the record throughout the length of the speech record. After the tape was chopped, the abbreviated records were transcribed on a second intact tape. Garvey's (1953) method was too cumbersome and time consuming, but the success of the general approach was a step towards a more efficient technique.

In 1954, Fairbanks, Everitt and Jaeger published a description of an electromechanical apparatus for the time compression or expansion of recorded speech. In the Fairbanks' apparatus, a continuous tape loop passes over a record head placing the signal that is to be compressed on a storage loop. Next, the tape passes over the sampling wheel, which reproduces samples of the signal that had been recorded. It then passes over an erase head that removes the signal from the storage loop so that it can be re-recorded on the next cycle. The sampling wheel is a cylinder, with four playback heads embedded in it, flush with its curved surface, and equally spaced around the curved surface. The tape, in passing over the curved surface of the sampling wheel, makes contact with approximately one-quarter of its surface. When the sampling wheel is stationary and one of the heads is contacted by the moving tape, the signal on the tape is reproduced as recorded. However, when the apparatus is adjusted for some amount of compression, the sampling wheel begins to rotate in the direction of the tape motion. Under these conditions, each of the four heads, in turn, makes and then loses contact with the tape. Each head reproduces the signal on the portion of the tape with which it makes contact. As the sampling wheels rotates, it arrives at a position where one head loses contact with the tape. Each head reproduces the signal on the portion of the tape with which it makes contact. As the sampling wheel rotates it arrives at a position where one head loses contact with the tape as the preceding head makes contact, therefore the segment of tape that is wrapped around the sampling wheel between these two heads never makes contact with a reproducing head and is therefore not reproduced. The segment of tape that is eliminated from the reproduction in this manner is always the same length, one-quarter of the circumference of the sampling wheel. The amount of speech compression depends upon the frequency with which the tape segments are eliminated, and the frequency depends, in turn, upon the rotational speed of the sampling wheel (Foulke, 1970).

Speech may be expanded in time by reversing this process. The sampling wheel is rotated in a direction opposite to that of the storage loop, so that samples of the signal recorded on it are periodically repeated. The speed and direction of the four-head assembly are under the control of the operator.

Foulke (1970) mentioned two other speech compressors based on the Fairbanks et al. (1954) design. The speech compressor manufactured by Graham makes use of a storage loop. The temporal value of the samples that are discarded during compression can be varied by changing the speed of the storage loop. Operation of the Graham compressor requires two tape recorders, one to provide its input, and one to receive its output.

The other compressor developed by Springer (Foulke, 1970), relies on the same basic principle as that of Fairbanks et al.

(1954). However, in the Springer approach, the storage loop, the recorder head and the erase head have been eliminated. Previously recorded tape passes from a supply reel over the surface of the sampling wheel to a take-up reel. The tape is sampled in the same manner described by Fairbanks et al. (1954). Operation of a compressor of the Springer type requires a tape recorder to receive its output.

Foulke (1970) reported that a computer may also be used for compressing speech by the sampling method. In this approach, speech that has been transduced to electrical form, for example, the output of a microphone or tape reproducing head, is temporally segmented by an analog-to-digital converter, and the segments are stored in the computer. The computer samples these segments according to a sampling rule for which it has been programmed, for example, discard every third segment. The retained samples are abutted in time and fed to the input of a digital-to-analog converter, and the signal at the output of this converter, compressed in time, is appropriate for transduction to acoustical form again (Foulke, 1970).

Other methods for the time-alteration of speech. The technique of speech synthesis suggests another possibility for the production of accelerated speech (Foulke, 1970). The speech synthesizer generates an electrical analog of the acoustical materials needed for the construction of speech sounds. A program of rules is provided for generating these analogs for the proper durations,

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at the proper intensities, and in proper conjunction or sequence. These rules may be varied to produce speech at any desired rate.

Another method for the compression of speech is harmonic compression, an outgrowth of research conducted at Bell Laboratories (Foulke, 1970). By means of a bank of Bessel band-pass filters, energy in the speech signal is distributed among 36 contiguous frequency bands. The output of each filter is supplied to a frequency divider, which preserves its amplitude and phase relationships, while reducing its frequency by one-half. The output of the 36 filters is then combined by means of a summing amplifier. This combined signal may be directly transduced to acoustical form, or recorded on tape or disc for subsequent reproduction. When a record or tape containing recorded speech is reproduced at twice the recorded speed, the time required for its reproduction is halved, and the component frequencies of the signal recorded on it are doubled. Therefore, the result is speech, undistorted with respect to pitch, that is reproduced at twice the original word rate and in one-half the original time. With harmonic compression, the speech rate can not be expanded only compressed.

The time-alteration of speech for the present study was accomplished in a manner similar to the sampling method described by Fairbanks et al. (1954). This was the same method used by Nelson (1976), therefore it was chosen for the present study so that a direct comparison of results could be made between this investigation and Nelson's (1976).

Stimulus Materials Used With Time-Altered Speech

The stimulus materials most widely used in the earliest time-compressed studies included the phonetically balanced word lists and the Word by Picture Identification Index (Ross & Lerman, 1971). The words were compressed in time, usually by 0% (175 words per minute, wpm), 30% (275 wpm) and 60% (425 wpm) compression and presented one at a time to a listener. The listener's task was to reproduce the words orally or in writing. Intelligibility was determined through the use of an intelligibility score, which was a percentage of correctly identified words. These procedures were used with normal adults (Garvey, 1953; Stricht, 1968) and normal school-age children (Beasley, Maki & Orchik, 1976; Beasley, Schwimmer & Rintelmann, 1972) to establish normative data. Expansion was not examined in these studies.

Other studies used compression of technical passages (Fairbanks, Guttman & Miron, 1957a, 1957b, 1957c; Goldhaber, 1970; Goldhaber & Weaver, 1968; Nelson, 1948) and literary passages (Foulke, 1968; Friedman & Johnson, 1968; Harwood, 1955; Reid, 1968; Stricht, 1968) to assess listening comprehension in adults. These passages were compressed to the same degree as the previously mentioned studies and comprehension was measured through multiple choice questions following each passage.

Woodcock and Clark (1968), Thompson and Silverman (1977) and DeWeaver (1979) used narrative passages presented at different rates of expansion and compression to evaluate comprehension among elementary school children. Multiple choice questions were used to measure listening comprehension.

Other studies have dealt with the effect of time-altered speech on the school-age child's comprehension of sentences. The types of sentences used in these studies can be divided into two groups. One group included those sentences in which syntactic structure was held constant. McCrosky and Thompson (1973) kept the structure of their sentences constant, so that all were active declarative sentences. Bonvillian, Raeburn and Horan (1979) varied the word length of their sentences, yet the syntactic structure remained stable.

The other group of studies used sentences which increased in syntactic complexity (Berry & Erickson, 1973; McCroskey & Nelson, 1975; Nelson, 1976; Nelson & McCroskey, 1978). The sentences were either arranged in order of increasing difficulty or in two levels of difficulty ("less difficult" and "more difficult") based on the syntactic structure of the sentence. The order of sentence arrangement in these studies was based on the work of Fraser, Bellugi and Brown (1963) and Lee (1970, 1971).

Fraser et al. (1963) compared the comprehension of sentence structures to the production of the same structures with a group of twelve children between the ages of 37 and 43 months. For their sentences, they chose grammatical forms which eliminated redundancy and isolated a single grammatical variable. They found that certain grammatical contrasts were more difficult than others to comprehend and established an order of increasing difficulty:

affirmative/negative, singular/plural of third person possessive pronoun, subject/object in active voice, present progressive/future tense, singular/plural marked by is/are, present progressive/past tense, mass noun/count noun, singular/plural marked by inflection, subject/object in passive voice and indirect object/direct object.

In the development of the receptive portion of the <u>Northwestern Syntax Screening Test</u> (NSST), Lee (1971) patterned her sentence pairs after those of Fraser et al. (1963). The <u>NSST</u> uses grammatical features such as prepositions, personal pronouns, negatives, plurals, reflexive pronouns, verb tenses, subject-object identification, possessives, wh-questions, yes-no questions, passives and indirect objects to assess comprehension. The sentence pairs have been arranged in order of increasing difficulty according to the performance of the 242 children used in the normative study.

Carrow, (1968) in developing the <u>Test for Auditory Comprehension of Language</u>, studied the auditory comprehension of language structure by children to obtain information about the sequence in which children learn to comprehend lexical and grammatical aspects of language. She found that mean language comprehension scores increased with age, with the greatest development of language comprehension occurring between the ages of 2-0 and 4-9. Further, some grammatical contrasts were more difficult to comprehend than others. Carrow (1968) noted that the children seemed to comprehend earlier those categories which were fundamentally unmarked and specified, such as present tense and singular number, but they had more difficulty with grammatical contrasts which were derived and marked such as past, future tense and plural number.

The review of the literature revealed numerous developmental studies concerning the children's acquisition of expressive syntax. From these studies, major stages of development have been established. Wood (1976) has characterized the stages of syntactic development in children from start to finish from the standpoint of production, but since comprehension generally precedes production (Fraser et al., 1963) these stages would appear to correspond to the development of syntactic comprehension as well.

Wood (1976) proposed two stages which contain the sentence types used in the time-altered speech studies of Nelson (1976), McCroskey and Nelson (1975) and Nelson and McCroskey (1978). The structure stage is characterized by the use of complete subject-predicate structures and includes sentences of the "less difficult" type or simple active declarative sentences. Wood (1976) stated that this stage is typical of the child from two to three years. The operational changes stage is characterized by changes which are performed on basic sentence structure to form more complicated relationships. These sentence types are similar to the "more difficult" sentences used in the time-altered studies of Nelson (1976), McCroskey and Nelson (1975) and Nelson and McCroskey (1978). This stage occurs around two-and-a-half years to four years (Wood, 1976).

The studies focusing on the development of syntactic comprehension (Carrow, 1968; Fraser et al., 1963; Lee, 1970, 1971; Savin & Perchonock, 1965; Wood, 1976) supported the notion that language comprehension increased with age and certain grammatical contrasts were more difficult to comprehend than others.

Effects of Time-Altered Speech

The early studies of Garvey (1953), Stricht (1968), Beasley, Schwimmer and Rintelmann (1972) and Beasley, Maki and Orchik (1976) found that as speech was compressed, word intelligibility decreased both for adults and children. Other studies, such as Nelson (1948); Harwood (1955); Fairbanks et al. (1957a, 1957b, 1957c); Foulke (1968); Friedman and Johnson (1968); Goldhaber and Weaver (1968); Reid (1968); Stricht (1968) and Goldhaber (1970) found that compression of connected speech reduced listening comprehension in adults. The conditions of expansion were not addressed in any of these studies.

Recently, other studies have measured the effects of both compression and expansion on listening comprehension in children. These studies have investigated the performance of normal children and atypical children whose chief problems were either cognitive, linguistic, physical or dialectical.

Normal children. Woodcock and Clark (1968) evaluated differences in comprehension among elementary school children who listened to a narrative passage presented at different rates of expansion and compression. One hundred and sixty-two children at three IQ levels were drawn from the following populations: sixth grade students ranging in IQ from 74-98 ("Low IQ" group), fifth grade students with IQs ranging from 90-110 ("Average IQ" group) and third grade students with IQs ranging from 102-121 ("High IQ" group). All three groups were of comparable mental age, with all subjects falling within a range of 9 years 4 months to 11 years 3 months as measured by the Peabody Picture Vocabulary Test (Dunn, 1959).

The materials used in this study, three standardized listening passages concerning historical-legendary figures, were presented at speaking rates of 78, 128, 178, 228, 278, 328, 378 and 428 words per minute with 178 words per minute serving as the normal rate of speech. The first two passages were used for training and familiarization; the third was used for criterion data. Comprehension was measured by a multiple choice test presented at the end of the passage.

Results showed that the listening rates of 228 to 328 wpm were more efficient for learning and retention than the normal rate of 178 wpm. Subjects with lower IQs performed better at rates which were slower than the most efficient rates for subjects with higher IQs, however the exact rates were not specified.

Bonvillian, Raeburn and Horan in their 1979 study used sentence imitation to measure comprehension of twelve subjects between the ages of 3 years 4 months and 4 years 4 months. The stimuli, 24 sentences of varying word length (3, 6, 9 or 12 words in length), were read and taped at a rate of one, two or three words per second by the experimenter. These three rates represented fast (3 words per second), slow (1 word per second) and normal (2 words per second) speaking rates. The results showed that children were more successful in imitating shorter sentences than longer sentences and sentences spoken at a rate nearer their own (2 words per second).

Berry and Erickson (1973) noted that children in everyday situations were not likely to be exposed to a machine that expanded and compressed the speech signal. Therefore, they investigated the effects of speaking rate on auditory comprehension when rate was varied deliberately by a normal speaker.

One hundred subjects, 50 first graders and 50 second graders, listened to five recordings of the receptive portion of the Northwestern Syntax Screening Test (Lee, 1971), each at a different speaking rate: 2.6, 3.4, 4.7, 5.3 and 6.3 syllables per second (sps). The stimulus sentences were spoken by an adult female who varied and checked the accuracy of the speaking rate by using a hand-held stopwatch. The results revealed that comprehension was better at the two slowest rates of 2.6 sps and 3.4 sps than at the fastest rates of 4.7 sps and 6.3 sps.

Using a pictured sentence comprehension test, Nelson (1976) measured the effects of speaking rate, sentence difficulty and listener age and sex on sentence comprehension by normal children between the ages of 5 years 6 months and 9 years 6 months of age. Four groups of sentences, half comprising a "less difficult" group and half comprising a "more difficult" group were arranged in order of increasing difficulty as determined by Fraser et al. (1963) and confirmed by Lee (1971) and were presented at various speaking rates including: fast (4.9 sps), moderately fast (4.0 sps), moderately slow (3.3 sps) and slow (2.5 sps). Variations in speaking rate were accomplished with an Eltro Rate Changer similar to the one described by Fairbanks et al. (1954).

The results for the "less difficult" and "more difficult" sentences were presented at the slow rate (2.5 sps) and the fast rate (4.9 sps) for each age level are summarized in Table 2. Scores have been converted to mean percentages.

With the exception of sex, all main effects were statistically significant. Listener age significantly influenced comprehension, with improved comprehension occurring as age increased. Differences between the four age groups were significant except those between the 8- and 9-year olds. Variation in speaking rate was also found to have a significant effect on sentence comprehension with comprehension at the slowest rate (2.5 sps) being significantly different from that of the fast rate (4.9 sps) and the moderately slow rate (3.3 sps). The main effect of sentence difficulty was statistically significant as well as the interaction between sentence difficulty and age. Greater differentiation of sentence difficulty was observed at the younger levels.

Atypical children. McCroskey and Nelson (1975) used the same procedures and methods in Nelson's 1976 study to compare auditory comprehension of spoken sentences by 60 children with normal language skills and 60 with reading disorders. Each group was comprised of twenty 7-, 8- and 9-year olds.

TABLE 2

THE INFLUENCE OF RATE, AGE AND DIFFICULTY ON COMPREHENSION

	"Less Difficult"		"More Difficult"	
	slow	fast	slow	fast
6-year olds	79%	71%	59%	62%
7-year olds	89%	86%	81%	76%
8-year olds	95%	90%	84%	86%
9-year olds	96%	95%	93%	97%

Results indicated that when speaking rate and difficulty were pooled for the normal 7-, 8- and 9-year olds, the mean percent correct was 82, 90 and 92 respectively; while for the reading disordered children, the mean percent correct was 74, 82, and 84. The results of the effects of speaking rate when sentence difficulty and listener age were pooled are summarized in Table 3. Performance on the "less difficult" and "more difficult" sentences when age and group ability were pooled is summarized in Table 4.

McCroskey and Nelson (1975) concluded that the reading disordered students were less proficient in comprehending spoken language regardless of age, speaking rate, or sentence difficulty. When speaking rate and linguistic complexity were pooled, listener age had a significant effect on comprehension for both groups. The authors suggested that maturation across ages seven through nine led to improved auditory comprehension for both normal and reading disordered children. Although the trend for both groups to improve with age appeared to be approximately equal, the results appeared to portray a tendency for children with reading problems to perform less well at all ages.

Rate of speaking had no significant effect upon comprehension by the normal students; however, rate did have a significant effect on comprehension with the reading disordered subjects. The slowest rate (2.5 sps) yielded significantly better auditory comprehension for children with reading disorders.

The analysis of variance for the interaction of group with sentence difficulty also showed significant effects. Auditory

TABLE 3

THE INFLUENCE OF SPEAKING RATE ON GROUP COMPREHENSION

	Normal	Reading Disordered
slow	87%	83%
moderately slow	89%	81%
moderately fast	90%	75%
fast	85%	76%

TABLE 4

THE INFLUENCE OF DIFFICULTY AND AGE ON

GROUP COMPREHENSION

	Normal		Reading Disordered	
	"Less"	"More"	"Less"	"More"
7-year olds	91%	78%	84%	64%
8-year olds	93%	86%	97%	74%
9-year olds	94%	91%	86%	79%

comprehension improved at each age in relation to the level of sentence difficulty for both normal and reading impaired subjects.

Nelson and McCroskey (1978) replicated their 1975 study to determine the effect of time-altered Standard English (SE) on children whose major dialect was Black English (BE), using 80 BE speaking children and 80 SE speaking children. Subjects were divided into four age groups with 20 subjects at each of the following levels: 6-, 7-, 8- and 9-years.

The performance of the BE and SE speaking subjects, when sentences were presented at the slow rate (2.5 sps) and fast rate (4.9 sps) for each age level, is summarized in Table 5. Scores have been converted to mean percentages.

Nelson and McCroskey (1978) concluded that BE speaking children experienced greater difficulty comprehending standard English than SE speaking children but comprehension in both groups increased with age. The variable of speaking rate, however, made no significant difference in comprehension for the SE speaking children. These results were consistent with their 1975 study, but not with Nelson's 1976 study, in which speaking rate was observed to have a significant effect on comprehension in normal children. Speaking rate did affect the ability of BE speaking children to comprehend standard English with significantly poorer comprehension occurring at the most rapid rate (4.9 sps) in comparison to other rates.

The main effect of sentence difficulty was significant for both groups with an additional age and difficulty interaction

TABLE 5

THE INFLUENCE OF RATE AND AGE ON COMPREHENSION

FOR SE AND BE SPEAKERS

	Standard English		Black English	
	slow	fast	slow	fast
6-year olds	71%	70%	55%	54%
7-year olds	81%	81%	69%	62%
8-year olds	89%	90%	89%	75%
9-year olds	92%	91%	81%	76%

occurring for SE speakers but not for BE speakers. By the time SE speaking children reached age 7, there were no significant differences between them and the 8- and 9-year olds on the easier sentences, and for the 8- and 9-year olds, there were no longer differences in comprehension as a function of sentence difficulty and age. However, the BE speaking subjects at 8-years still showed significantly more errors on the "more difficult" sentences than the "less difficult" ones. Nelson and McCroskey (1978) suggested that optimum comprehension skills for the sentences tested were achieved among the SE speaking subjects by 8-years, but the BE speaking subjects still were developing proficiencies through age 9.

McCroskey and Thompson (1973) studied the effects of rate on comprehension of spoken messages by children with specific learning disabilities. Twenty children between 5 and 17 years of age who demonstrated a disability in comprehending spoken messages were subjects for the research. The stimuli, simple declarative sentences, were presented at five predetermined message rates, including two conditions of expansion (2.3 sps, 2.9 sps), a normal rate (3.6 sps) and two conditions of compression (5.0 sps, 6.8 sps). The experimenters found that rate did not influence the comprehension of the message when data from all subjects were pooled. However, an analysis of data from the ten youngest children, ages 5 years 1 month to 10 years 3 months, revealed significant differences in comprehension according to rate of speech though the specific rates affecting comprehension were not mentioned. It was speculated that the stimulus material may have been too easy for the oldest children, since it consisted of high probability and high frequency words, therefore their auditory processing capabilities may not have been taxed by the experimental task.

Blosser, Weidner and Deniro (1976) studied the effect of speech expansion on the presentation of receptive auditory tasks to 40 language-impaired and 40 normal children between the ages of 5 years 5 months and 8 years of age. The tasks consisted of Token Test (Noll, 1970) commands presented at 4 different rates, 3 rates of expansion (2.5 sps, 3.4 sps & 4.2 sps) and one normal rate (5.0 sps). Rate I was the slowest at 2.5 sps, followed by Rate II at 3.4 sps, Rate III at 4.2 sps and Rate IV at 5.0 which served as the normal criterion.

The results showed that performance scores as they related to sex and language ability were significant. Performance scores obtained by the LN group overall as well as by females and males individually decreased as the rate of speech increased. The optimal presentation rate for all subjects was up to 2.5 sps but the normal children's optimal presentation rate was up to 4.2 sps while the language-impaired children's presentation rate was up to 3.4 sps.

DeWeaver (1979) studied the comprehension of Talking Book material played at three speaking rates slow (123 wpm), normal (164 wpm) and fast (203 wpm), with 48 physically handicapped students in grades one through six. The results of a multiple choice test presented at the end of each passage showed that comprehension at 123 wpm was superior to 203 wpm. Differences between comprehension at either of the two other rates was not significant nor were age and reading ability found to be significant.

As previously mentioned, studies have found that variability in the comprehension of altered speech becomes more apparent as rates are increased and decreased from the norm. Blosser et al. (1976) believed this variability in comprehension was also related to age (Nelson, 1976), intelligence, stimulus parameters (Miron & Brown, 1968), linguistic factors (McCroskey & Thompson, 1973; Nelson, 1976) and the inability to discern and match language interrelationships (Feidman & Johnson, 1968).

In summarizing the literature, it has been noted that the auditory processing skills of language-impaired children may be inadequate for interpretation of spoken language (Barr, 1972, 1976; Sanders, 1977; Semel, 1976; Wiig & Semel, 1980). Aram and Nation (1982) have reported that rate of speech may cause a disruption in the auditory processing system of some language-impaired children.

With the development of equipment which can expand or compress recorded speech, with little of no pitch distortion (Fairbanks, et al. 1954), several investigations have attempted to study the effects of time-altered speech on comprehension in normal and atypical populations. While studies of normal populations have not demonstrated consistently the effects of time-altered speech on comprehension, results with atypical populations have shown conclusively that speaking rate does have a significant influence on comprehension. When speaking rate is decreased, comprehension increases. Few studies have used samples from the population with which this study is concerned--the language-impaired. More research in this area should lead to improvement in the effectiveness of therapy and recommendations for the classroom teacher through better definition of the specific effects of rate and sentence complexity on comprehension in the language-impaired population.

CHAPTER 3

METHODS AND PROCEDURES

The purpose of this study was to investigate the singular and interacting effects of speaking rate, sentence difficulty and listener age upon sentence comprehension by language-normal and language-impaired children between the ages of six and eight.

The analysis of variance (ANOVA) model for this study was a complex four-way mixed design with two variables representing independent groups and the other two variables representing repeated measures. The independent variables were language ability (language-normal and language-impaired) and age (six, seven and eight year olds). The repeated measures were sentence difficulty ("less difficult" and "more difficult") and speaking rate (slow, moderately slow, moderately fast and fast). Counterbalancing of the order of presentation of speaking rates was only partially achieved. Due to the availability of a single tape at the time of testing, only two orders were used instead of the four that were planned.

Subjects

The two groups of subjects in this study included one group of language-impaired children and one group of language-normal children.

Language-Impaired Group

The language-impaired group included thirty children, ten at each of three age levels, 6-years (plus or minus 4 months), 7-years (plus or minus 4 months) and 8-years (plus or minus 4 months). At the time of testing, all subjects were enrolled in an elementary school program in Scotland County in North Carolina and were receiving speech and language therapy. Subjects were identified as language-impaired on the basis of depressed performance (1 SD below the mean) on the "Processing Word and Sentence Structure" subtest of the Clinical Evaluation of Language Function (CELF) (Semel & Wiig, 1980) and the clinical judgement of a speech, language and hearing clinician. The "Processing Word and Sentence Structure" subtest of the CELF (Semel & Wiig, 1980) identifies language-impaired children who demonstrate reduced comprehension of linguistic messages. Other criteria for selection included:

1. Normal intelligence (Age Deviation Score = 88 to 111) as measured by performance on the Columbia Mental Maturity Scale (CMMS) (Burgemeister, Blum & Lorge, 1972).

2. Absence of gross peripheral defects of audition or vision as determined by school records.

3. No previous history of psychosocial and/or neurological problems as determined by school records and teacher interview.

4. Native speakers of English from monolingual homes as determined by school records.

Tables 6, 7 and 8 present a descriptive summary of pertinent subject characteristics for the language-impaired group.

TABLE 6

SUBJECT CHARACTERISTICS FOR LANGUAGE-IMPAIRED 6-YEAR OLDS

SUBJECT	AGE IN MONTHS	SEX	CMMS (ADS)	CELF SUBTEST #1
1	75	M	89	24
2	69	F	96	24
3	69	F	111	24
4	74	F	94	24
5	74	M	99	28
6	75	M	96	20
7	75	M	95	26
8	76	M	92	20
9	71	M	95	26
10	68	F	111	24
RANGE	68-76		89-111	20-28
MEAN	72.3		97.8	24

CMMS = Columbia Mental Maturity Scale
ADS = Age Deviation Score
CELF = Clinical Evaluation of Language Function
SUBTEST #1 = Processing Word and Sentence Structure

TABLE 7

SUBJECT CHARACTERISTICS FOR LANGUAGE-

IMPAIRED 7-YEAR OLDS

SUBJECT	AGE IN MONTHS	SEX	CMMS (ADS)	CELF SUBTEST #1
1	80	M	111	28
2	81	M	91	24
3	88	F	99	30
4	86	M	92	30
5	81	M	94	28
6	87	F	91	30
7	82	M	89	24
8	82	F	97	26
9	82	F	94	24
10	82	M	89	26
RANGE	80-88		89-111	24-30
MEAN	83.1		94.7	27

CMMS = Columbia Mental Maturity Scale
ADS = Age Deviation Score
CELF = Clinical Evaluation of Language Function
SUBTEST #1 = Processing Word and Sentence Structure

TABLE 8

SUBJECT CHARACTERISTICS FOR LANGUAGE-

IMPAIRED 8-YEAR OLDS

SUBJECT	AGE IN MONTHS	SEX	CMMS (ADS)	CELF SUBTEST #1
1	92	M	96	32
2	99	M	95	35
3	92	M	90	30
4	92	M	111	36
5	99	M	90	30
6	92	F	90	30
7	92	M	97	36
8	99	F	89	32
9	95	F	89	33
10	99	F	102	32
RANGE	92-99		89-111	30-36
MEAN	95.1		94.9	32.6

CMMS = Columbia Mental Maturity Scale
ADS = Age Deviation Score
CELF = Clinical Evaluation Of Language Function
SUBTEST #1 - Processing Word and Sentence Structure

Language-Normal Group

The language-normal group included thirty children, ten at each of three age levels, 6-years (plus or minus 4 months), 7-years (plus or minus 4 months) and 8-years (plus or minus 4 months). At the time of testing, all subjects were enrolled in a public school setting in Scotland County in North Carolina. All subjects were judged language-normal on the basis of age appropriate performance on the "Processing Word and Sentence Structure" subtest of the CELF (Semel & Wiig, 1980) and clinical observation. Other criteria for selection were the same as for the language-impaired group. Tables 9, 10 and 11 present a descriptive summary of pertinent subject characteristics for the language-normal group.

Stimuli

A pictured sentence comprehension test patterned after the Imitation-Comprehension-Production Test (Fraser et al., 1963) and the Northwestern Syntax Screening Test (Lee, 1971) was used to measure comprehension. An example of one of the test plates is shown in Figure 2. The test consisted of 40 sentences divided into four syntactically matched groups, each containing different versions of the same sentence types arranged in order of increasing difficulty (Fraser et al., 1963; Lee, 1971). See Appendix A for a list of the 40 sentences.

For purposes of analysis, the first five sentences comprised the "less difficult" group, the second five the "more difficult" group. Those in the "less difficult" group were all simple active affirmative declarative sentences and required discrimination of

TABLE 9

SUBJECT CHARACTERISTICS FOR LANGUAGE-

NORMAL 6-YEAR OLDS

SUBJECT	AGE IN MONTHS	SEX	CMMS (ADS)	CELF SUBTEST #1
1	75	M	99	34
2	69	M	103	34
3	70	F	106	38
4	74	M	102	40
5	74	M	106	34
6	75	F	108	40
7	72	F	106	35
8	76	M	111	40
9	74	M	108	36
10	68	F	97	40
RANGE	68-76		97-111	34-40
MEAN	72.7		104.6	37.1

CMMS = Columbia Mental Maturity Scale
ADS = Age Deviation Score
CELF = Clinical Evaluation of Language Function
SUBTEST #1 - Processing Word and Sentence Structure

TABLE 10

SUBJECT CHARACTERISTICS FOR LANGUAGE-

NORMAL 7-YEAR OLDS

SUBJECT	AGE IN MONTHS	SEX	CMMS (ADS)	CELF SUBTEST #1
1	81	M	111	36
2	80	F	98	39
3	88	F	101	44
4	86	F	96	38
5	80	F	108	43
6	87	F	91	40
7	88	M	101	41
8	85	F	111	40
9	82	M	94	40
10	87	F	99	40
RANGE	80-87		91-111	36-40
MEAN	84.4		101	40.1

CMMS = Columbia Mental Maturity Scale
ADS = Age Deviation Score
CELF = Clinical Evaluation of Language Function
SUBTEST #1 = Processing Word and Sentence Structure

TABLE 11

SUBJECT CHARACTERISTICS FOR LANGUAGE-

NORMAL 8-YEAR OLDS

SUBJECT	AGE IN MONTHS	SEX	CMMS (ADS)	CELF SUBTEST #1
1	98	F	99	44
2	99	F	108	46
3	96	M	92	45
4	97	M	111	45
5	99	M	97	46
6	98	F	102	44
7	92	M	100	42
8	99	M	98	42
9	97	F	94	42
10	99	F	111	46
RANGE	92-99		92-111	42-46
MEAN	97.4		101.2	44.2

CMMS = Columbia Mental Maturity Scale
ADS = Age Deviation Score
CELF = Clinical Evaluation of Language Function
SUBTEST #1 - Processing Word and Sentence Structure

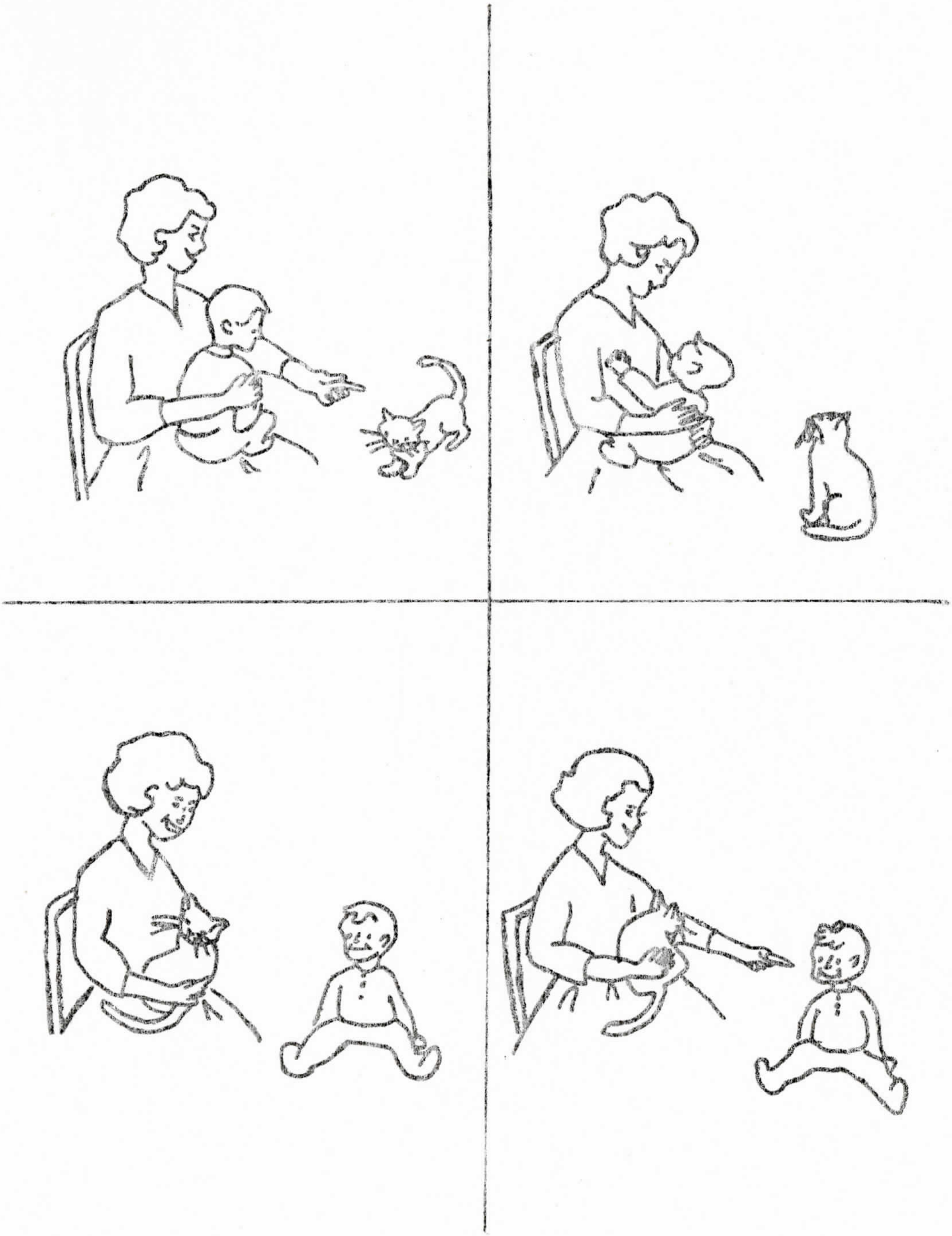


Figure 2. Test Plate

such features as number marked by the auxiliary "is/are" only, or person and number marked on nominative and genitive personal pronouns. The "more difficult" group included embedded and passive sentences and required discrimination of number marked by single bound morphemes and discrimination of accusative/dative relationships.

The variation in speaking rate was accomplished with an Eltro Rate Changer, similar to the one described by Fairbanks et al. (1954). Using the Eltro Rate Changer, it was possible to produce a rate-altered tape which was played on a Wollensak portable reel-to-reel tape player. The rates expressed as syllables per second (sps) values or as a percentage of normal message time (3.5 sps in this study) (Nelson, 1976), were "fast" (4.9 sps, 70%), "moderately fast" (4.0 sps, 83%), "moderately slow" (3.3 sps, 103%) and "slow" (2.5 sps, 135%).

Method

The 6-year old subjects were tested in groups of three and the 7- and 8-year old subjects were tested in groups of four in a classroom used by the speech-language clinician. The recorded stimuli were played from a central location and were clearly audible in all seating positions.

All subjects heard each of the four groups of sentences at a different speaking rate. Response choices were indicated by marking one picture from a set of four in individual response booklets. Practice items preceded the test stimuli to insure that all children understood the procedure. See Appendix B for tape-recorded instructions.

Each group required approximately 15 minutes for administration, but no time limit was imposed. The tape recorder was stopped when any child was seen to require more time than the seven second response pause after each test item. No segment of the recorded stimuli was repeated.

Subjects were randomly assigned to listen to one of two speaking rate orders. The first order of speaking presentation was moderately slow, slow, moderately fast and fast, the second order was slow, moderately fast, fast and moderately slow. Equal inter-stimulus intervals of seven seconds were maintained throughout the test. This was done to produce a constant response time between each sentence. Such a provision prevented comprehension of expanded sentences from being given the added advantage of a longer interval in which to make a choice.

The response booklets were hand-scored within one week after testing. Each picture marked correctly was given one point. The total number of correct responses was obtained for each group of sentences at each of the four speaking rates. The scores were then transferred to computer coding sheets and submitted to appropriate statistical analysis using the Biomedical Computer Program-P series (1979) through the computer system at Appalachian State University.

CHAPTER 4

RESULTS AND ANALYSIS

Assumptions Underlying Design of Study

The analysis of variance (ANOVA) model for repeated measures used in this study was a complex four-way mixed design. This repeated-measures mixed-model ANOVA has two conditions called assumptions of compound symmetry which must be met before the analysis is justified.

1. The first assumption, homogeneity of within treatment variance, requires equal variability of scores within each group.

2. The second assumption which is sufficient but not necessary is homogeneity of covariance between pairs of treatments. This condition requires that the correlation between any two treatments be equal.

The test for compound symmetry was not met between groups on the repeated measure of rate, therefore Levene's test for equality of variance was used to retest the first assumption (Glass & Stanley, 1970). Levene's test is a one-way analysis of variance on the absolute values of the difference between each observation and the mean of its group. Levene's test showed homoegeneity of within treatment variance, therefore the first assumption was met and the analysis was justified.

Statement of the Hypotheses

To give direction to the data analysis the following hypotheses were developed and tested at the .05 level of significance.

Ho. 1 There is no significant difference in the comprehension of "less difficult" sentences among 6-, 7- and 8-year old language-normal children.

1.1 There is no significant difference in the comprehension of "less difficult" sentences between 6- and 7-year old language-normal children.

1.2 There is no significant difference in the comprehension of "less difficult" sentences between 6- and 8-year old language-normal children.

1.3 There is no significant difference in the comprehension of "less difficult" sentences between 7- and 8-year old language-normal children.

Ho. 2 There is no significant difference in the comprehension of "more difficult" sentences among 6-, 7- and 8-year old language-normal children.

2.1 There is no significant difference in the comprehension of "more difficult" sentences between 6- and 7-year old language-normal children.

2.2 There is no significant difference in the comprehension of "more difficult" sentences between 6- and 8-year old language-normal children.

2.3 There is no significant difference in the comprehension of "more difficult" sentences between 7- and 8-year old language-normal children.

Ho. 3 There is no significant difference in the comprehension of "less difficult" sentences among 6-, 7- and 8-year old language-impaired children.

3.1 There is no significant difference in the comprehension of "less difficult" sentences between 6- and 7-year old language-impaired children.

3.2 There is no significant difference in the comprehension of "less difficult" sentences between 6- and 8-year old language-impaired children.

3.3 There is no significant difference in the comprehension of "less difficult" sentences between 7- and 8-year old language-impaired children.

Ho. 4 There is no significant difference in the comprehension of "more difficult" sentences among 6-, 7- and 8-year old language-impaired children.

4.1 There is no significant difference in the comprehension of "more difficult" sentences between 6- and 7-year old language-impaired children.

4.2 There is no significant difference in the comprehension of "more difficult" sentences between 6- and 8-year old language-impaired children.

4.3 There is no significant difference in the comprehension of "more difficult" sentences between 7- and 8-year old language-impaired children.

Ho. 5 There is no significant difference between language-normal children's ability to comprehend "less difficult" sentences when presented at four speaking rates: slow, moderately slow, moderately fast and fast.

5.1 There is no significant difference between language-normal children's ability to comprehend "less difficult" sentences when presented at a slow versus a fast speaking rate.

5.2 There is no significant difference between language-normal children's ability to comprehend "less difficult" sentences when presented at a moderately slow versus a fast speaking rate.

5.3 There is no significant difference between language-normal children's ability to comprehend "less difficult" sentences when presented at a moderately fast versus a fast speaking rate.

5.4 There is no significant difference between language-normal children's ability to comprehend "less difficult" sentences when presented at a moderately slow versus a slow speaking rate.

5.5 There is no significant difference between language-normal children's ability to comprehend "less difficult" sentences when presented at a slow versus a moderately fast speaking rate.

5.6 There is no significant difference between language-normal children's ability to comprehend "less difficult" sentences when presented at a moderately slow versus a moderately fast speaking rate.

Ho. 6 There is no significant difference between language-normal children's ability to comprehend "more difficult" sentences when presented at four speaking rates: slow, moderately slow, moderately fast and fast.

6.1 There is no significant difference between language-normal children's ability to comprehend "more difficult" sentences when presented at a slow versus a fast speaking rate.

6.2 There is no significant difference between language-normal children's ability to comprehend "more difficult" sentences when presented at a moderately slow versus a fast speaking rate.

6.3 There is no significant difference between language-normal children's ability to comprehend "more difficult" sentences when presented at a moderately fast versus a fast speaking rate.

6.4 There is no significant difference between language-normal children's ability to comprehend "more difficult" sentences when presented at a moderately slow versus a slow speaking rate.

6.5 There is no significant difference between language-normal children's ability to comprehend "more difficult" sentences when presented a slow versus a moderately fast speaking rate.

6.6 There is no significant difference between language-normal children's ability to comprehend "more difficult" sentences when presented at a moderately slow versus a moderately fast speaking rate.

Ho. 7 There is no significant difference between language-impaired children's ability to comprehend "less difficult" sentences when presented at four speaking rates: slow, moderately slow, moderately fast and fast.

7.1 There is no significant difference between language-impaired children's ability to comprehend "less difficult" sentences when presented at a slow versus a fast speaking rate.

7.2 There is no significant difference between language-impaired children's ability to comprehend "less difficult" sentences when presented at a moderately slow versus a fast speaking rate.

7.3 There is no significant difference between language-impaired children's ability to comprehend "less difficult" sentences when presented at a moderately fast versus a fast speaking rate.

7.4 There is no significant difference between language-impaired children's ability to comprehend "less difficult" sentences when presented at a moderately slow versus a slow speaking rate.

7.5 There is no significant difference between language-impaired children's ability to comprehend "less difficult" sentences when presented at a slow versus a moderately fast speaking rate.

7.6 There is no significant difference between language-impaired children's ability to comprehend "less difficult" sentences when presented at a moderately slow versus a moderately fast speaking rate.

Ho. 8 There is no significant difference between language-impaired children's ability to comprehend "more difficult" sentences when presented at four speaking rates: slow, moderately slow, moderately fast and fast.

8.1 There is no significant difference between language-impaired children's ability to comprehend "more difficult" sentences when presented at a slow versus a fast speaking rate.

8.2 There is no significant difference between language-impaired children's ability to comprehend "more difficult" sentences when presented at a moderately slow versus a fast speaking rate.

8.3 There is no significant difference between language-impaired children's ability to comprehend "more difficult" sentences when presented at a moderately fast versus a fast speaking rate.

8.4 There is no significant difference between language-impaired children's ability to comprehend "more difficult" sentences when presented at a moderately slow versus a slow speaking rate.

8.5 There is no significant difference between language-impaired children's ability to comprehend "more difficult" sentences when presented at a slow versus a moderately fast speaking rate.

8.6 There is no significant difference between language-impaired children's ability to comprehend "more difficult" sentences when presented at a moderately slow versus a moderately fast speaking rate.

Ho. 9 There is no significant difference between language-normal children's ability to comprehend "less difficult" and "more difficult" sentences.

Ho.10 There is no significant difference between language-impaired children's ability to comprehend "less difficult" and "more difficult" sentences.

Ho. 11 There is no significant difference in the comprehension of "less difficult" sentences between language-normal and language-impaired children.

Ho. 12 There is no significant difference in the comprehension of "more difficult" sentences between language-normal and language-impaired children.

Ho. 13 There is no significant interaction between age and language ability.

Ho. 14 There is no significant interaction between rate and age.

Ho. 15 There is no significant interaction between rate and language ability.

Ho. 16 There is no significant interaction between rate, age and language ability.

Ho. 17 There is no significant interaction between sentence difficulty and age.

Ho. 18 There is no significant interaction between sentence difficulty and language ability.

Ho. 19 There is no significant interaction between sentence difficulty, age and language ability.

Ho. 20 There is no significant interaction between rate and sentence difficulty.

Ho. 21 There is no significant interaction between rate, sentence difficulty and age.

Ho. 22 There is no significant interaction between rate, sentence difficulty and language ability.

Ho. 23 There is no significant interaction between rate, sentence difficulty, age and language ability.

Results

Individual raw scores are included in Appendix C and further summarized in Table 12, which reports the means and standard deviations obtained for each rate as a function of complexity for each age group. The language-normal (LN) 6-year olds' raw scores ranged from 10 to 15 on the "less difficult" sentences, with a combined mean level of performance for all rates averaged together of 3.18. The individual means for the slow, moderately slow, moderately fast and fast speaking rates were 3.4, 2.8, 3.4 and 3.1 respectively. On the "more difficult" sentences, the LN 6-year olds' scores ranged from 11 to 16 with a combined mean level performance of 3.18. The individual means for the four speaking rates in the order mentioned above, were 3.2, 2.9, 3.4 and 3.2.

The LN 7-year olds' raw scores ranged from 9 to 17 on the "less difficult" sentences, with a combined mean level of performance of 3.4. The individual means for the four speaking rates were 3.9, 3.1, 4.0 and 2.6. On the "more difficult" sentences, the LN 7-year olds' raw scores ranged from 13 to 19 with a combined mean level of performance of 3.85. The individual means for the four speaking rates were 3.8, 3.4, 4.6 and 3.6.

The LN 8-year olds' raw scores on the "less difficult" sentences ranged from 11 to 18, with a combined mean level of

TABLE 12

PERFORMANCE OF THE LANGUAGE-NORMAL AND LANGUAGE-IMPAIRED GROUPS AS A FUNCTION OF AGE, RATE AND DIFFICULTY

		6-Year Olds (n=20)				7-Year Olds (n=20)				8-Year Olds (n = 20)			
		Less Difficult		More Difficult		Less Difficult		More Difficult		Less Difficult		More Difficult	
	Rate	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
Language-Normal (n=30)	1	3.40	1.08	3.20	1.03	3.90	.74	3.80	.92	3.60	.70	4.50	.85
	2	2.80	1.23	2.90	1.10	3.10	.99	3.40	1.27	3.20	.79	3.80	1.23
	3	3.40	1.27	3.40	1.08	4.00	1.41	4.60	.52	3.90	.88	4.60	.70
	4	3.10	.99	3.20	.79	2.60	.97	3.60	1.17	2.80	1.32	4.40	.70
	Combined	3.18	.29	3.18	.21	3.40	.67	3.85	.53	3.38	.48	4.33	.36
Language-Impaired (n=30)	1	2.30	1.42	2.70	1.16	2.70	.95	3.10	1.29	3.60	1.35	3.20	1.32
	2	2.90	.74	1.80	1.03	2.30	.82	2.10	1.20	3.20	1.40	2.80	1.23
	3	3.10	1.10	2.40	.70	2.30	.82	2.30	1.42	2.50	1.08	4.00	.82
	4	1.80	1.14	1.90	1.10	2.50	.85	2.40	1.58	3.10	.88	3.00	1.63
	Combined	2.53	.59	2.20	.43	2.45	.19	2.48	.43	3.10	.45	3.25	.53

Rate 1 = slow (2.5 sps)
Rate 2 = moderately slow (3.3 sps)
Rate 3 = moderately fast (4.0 sps)
Rate 4 = fast (4.9 sps)

performance of 3.38. The individual mean for the four speaking rates were 3.6, 3.2, 3.9 and 2.8. On the "more difficult" sentences, the LN 8-year olds' raw scores ranged from 13 to 20, with a combined mean level of performance of 4.33. The individual means for the four speaking rates were 4.5, 3.8, 4.6 and 4.4.

The language-impaired (LI) 6-year olds' raw scores ranged from 8 to 13 on the "less difficult" sentences, with a combined mean level of performance of 2.53. The individual means for the four speaking rates, presented in the same order as mentioned previously, were 2.3, 2.9, 3.1 and 1.8. On the "more difficult" sentences, the LI 6-year olds' raw scores ranged from 6 to 12, with a combined mean level of performance of 2.2. The individual means for the four speaking rates were 2.7, 1.8, 2.4 and 1.9.

The LI 7-year olds' raw scores on the "less difficult" sentences ranged from 8 to 13, with a combined mean level of performance of 2.45. The individual means for the four speaking rates were 2.7, 2.3, 2.3 and 2.5. On the "more difficult" sentences, the LI 7-year olds' raw scores ranged from 5 to 13, with a combined mean level of performance of 2.48. The individual means for the four speaking rates were 3.1, 2.1, 2.3 and 2.4.

The LI 8-year olds' raw scores on the "less difficult" sentences ranged from 9 to 15, with a combined mean score of 3.10. The individual means for the four speaking rates were 3.6, 3.2, 2.5, and 3.1. On the "more difficult" sentences, the LI 8-year olds' raw scores ranged from 10 to 19, with a combined mean level of performance of 3.25. The individual means for the four speaking rates were 3.2, 2.8, 4.0 and 3.0.

Data Analysis

The results as presented in Table 12 were submitted to an analysis of variance included in Table 13, which shows significant differences in total scores for both language-normal and language-impaired groups. Because of two, two-way interactions between difficulty and language ability and difficulty and age, it was not possible to use the total scores for purposes of comparison. Therefore, it was decided to analyze performance on the "less difficult" and "more difficult" sentences individually.

The assignment of sentences to the "more" or "less difficult" group was based on information from previous research (Nelson, 1976). For purposes of analysis, the test sentences were divided into two levels of difficulty, "less difficult" and "more difficult" which appeared to load the stimulus material in favor of finding significant differences in comprehension as a function of sentence difficulty. These data were analyzed using an ANOVA for repeated measures and resulted in a three-way interaction of difficulty, language ability and age (Table 14), precluding further analysis on the "less difficult" sentences. For this reason, the researcher elected to analyze only the "more difficult" sentences. Therefore, the following hypotheses were not tested: Ho. 1-1.3, Ho. 3-3.3, Ho. 5-5.6, Ho. 7-7.6, Ho. 9-11, Ho. 17-21 and Ho. 23. Furthermore, it is beyond the scope of this study to account for this interaction effect on the "less difficult" sentences, although general

TABLE 13

ANALYSIS OF VARIANCE FOR LANGUAGE ABILITY, AGE,

RATE AND DIFFICULTY VARIABLES

Source	*SS*	*df*	*MS*	*F*
Between Subjects:				
Language (L)	93.63	1	93.63	77.28*
Age (A)	45.25	2	22.63	18.68*
L + A	5.05	2	2.53	2.09
Error	65.43	54	1.21	
Within Subjects:				
Rate (R)	29.12	3	9.71	7.56*
R + L	4.82	3	1.61	1.25
R + A	1.55	6	.26	.20
R + L + A	10.55	6	1.76	1.37
Error	207.98	162	1.28	
Difficulty (D)	5.21	1	5.21	4.12*
D + L	8.01	1	8.01	6.33*
D + A	10.20	2	5.10	4.03*
D + L + A	1.25	2	.63	.50
Error	68.33	54	1.27	
R + D	5.34	3	1.78	1.71
R + D + L	4.84	3	1.61	1.55
R + D + A	4.80	6	.80	.77
R + D + L + A	12.35	6	2.06	1.98
Error	168.68	162	1.04	

*$p < .05$

TABLE 14

ANALYSIS OF VARIANCE FOR LANGUAGE ABILITY, AGE AND RATE ON THE "LESS DIFFICULT" SENTENCES

Source	SS	df	MS	F
Between Subjects:				
Language (L)	23.44	1	23.44	23.45*
Age (A)	6.76	2	3.38	3.38*
L + A	4.56	2	2.29	2.29
Error	53.96	54	1.00	
Within Subjects:				
Rate (R)	13.91	3	4.64	3.96*
R + L	7.48	3	2.49	2.13
R + A	4.48	6	0.75	0.64
R + L + A	14.66	6	2.44	2.09*
Error	189.73	162	1.17	

*$p < .05$

speculations as to the contamination of the "less difficult" sentences will be made in a later discussion.

The analysis of variance for the "more difficult" sentences is shown in Table 15. The results are discussed in reference to the two independent variables, language ability and age and the repeated measure variable of speaking rate.

Language Ability

The results of the analysis showed that language-impaired (LI) children experienced greater difficulty comprehending spoken language than the language-normal (LN) children. Differences between the LI and the LN groups were significant, $F\ (1, 54) = 52.94$, $p < .05$, resulting in the rejection of Ho. 12. A post hoc analysis using Duncan's Multiple Range Test (Glass & Stanley, 1970) revealed statistically significant differences between performance of the LN and LI groups at each of three age levels. In other words, the LN 6-year olds' comprehension was significantly better than that of the LI 6-year olds' as was the comprehension of the LN 7- and 8-year olds' in comparison to the LI 7- and 8-year olds'.

Age

Listener age had a significant effect on comprehension of spoken language for both the LN and LI groups, $F\ (2, 54) = 16.48$, $p < .05$, therefore Ho. 2 and Ho. 4 were rejected. Applying the Duncan's Multiple Range Test (Glass & Stanley, 1970) to the data, it was shown that both the 7- and 8-year old LN children's comprehension was significantly better than that of the 6-year old LN

TABLE 15

ANALYSIS OF VARIANCE FOR LANGUAGE ABILITY, AGE AND RATE ON THE "MORE DIFFICULT" SENTENCES

Source	SS	df	MS	F
Between Subjects:				
Language (L)	78.20	1	78.20	52.94*
Age (A)	48.70	2	24.35	16.48*
L + A	1.73	2	0.87	0.59
Error	79.78	54	1.48	
Within Subjects:				
Rate (R)	20.55	3	6.85	5.94*
R + L	2.18	3	0.73	0.63
R + A	1.87	6	0.31	0.27
R + L + A	8.23	6	1.37	1.19
Error	186.93	162	1.15	

*$p < .05$

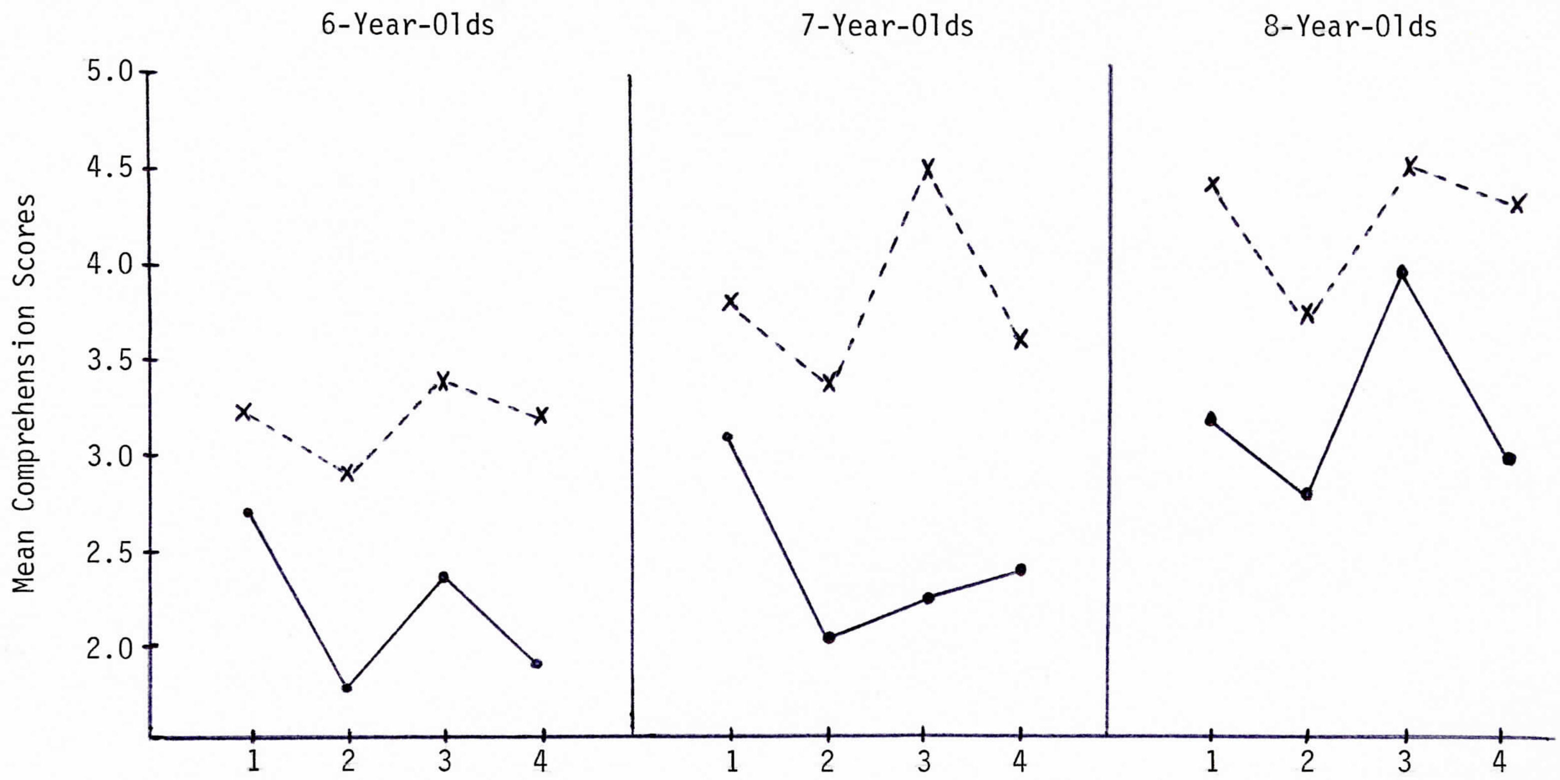
children resulting in the rejection of hypotheses 2.1 and 2.2. There was no significant difference in comprehension between 7- and 8-year old LN children so Ho. 2.3 was not rejected. With regard to the LI group, it was found that the 8-year old children's comprehension was significantly better than that of 6- and 7-year olds', therefore Ho. 4.2 and 4.3 were rejected. The 7-year old LI children's comprehension was not significantly better than the 6-year olds', therefore Ho. 4.1 was not rejected.

Speaking Rate

The main effect of speaking rate was found to be significant for the combined LN and LI groups, F (3, 162) = 5.94, $p < .05$, therefore Ho. 6 and Ho. 8 were rejected. The effects of speaking rate on comprehension for both groups according to age level is represented in Figure 3.

In view of the fact that the main effect for the four rates was significant for the LN and LI children, Duncan's Multiple Range Test (Glass & Stanley, 1970) was applied to the data to determine which rates were accounting for the significance.

Language-normal children. For the LN children, the analysis showed that the moderately fast rate was significantly different from the fast rate, F (1, 27) = 4.74, $p < .05$, with the moderately fast rate yielding significantly higher comprehension scores, therefore Ho. 6.3 was rejected. There were also significant differences in performance between age levels at the moderately fast speaking rate, with 7-year old LN children obtaining higher comprehension



Rate 1 = slow
Rate 2 = moderately slow
Rate 3 = moderately fast
Rate 4 = fast

x--x = language-normal
.-. = language-impaired

Figure 3. The Effects of Speaking Rate on Comprehension of "More Difficult" Sentences as a Function of Listener Age and Language Ability.

scores than 6-year old LN children and 8-year old LN children obtaining higher comprehension scores than 6-year old LN children.

The slow rate was significantly different from the moderately fast rate, $\underline{F}$ (1, 27) = 4.17, $\underline{p}$ < .05, with the moderately fast rate yielding significantly higher comprehension scores for LN children, and resulting in rejection of Ho. 6.5. The significant differences in performance between age levels for the moderately fast rate were the same as mentioned previously.

The moderately slow rate was significantly different from the moderately fast rate, $\underline{F}$ (1, 27) = 10.10, $\underline{p}$ < .05, with the moderately fast rate yielding significantly higher comprehension scores for LN children therefore, Ho. 6.6 was rejected. The significant differences in performance between age levels for the moderately fast rate were the same as mentioned previously. There were no significant differences in the slow versus fast rates, the moderately slow versus fast rates and the moderately slow versus slow rates for the LN children, therefore Ho. 6.1, 6.2 and 6.5 were not rejected.

<u>Language-impaired children</u>. For the LI children, the analysis showed that the slow rate was significantly different from the moderately slow rate, $\underline{F}$ (1, 27) = 4.61, $\underline{p}$ < .05, with the slow rate yielding significantly higher comprehension scores, therefore Ho. 8.4 was rejected. There were no significant differences between the age levels.

The moderately slow rate was significantly different from the moderately fast rate, $\underline{F}$ (1, 27) = 5.33, $\underline{p}$ < .05, with the moderately fast rate yielding significantly higher comprehension scores for the LI children, and resulting in rejection of Ho. 8.6. There were also significant differences in performance between age levels at the moderately fast speaking rate with 8-year old LI children obtaining higher comprehension scores than 6-year old LI children and 8-year old LI children obtaining higher comprehension scores than 7-year old LI children.

There were no significant differences in the slow versus fast rates, the moderately slow versus fast rates, the moderately fast versus fast rates or the slow versus moderately fast rates for LI children, therefore Ho. 8.1, 8.2, 8.3 and 8.5 were not rejected.

Interactions

There were no significant interactions in comprehension of the "more difficult" sentences between age and language ability, rate and age, rate and language ability or rate, age and language ability, therefore Ho. 13, Ho. 14, Ho. 15 and Ho. 16 were not rejected.

CHAPTER 5

SUMMARY AND CONCLUSIONS

Summary

The purpose of this study was to measure the singular and interacting effects of speaking rate, sentence difficulty and listener age on sentence comprehension by language-normal and language-impaired children between the ages of six and eight.

Subjects were thirty language-normal children and thirty language-impaired children, all monolingual speakers of average intelligence with no gross peripheral defects of audition or vision.

A pictured sentence comprehension test patterned after the Imitation-Comprehension-Production Test (Fraser et al., 1963) and the Northwestern Syntax Screening Test (Lee, 1971) was used to measure comprehension. The test consisted of forty sentences divided into four syntactically matched groups, each containing different versions of the same sentence types arranged in order of increasing difficulty (Fraser et al., 1963; Lee, 1971). For purposes of analysis the first five sentences comprised the "less difficult" group, the second five the "more difficult" group. These sentences were presented at four speaking rates expressed as syllables per second including: fast (4.9 sps), moderately fast (4.0 sps), moderately slow (3.3 sps) and slow (2.5 sps). The variation in speaking rate was accomplished with an Eltro Rate Changer. Response choices were indicated by marking one picture from a set of four in individual response booklets.

The variables in the experimental design included two groups, three age classifications, four rates and two difficulty levels. Data were analyzed with an analysis of variance for repeated measures (BMDP, 1979).

The influence of sentence difficulty on language comprehension in LN and LI children was not clearly resolved in this study. Results of the analysis of variance showed two, two-way interactions between difficulty and language ability and difficulty and age when total scores ("less difficult" + "more difficult") were used. When the two difficulty levels were analyzed separately, there was a three-way interaction on the "less difficult" sentences between difficulty, language ability and age. Therefore, conclusions were drawn only on the "more difficult" sentences. The results of the analysis showed that LI children experienced greater difficulty comprehending spoken language than LN children, at each age level. Listener age also had a significant effect on comprehension. The comprehension skills tested were found to develop by age 7 in the LN population, but the LI population was still developing the test skills up to age 8. The overall effect of speaking rate on comprehension of spoken language was also found to be significant for both the LN and LI groups. The preferred speaking rate for the LN children was moderately fast; for the LI children, both slow and moderately fast were preferred.

Discussion

In reviewing the responses on the "less difficult" sentences, it was interesting to note that sentence #1, set 2, "The dog is upon the chair" and sentence #1, set 3, "The cat is upon the chair" were consistently missed by both the LN and LI groups. It is believed that the use of the word "upon" may have caused confusion in the children who were more accustomed to hearing the preposition "on" and therefore did not respond appropriately.

It is also noteworthy that the tape containing the stimulus sentences was a reproduction of Nelson's original tape which she used in her 1976 study. Reproduction of the tape may have caused increased distortion. Several of the "less difficult" sentences were judged on single morphemes, such as a plural "s" marker (cat/cats), a past tense marker "ed" and a third person singular "s" (spilled/spills). Distortion on the tape may have blocked out these very important morphemes and contributed to incorrect responses on the "less difficult" sentences.

There were two other factors which the researcher believed may have contributed to the contamination of the "less difficult" sentences--order of sentence presentation and overuse of stimulus pictures. In the order of sentence presentation, the "less difficult" sentences always preceded the "more difficult" sentences. To avoid the possibility of an order effect, the order of sentence presentation should have been counterbalanced. Secondly, the same stimulus pictures were used more than once. If the children marked the correct picture for the sentence, "The milk spills" when they heard "The milk spilled" and were confronted with a foil showing "The milk spills," they tended to mark that picture again. This problem possibly could have been eliminated if the taped instructions had included a statement, such as: "You will see some of the same pictures more than once, but the sentences you hear will be different each time. So, you should listen carefully to each sentence and be sure you always mark the picture that goes with the sentence you heard on the tape recorder."

In the present study, it was observed that LN children comprehended more spoken language than the LI children. The differences between the two language groups at each of the three age levels showed that the LI children demonstrated a considerable reduction in comprehension of spoken language when compared to the LN children. These findings are in agreement with other studies comparing normal and atypical groups of children on comprehension tasks (McCroskey & Nelson, 1975; Nelson & McCroskey, 1978). McCroskey and Nelson (1975) compared LN children to reading disordered children and found the disordered population to have depressed comprehension scores when compared to the LN group. Nelson and McCroskey (1978) also found Black English speaking children to have significantly lower comprehension scores when compared to Standard English speaking children.

According to the present study, there was also evidence to support the conclusion that comprehension of spoken language increases with age which is in direct agreement with McCroskey and Nelson (1975), Nelson (1976) and Nelson and McCroskey (1978). It appeared that both groups (LN and LI) showed improved comprehension with age. However, it was interesting to note that by the time the LN children reached age 7, there was no significant difference between their performance and that of the 8-year olds. These results suggest that optimum comprehension skills for the sentences tested were achieved among LN subjects in this study by age 7. These findings are not in agreement with McCroskey and Nelson (1975), Nelson and McCroskey (1978) or Nelson (1976), which showed that optimum comprehension skills were not achieved by the LN children until age 8.

For the LI children, significant differences were found between 6- and 8-year olds and 7- and 8-year olds but not 6- and 7-year olds. These findings indicate that the LI children are still making gains in comprehension between the ages of 7 and 8, whereas the LN children are not. McCroskey and Nelson (1975) found their atypical populations (reading disordered) to develop comprehension skills by age 8, and Nelson and McCroskey (1978) found Black English speaking subjects to be developing proficiencies with the test sentences through age 9.

The main effect of speaking rate was found to be significant for both the LN and LI groups. It appeared that for the LN group, the moderately fast speaking rate (4.0 sps) yielded the highest comprehension scores. Therefore, for this group, optimum comprehension occurs at a rate slightly faster than normal (3.5 sps). This finding is supported by Woodcock and Clark (1968) and Nichols (1957), who believe that for some children, the normal speaking rate may be inefficient because the brain is capable of processing information at rates much faster than it receives them and therefore fills in time between messages with other thoughts.

The effects of rate on the LN group in the present study are not in agreement with McCroskey and Nelson (1975) or Nelson and McCroskey (1978) who were unable to find a significant effect for rate in their LN populations. Nor do the present results agree with Nelson's 1976 study of LN children, in which she found rate to have a slight effect on comprehension with the slowest rate yielding significantly higher comprehension scores.

In reviewing the effects of rate on the LI children in the present study, it can be concluded that for this group, optimal comprehension occurred at both the slow and the moderately fast speaking rates. These conclusions are in partial agreement with such studies as McCroskey and Thompson (1973), McCroskey and Nelson (1975) and Nelson and McCroskey (1978) who found that their atypical populations showed superior comprehension at the slow speaking rate.

It is interesting to note that within the LI group of the present study, two subgroups of children may have been identified. The first group, with optimum comprehension at the slow speaking rate, are those children who are characterized by a language impairment accompanied with an impaired rate of processing. These children are unable to adequately process rapidly incoming acoustic information, though they are able to deal with slower auditory signals (Aram & Nation, 1982; Lubert, 1981; Woodcock & Clark, 1968).

The other subgroup of LI children, with optimum comprehension occurring at the moderately fast speaking rate did not show an impaired rate of processing; instead, they performed similar to the LN children. These results concur with Aram and Nation (1982) who have indicated that not all language processing disorders are associated with auditory rate problems.

Presently, there are few available diagnostic tools for the identification of language-impaired children with accompanying auditory processing impairments. To informally evaluate the comprehension of language-impaired children in terms of syntax and speaking rate, speech and language clinicians could require children to interpret classroom materials which include syntactic constructions of increasing complexity, presented at normal and slowed speaking rates. As these factors are varied a breakdown or impairment in performance should be observed and appropriate management strategies undertaken. If sentence difficulty seems to adversely affect comprehension then the use of simpler syntactic constructions as a part of the regular therapy session and within the classroom may improve the child's ability to function receptively. Similarly, slowing the rate of presentation by inserting pauses between phrases or the major components within a phrase may improve comprehension and assist the child in interpreting spoken instructions and other pertinent information. These preliminary suggestions should be helpful until standardized protocols for the evaluation and management of auditory processing problems have been developed.

Conclusions and Suggestions for Future Research

Efficient auditory processing skills are essential for social and educational growth. Children whose processing of auditory language is inadequate for interpersonal and educational interactions will find it difficult to survive in a society where the attainment of information is so dependent on the aural modality. This is especially true in today's educational setting where more than 50% of the time in school learning situations is spent in listening (Markgraf, 1966; Wilt, 1966).

As a result of the present investigation, the following suggestions are made for future research.

1. If the present study is to be replicated, it is suggested that a larger number of subjects be included in each language ability group and that LI and LN subjects be matched on the basis of mean length of utterance as well as age in order to determine if a delay or a disorder in auditory processing exists.

2. It is also suggested that the "less difficult" sentences be revised and that the order of presentation be counterbalanced for the "less difficult" and "more difficult" sentences.

3. Diagnostic tools should be developed for identification of LI children whose rate of processing of spoken language is impaired.

4. Data should be collected on the effects of everyday use of time-altered speech in classroom listening centers within a school setting.

5. An investigation should be conducted to determine if teachers naturally alter the rate of their speech for children with language and/or processing problems.

6. The effect of time-altered speech when used as a therapy technique needs further investigation.

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APPENDIX A

Stimulus Sentences

APPENDIX A

STIMULUS SENTENCES

<u>Set 1</u>

Ex. The boy has a ball.
Ex. The girl is standing.
1. The cat is behind the chair.
2. He goes upstairs.
3. The deer is running.
4. The boy sees the cats.
5. The milk spills.
6. This is their dog.
7. Mother says, "Look what is here."
8. The boys write.
9. The boy is pushed by the girl.
10. The mother shows the kitty the baby.

<u>Set 2</u>

Ex. The boy is sitting.
1. The dog is upon the chair.
2. She goes outside.
3. The sheep are running.
4. The girl sees the dog.
5. The coke spilled.
6. This is his cat.
7. Daddy says, "Look who is here."
8. The boy reads.
9. The car is pushed by the truck.
10. The daddy shows the baby the doggy.

<u>Set 3</u>

Ex. The girl has a ball.
1. The cat is upon the chair.
2. She goes upstairs.
3. The deer are running.
4. The boy sees the cat.
5. The milk spilled.
6. This is her dog.
7. Mother says, "Look who is here."
8. The boy writes.
9. The girl is pushed by the boy.
10. The mother shows the baby the kitty.

<u>Set 4</u>

Ex. The boy has a book.
1. The dog is behind the chair.
2. He goes outside.
3. The sheep is running.
4. The girl sees the dogs.
5. The coke spills.
6. This is their cat.
7. Daddy says, "Look what is here."
8. The boys read.
9. The truck is pushed by the car.
10. The daddy shows the doggy the baby.

APPENDIX B

Tape-Recorded Instructions

APPENDIX B

TAPE-RECORDED INSTRUCTIONS

You have a booklet of pictures in front of you. Look at the first page with pictures on it. Has everyone found the first page? If you have, raise your hand.

Okay. Now listen carefully. You will hear a sentence which goes with one of the pictures. When you hear the sentence, mark an X on the picture which goes with it. Listen to the first sentence and mark the picture which shows what is happening to the sentence. Ready, listen.

"The boy has a ball."

You should have marked the picture where the boy has a ball. Did everyone mark the picture like this one.

You will have to listen carefully because some of the sentences will sound fast, and some will sound slow. As soon as you hear the sentence, mark the picture you think goes with it, and turn the page. Always mark a picture, even if you are not sure which one is right.

Are you ready? Turn to the next picture page. As soon as you hear the sentence, mark the picture you think is right and wait.

"The girl is standing."

You should have marked this picture.

Now we are ready to begin. Turn the page and listen. As soon as you hear the sentence, mark the picture you think is right, and turn the page. We won't stop anymore.

Ready, listen.

APPENDIX C

Subjects' Raw Scores at Each Speaking Rate as a Function of Age, Language Ability and Difficulty

APPENDIX C

Raw Scores for "Less Difficult" Sentences

Language-Normal Subjects

		Rates				
Age	Subject	slow	mod. slow	mod. fast	fast	Total
6-years	1	4	5	3	2	14
	2	5	3	2	2	12
	3	2	3	3	3	11
	4	4	2	2	3	11
	5	2	3	5	5	15
	6	4	1	5	2	12
	7	4	3	4	4	15
	8	4	1	5	3	13
	9	3	3	4	4	13
	10	2	2	3	3	10
	Range	2-5	1-5	2-5	2-5	10-15
	Mean	3.4	2.8	3.4	3.1	12.6
	SD	1.08	1.23	1.27	.99	1.71
7-years	11	5	3	4	3	15
	12	3	2	5	3	13
	13	3	2	3	4	12
	14	4	2	5	2	13
	15	5	3	5	3	16
	16	4	2	5	1	12
	17	3	5	4	5	17
	18	4	3	4	3	14
	19	4	3	1	1	9
	20	4	4	4	3	15
	Range	3-5	2-5	1-5	1-5	9-17
	Mean	3.9	3.1	4.0	2.6	13.6
	SD	.70	.79	.88	1.32	2.12
8-years	21	3	3	3	4	13
	22	4	5	5	4	18
	23	4	3	3	3	13
	24	4	2	5	1	12
	25	3	3	4	1	11
	26	5	4	4	3	16
	27	4	3	5	2	14
	28	3	4	2	3	12
	29	3	3	4	4	14
	30	3	2	3	4	12
	Range	3-5	2-5	2-5	1-4	11-18
	Mean	3.6	3.2	3.9	2.8	13.5
	SD	.70	.79	.88	1.32	2.12

Raw Scores for "Less Difficult" Sentences

Language-Impaired Subjects

Rates

Age	Subjects	slow	mod. slow	mod. fast	fast	Total
6-years	1	4	4	4	0	12
	2	2	3	2	1	8
	3	0	3	2	4	9
	4	2	2	2	3	9
	5	4	3	4	2	13
	6	3	3	3	2	11
	7	1	2	3	2	8
	8	1	4	2	2	9
	9	2	2	4	1	9
	10	4	3	5	1	13
	Range	0-4	2-4	2-5	0-4	8-13
	Mean	2.3	2.9	3.1	1.8	10.1
	SD	1.42	.74	1.1	1.14	1.97
7-years	11	2	3	2	3	10
	12	2	3	2	2	9
	13	3	3	3	3	12
	14	2	2	3	2	9
	15	4	2	2	1	9
	16	1	1	3	3	8
	17	3	1	3	3	10
	18	3	2	3	3	11
	19	4	2	1	1	8
	20	3	3	4	3	13
	Range	1-4	1-3	1-4	1-3	8-13
	Mean	2.7	2.3	2.3	2.5	9.9
	SD	.95	.82	.82	.85	1.66
8-years	21	5	3	5	2	15
	22	5	2	2	3	12
	23	4	4	1	4	13
	24	4	3	4	4	15
	25	4	2	3	0	9
	26	2	2	2	4	10
	27	1	2	4	5	12
	28	5	3	2	4	14
	29	3	2	3	3	11
	30	3	4	3	3	13
	Range	1-5	2-4	1-5	0-5	9.15
	Mean	3.6	3.2	2.5	3.1	12.4
	SD	1.35	1.40	1.08	.88	2.01

Raw Scores for "More Difficult" Sentences

Language-Normal Subjects

Age	Subject	slow	mod. slow	mod. fast	fast	Total
		Rates				
6 years	1	1	2	3	5	11
	2	3	1	2	3	9
	3	3	3	5	2	13
	4	3	3	4	3	13
	5	4	3	3	4	14
	6	4	2	5	3	14
	7	3	2	3	2	10
	8	5	3	4	4	16
	9	3	3	4	3	13
	10	3	4	4	3	14
	Range	1-5	1-4	2-5	2-5	11-16
	Mean	3.2	2.9	3.4	3.2	12.7
	SD	1.03	1.10	1.08	.79	2.11
7-years	11	5	4	5	4	18
	12	3	3	4	3	13
	13	3	5	3	2	13
	14	3	4	5	4	16
	15	4	3	4	3	14
	16	5	1	5	5	16
	17	3	4	5	4	16
	18	5	3	4	2	14
	19	4	5	5	5	19
	20	3	5	5	2	15
	Range	3-5	1-5	3-5	2-5	13-19
	Mean	3.8	3.4	4.6	3.6	15.4
	SD	.92	1.27	.52	1.17	2.01
8-years	21	5	5	4	5	19
	22	5	5	4	4	18
	23	3	5	4	4	16
	24	5	3	4	4	16
	25	5	3	5	5	18
	26	5	1	4	3	13
	27	5	5	5	5	20
	28	5	5	5	4	19
	29	3	3	5	5	16
	30	4	4	5	5	18
	Range	3-5	1-5	4-5	3-5	13-20
	Mean	4.5	3.8	4.6	4.4	17.3
	SD	.85	1.23	.70	.70	2.06

Raw Scores for "More Difficult" Sentences

Language-Impaired Subjects

		Rates				
Age	Subject	slow	mod. slow	mod. fast	fast	Total
6-years	1	2	3	3	2	10
	2	1	1	2	2	6
	3	3	3	2	2	10
	4	3	3	4	2	12
	5	1	1	3	2	7
	6	3	3	3	3	12
	7	3	2	1	0	6
	8	5	2	2	1	10
	9	3	1	2	2	8
	10	3	0	3	1	7
	Range	1-5	0-3	1-4	0-4	6-12
	Mean	2.7	1.8	2.4	1.9	8.8
	SD	1.16	1.03	.70	1.10	2.30
7-years	11	1	1	4	4	10
	12	3	1	2	3	9
	13	4	3	2	3	12
	14	4	2	4	3	13
	15	3	2	1	3	9
	16	3	2	5	3	13
	17	5	1	5	0	11
	18	3	3	3	2	11
	19	4	0	0	1	5
	20	1	2	1	2	6
	Range	1-5	0-3	0-5	0-4	5-13
	Mean	3.1	2.1	2.3	2.4	9.9
	SD	1.29	1.20	1.42	1.58	2.73
8-years	21	5	2	5	5	17
	22	3	3	3	3	12
	23	3	2	3	2	10
	24	4	5	5	2	16
	25	1	4	2	4	11
	26	2	3	3	4	12
	27	4	5	5	5	19
	28	2	3	4	3	12
	29	5	1	4	0	10
	30	3	2	4	2	11
	Range	1-5	1-5	2-5	0-5	10-19
	Mean	3.2	2.8	4.0	3.0	13.0
	SD	1.32	1.23	.82	1.63	3.16

VITA

On May 7, 1955, Lynn Moberg Mason was born in Galesburg, Illinois, where she resided until the age of 14. At that time her family moved to Laurinburg, North Carolina where she graduated from Scotland High School in 1973. In May 1977, she graduated from East Carolina University with a Bachelor of Science degree in Speech Pathology.

From 1977 to 1981 she was employed as a speech and language specialist for the Scotland County School System in Laurinburg, North Carolina. In June of 1981, she entered the Master's program at Appalachian State University and received her Master's of Arts degree in May 1982. During the time she attended graduate school she was employed as a graduate assistant and served as secretary to the Graduate Student Association Senate.

Her parents are Mr. and Mrs. Donn R. Moberg of Laurinburg, North Carolina. She is married to James Walter Mason, III and they reside at 723 South Pine Street, Laurinburg, North Carolina.