CHILDREN'S PERCEPTION OF TEMPORALLY DISTORTED SENTENTIAL APPROXIMATIONS AND NORMAL SENTENCES

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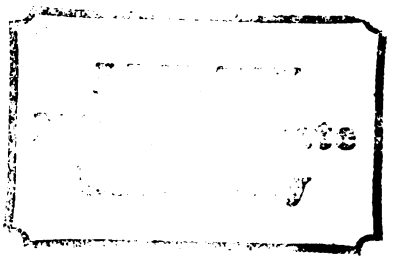
THESIS



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Children's Perception of Temporally Distorted Sentential Approximations and Normal Sentences

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ABSTRACT

CHILDREN'S PERCEPTION OF TEMPORALLY DISTORTED SENTENTIAL APPROXIMATIONS AND NORMAL SENTENCES

By

Anne K. Flaherty

A review of the literature suggested that auditory perceptual processing and short-term memory interact with each other and are temporally biased. One way to investigate this concept is to control stimulus duration and vary the silent interstimulus interval in an auditory recall task. The stimuli used in auditory recall tasks have been primarily digits and word lists, which do not adequately assess higher central nervous system processing and the functions of short-term memory. It is necessary to use more syntactically and semantically meaningful material.

The purpose of this study was to explore the underlying system involved in perceptually processing speech stimuli by imposing syntactic and semantic constraints upon stimuli of a sentential nature. This study investigated the effects of modified silent interstimulus interval ratio of sentential approximations to normal English upon

the auditory perceptual processing of normal second and fourth grade children.

In order to increase syntactic and semantic complexity, ten three-word and ten five-word first order sentential approximations, ten three-word and ten five-word second order sentential approximations, and ten three-word and ten five-word normal sentences were constructed. The sentential approximations and normal sentences were read by a male speaker from a Second Level standardized reading list of monosyllabic words. These forty sentential approximations and twenty normal sentences were made into three experimental conditions, each condition with a specific silent interstimulus interval size. Word duration remained constant (normal speaking rate) and three interstimulus interval sizes (200msec, 400msec, and unaltered) were used.

Sixty second and fourth grade children from an elementary school in southern Michigan served as subjects. All subjects had normal hearing as assessed by school screening tests. Each of the three experimental conditions--sixty sentences--was presented via a tape recorder under earphones to ten second graders and ten fourth graders. The experimenter using standardized instructions asked the subjects to repeat exactly what they heard on the tape.

An item error analysis was performed on the total number of words recalled for the sixty "sentences." Any words substituted, deleted, or in wrong order were considered in error.

The results of this study demonstrated that grade, silent interstimulus interval, order of approximation of stimuli to full grammaticality, and sentence length were important factors in auditory perception of speech and language.

Recall performance, on sentential stimuli, of the fourth grade group was substantially higher than the second grade group for all three silent interstimulus interval conditions. For both grades there was a small difference as a function of interstimulus interval size, with the unaltered condition showing the highest recall accuracy and the 400msec condition showing the poorest recall accuracy. For all three interstimulus interval conditions the children in both grades recalled three-word "sentences" more accurately than five-word "sentences."

The effect of sentential order revealed that highest recall accuracy was obtained on the normal sentences, whereas the first order sentential approximations showed the lowest recall accuracy. These data supported the contention that increasing the order of sentential approximations provided more cues to perception, thereby aiding recall. The interstimulus interval by sentence length by order interaction reveals that for all

interstimulus interval conditions, there were only slight differences for the three-word sentences as a function of order of approximation. However, for five-word sentences, there were substantial differences in percent correct performance as a function of order of approximation. The interaction between sentence length and order demonstrated a breakdown in performance for the first and second order conditions for the five-word sentences, whereas essentially no breakdown in performance as a function of order was found for three-word sentences.

The interaction between grade, interstimulus interval, and sentence length showed that both second and fourth graders maintained high scores for all three interstimulus interval conditons at the three-word sentence length condition. However, the children in both grades showed a reduction in accuracy of performance on five-word sentences for all three interstimulus interval conditions.

Finally, for all measures, as grade level increased, percentage correct scores improved.

This investigation sought to study the simultaneous interactions of these variables upon the perceptual analysis of language, especially as related to the contributions of word duration, interstimulus interval, and sentence length embedded in sentential approximations and normal sentences. The findings of this investigation support implications which may be important in discussing theories of normal

development of speech and language and the applications of these theories to clinical situations.

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By

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Director of Thesis

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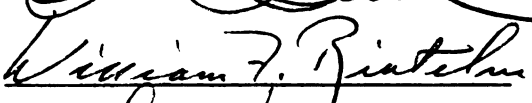

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

A review of the literature revealed a major interest in the area of speech perception by several investigators. Researchers, in looking for data concerning human information processing, have been concerned with the physical characteristics of the stimuli including such dimensions as duration and time and also with the physiological variables of the individual's perceptual system, including such factors as attention, prior experience, and short-term memory. The purpose of this investigation is to study children's auditory perception abilities, as reflected in the influence of temporal distortion of sentential stimuli.

Auditory Perception and Short-Term Memory

Several descriptions and models of short-term memory have been proposed (Aaronson, 1967; Broadbent, 1957; Pollack, 1959; Sperling, 1963). Most of these models view memory as a two-stage process. The first stage is an

unstable, large capacity storage system having a fast decay time. It is a parallel processing system whereby more than one stimulus item can be dealt with simultaneously. Stage II is characterized by a small storage capacity system with a slower decay system. Stimulus items are received into Stage II in an ordered series from Stage I. Thus, if items arrive in Stage II at too rapid a rate, interference of the perceptual analysis of the message may occur. Rapid decay will occur if stimulus items are left too long in Stage I, again interfering with perceptual analysis. It has been suggested (Aaronson, 1967) that the three parameters of (1) Presentation rate, (2) Interstimulus interval, and (3) Stimulus duration may be manipulated in order to investigate the short-term memory characteristics of auditory perceptual processing. The process of time compressing or expanding the duration of the stimulus and/or the silent interstimulus interval alters the presentation rate. The importance of varying presentation rates in the functioning of auditory short-term memory has been presented by Aaronson (1967). An increase in presentation rate is thought to allow for information processing prior to loss of information from short-term memory shortage. It is thought that decreased presentation rates provide more response time to process the stimuli thereby allowing the utilization of individual memory strategies.

Shriner and Daniloff (1970) showed the importance of the interstimulus interval for resynthesis of words by

varying the silent interphonemic interval of words and presenting these words to children. In the task employing meaningful stimuli with an increase in the silent interphonemic interval, resynthesis abilities of segmented CVC syllables decreased to about a silent interphonemic interval of 200msec, with no further decrease to 400msec intervals. However, the task employing non-meaningful stimuli showed a reverse pattern of no decrement in resynthesis abilities to 200msec and then a decline out to a 400msec interval. These results may be an indication of the importance of semantic constraints in a task requiring auditory perceptual processing. Aaronson and Sternberg (1964), in holding word duration constant and varying interstimulus interval, found that an increase in presentation rate will yield a decrease in recall accuracy, thereby indicating that interstimulus interval is an important parameter in auditory perceptual processing.

Beasley and Shriner (1973) investigated the relationship of word duration and interstimulus interval by covarying the temporal length of these two parameters. These temporal manipulations were performed upon first and second order sentential approximations, and the subjects (normal hearing yound adults) were required to recall the sentential sequences. Results demonstrated that stimulus duration, the silent interstimulus interval size and the order of approximations of stimulus materials to full grammaticality were important factors in auditory

perception. Word duration was shown to be an important factor in the recall of sentential stimuli (Beasley and Shriner, 1973). It was found that the number of items correctly recalled increased as word duration increased. The major difference in recall accuracy between first order and second order sentential approximations was at the 300msec word duration level, indicating that 200msec and 400msec are nearing anchor points beyond which no decrease or increase, respectively, in recall accuracy of items would be expected. These same findings may apply to the variable of silent interstimulus interval in a recall task. The importance of the silent interstimulus interval in a task involving recall of sentential stimuli has not been adequately defined. It is necessary then to control word duration and vary the silent interstimulus interval in order to determine its importance in an auditory recall task.

Sentential Stimuli and Short-Term Memory

The current theoretical bases of short-term memory as related to time must be considered incomplete, partly because empirical investigations have failed to consider sentential stimuli adequately. The traditional auditory perceptual testing paradigm (e.g., as used in audiology) uses stimuli such as clicks, pure tones, digits and word lists. It may be contended that non-sentential acoustic stimuli primarily assess the peripheral mechanism (Bocca and Calearo, 1963; Calearo and Lazzaroni, 1957; Bocca, 1967)

and that central nervous system perceptual functioning is not adequately assessed by word lists (Pollack, 1967). Jerger (1960) discussed the principle underlying the concept of reducing stimuli redundancy for the purposes of audiological evaluation and referred to this as the "Subtlety Principle." He proposed ". . . that the subtlety of the auditory manifestation increases as the site of lesion progresses from peripheral to central" (p. 4). Jerger included in his theory the Bottleneck Principle where he noted that ". . . the process of a complex auditory stimulus encounters a very real bottleneck in the eighth nerve and lower brain stem" (p. 4). Thus, it may be hypothesized that increasingly more subtle stimuli are needed to assess the lower brain stem and cortical functioning of auditory processing. That is, determining normal functioning at the cortical level must be accomplished with measures requiring subtle decisions on the part of the listener (Miller, 1965).

The term "multiple-cueing," introduced by Harris (1960), described the number of cues available to the listener including time and order characteristics. Adequate assessment of higher order neurological functioning as related to language processing is restricted unless multiple-cueing characteristics of normal language are somehow utilized. Speech perception, in this view characterized by redundancy reduction and multiple-cueing, then, becomes related to the broader problem of determining the

bases for language perception and comprehension. As long as the perceptual processing of speech and language is studied using words spoken in isolation, the possibility of the existence of larger perceptual units which may modify current theories of auditory perception (Liberman, 1969; Jacobson, Fant, and Halle, 1965; Chomsky and Halle, 1968) and short-term memory (Aaronson, 1967; Broadbent, 1957) would not be revealed. It also may be argued that the study of pure tones and single-word stimuli fail to test the subjects' competence in handling sentential stimuli, since in fact sentences and phrases are the very "core" of oral language processing.

Investigators have shown that intelligibility increases as the number of alternatives is restricted in message sets (Pollack, Rubenstein, and Decker, 1960; Pollack and Pickett, 1964). The fact that the subject must draw from an open or undetermined message set is another problem with testing methods currently employed (Speaks and Jerger, 1965). By imposing syntactic and semantic constraints through the use of approximated sentential stimuli, the subject is able to choose from a narrower range of alternatives.

Previous Investigations Involving Temporally Distorted Stimuli

In previous investigations involving responses to temporally distorted speech, children (Maki, Beasley, and Orchik, 1973) tended to have more difficulty than adults

(Beasley, Schwimmer, and Rintelmann, 1972) with a discrimination measure that required responses to an open message set. Differences in the performance of adults as compared to children in auditory processing may be due to the fact that there is a difference in familiarity with language, as adults have experienced a longer period of language use. It has also been said that possibly an open set message is more affected by reduced temporal redundancy than a closed message set (Maki, Beasley, and Orchik, 1973).

A preliminary study with children (Flaherty and Cribbs, 1973) was conducted to investigate the effects of a modified silent interstimulus inteval (200msec) and order of sentential approximations (first and second order) as compared to an unaltered interval. The number of items correctly recalled in the first and second order sentential approximations and normal sentences was analyzed. There were six listeners, three second graders, and three fourth graders. Each listener received all experimental conditions.

The effect of interstimulus interval in this study suggested that the ability of children to recall normal sentences was consistently more accurate than the experimentally treated interval for both orders of sentential approximations and for both grade levels, as shown in Figure 1.

The results of the Flaherty and Cribbs study also indicated that recall accuracy was aided when the order of

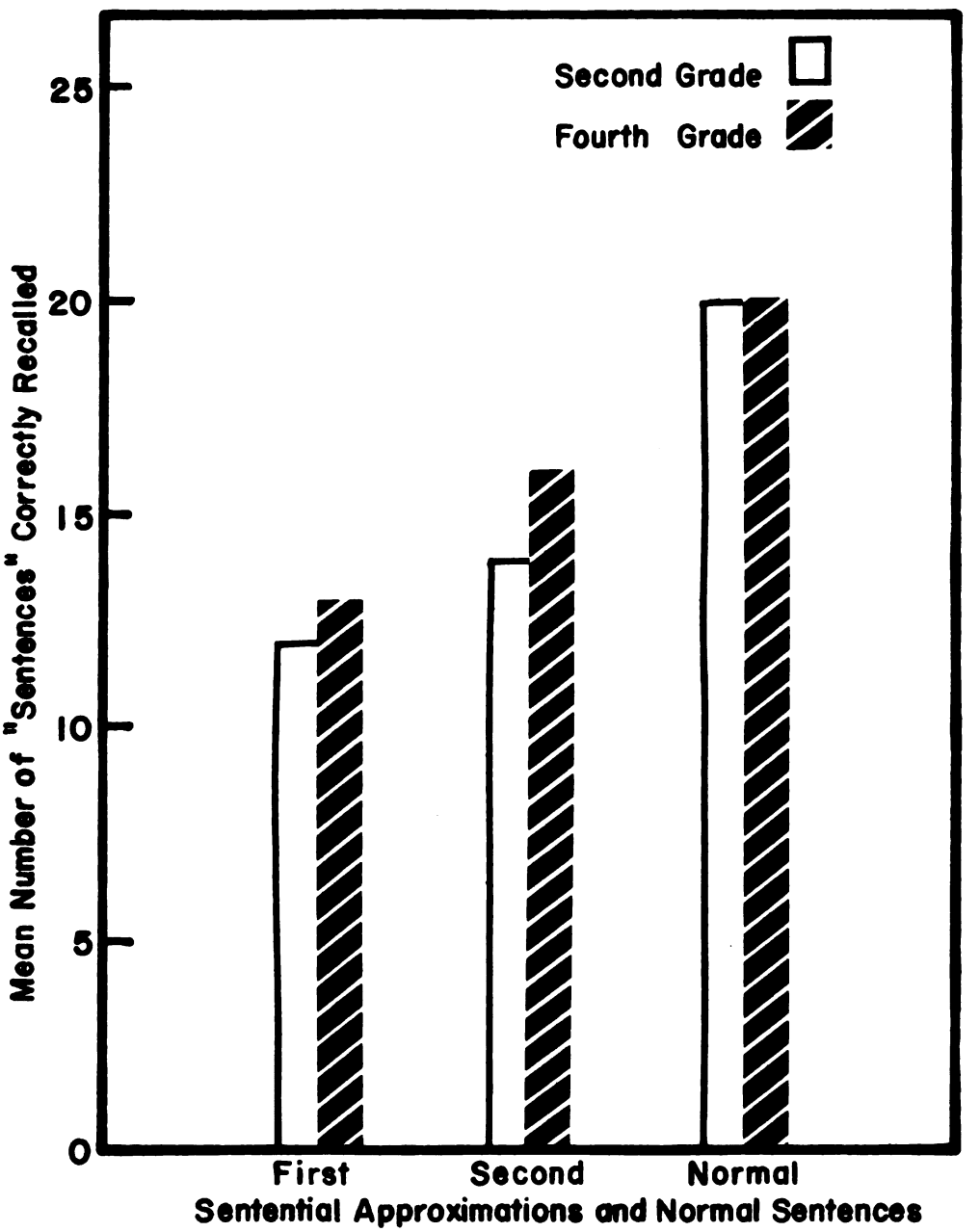

Figure 1. Mean number of sentences correctly recalled as a function of grade and interstimulus interval and two orders of sentential approximations and normal sentences.

sentential approximations was increased, approaching that of normal sentences. It appears that recall accuracy improved with an increase in grade level.

The effect of sentence length in relation to mean number of words recalled for first and second order sentential approximations demonstrated that three-word sentential approximations were more readily recalled than the five-word sentential approximations. For the normal sentence condition, there was no difference in recall accuracy as a function of sentence length, each being recalled with one hundred percent accuracy (see Figure 2).

Statement of the Problem

There seems to be little doubt that auditory perceptual processing is temporally-biased. The exact nature of the temporal factors involved in this processing is as yet undetermined. The current theory of short-term memory, based predominantly upon non-sentential stimuli, cannot be considered complete unless it is extended to include sentential stimuli. It is not considered complete because the non-sentential stimuli, such as pure tones, clicks, digits, and word lists do not adequately assess higher central nervous system perceptual functioning. Using sentential stimuli, in order to obtain information concerning higher central nervous system perceptual functioning, Beasley and Shriner (1973) gathered normative data for adults.

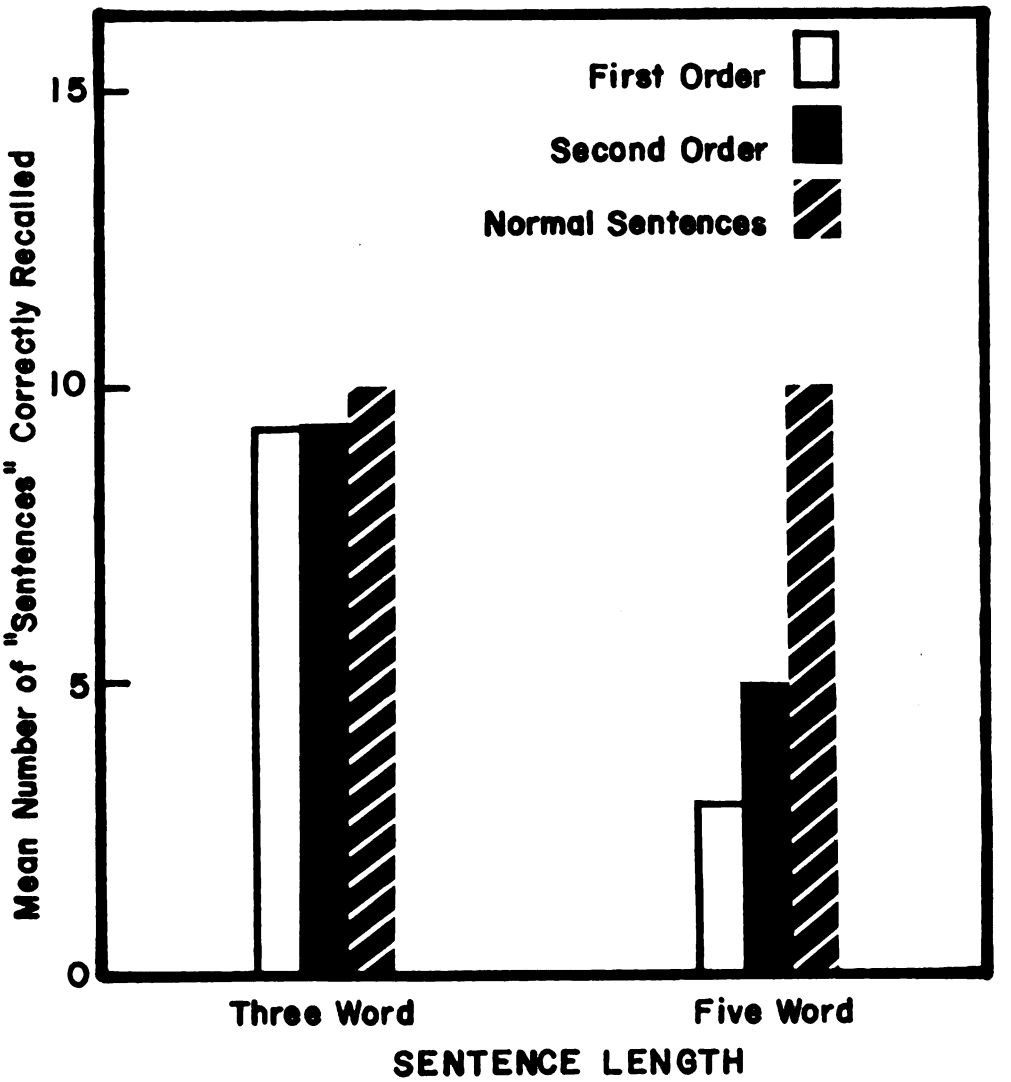

Figure 2. Mean number of sentences correctly recalled as a function of sentence length and order.

There now exists the need to begin investigation in the same direction with children in order to answer questions concerning their auditory functioning during childhood. It is necessary to determine how normal hearing children respond to the parameters of stimulus duration, interstimulus interval, order of sentential approximations and sentence length, and to determine whether this ability is a function of age and can be considered developmental.

Thus, the purpose of this study was to explore the underlying system involved in processing speech stimuli by imposing syntactic and semantic constraints upon the sentential input and by simultaneously controlling the amount of time given to select among the sentential stimuli and normal sentences presented. The effects of modified silent interstimulus interval ratios of sentential approximations to normal English upon the auditory perceptual processing of normal second and fourth grade children was investigated.

Specifically, the following questions were studied:

1. What would be the recall accuracy of second and fourth grade children for first order and second order sentential approximations and normal sentences?
2. What would be the recall accuracy of second and fourth grade children for three-word and five-word sentential approximations and three-word and five-word normal sentences?

3. What would be the recall accuracy of second and fourth grade children for silent interstimulus intervals of 200msec, 400msec, and ulaltered--an interstimulus interval of normal speaking rate--, respectively.
4. What would be the effects of interactions of the above factors and their associated levels upon recall accuracy?

CHAPTER II

EXPERIMENTAL PROCEDURES

Subjects

Thirty second grade and thirty fourth grade children from the Laingsburg Elementary School served as subjects. All children had been recently screened for hearing by the Intermediate School District, and were judged to have hearing within normal limits (re: ISO, 1964). Each of the three experimental conditions (200msec, 400msec, and unaltered--an interstimulus interval of normal speaking rate) was presented to ten second and ten fourth grade children. (See Figure 4, page 22, for the pictorial representation of the design.)

Design and Stimuli

The stimulus materials were similar to those used in a previous investigation of recall accuracy by Flaherty and Cribbs (1973). The stimuli consisted of three experimental tapes:

(1) Ten three-word and ten five-word first order sentential approximations, each with a silent interstimulus interval of 200msec between each word; ten three-word and

ten five-word second order sentential approximations, each with a silent interstimulus interval of 200msec between each word; ten three-word and ten five-word normal sentences, each with a silent interstimulus interval of 200msec between each word.

(2) Ten three-word and ten five-word first order sentential approximations, each with a silent interstimulus interval of 400msec between each word; ten three-word and ten five-word second order sentential approximations, each with a silent interstimulus interval of 400msec between each word; ten three-word and ten five-word normal sentences, each with a silent interstimulus interval of 400msec between each word.

(3) Ten three-word and ten five-word first order sentential approximations, each with an unaltered interstimulus interval; ten three-word and ten five-word second order sentential approximations, each with an unaltered interstimulus interval; ten three-word and ten five-word normal sentences, each with an unaltered interstimulus interval.

The sentential approximations to full grammatical sentences were ordered in a manner similar to that described by Speaks and Jerger (1965). For the purpose of this investigation the sentential approximations to full grammatical sentences were constructed using words taken from the Basal Vocabulary of the primary reader workbook, ON WE GO (Teacher Edition) (Second Level) (Houghton Mifflin, 1966). One hundred monosyllabic words chosen randomly by

Table 1.--Examples of the First and Second Order Sentential Approximations and Normal Sentences Used in This Study.

	FIRST ORDER SENTENTIAL APPROXIMATIONS				
1	go	girl	zoo		
2	men	zoo	pop	nest	is
3	take	hot	girl		
4	red	play	late	I	call
5	food	jar	wish		
	SECOND ORDER SENTENTIAL APPROXIMATIONS				
1	men	will	do		
2	I	put	up	to	like
3	that	man	of		
4	here	all	of	stop	tree
5	snow	time	will		
	NORMAL SENTENCES				
1	I will play.				
2	We went to the zoo.				
3	The cat played.				
4	That girl is not good.				
5	I know you.				

Table 2.--Means and standard deviations in Msec of graphic level recordings for the three experimental conditions.

ISI Ratio in Msec	Order of Sentential Approximation	Interstimulus Interval	
		M	SD
200	1st Order	6.17	.7
	2nd Order	6.25	.519
	Normal	6.48	.436
400	1st Order	12.46	.655
	2nd Order	12.31	2.2
	Normal	12.22	1.3

the experimenter were taken from the ON WE GO list and randomized into a new list (see Appendix A).

For the first order sentences, the words were randomly chosen from the revised list. Ten three-word and ten five-word sentential approximations were constructed to constitute the first order sentential stimuli.

Construction of the second order sentences was accomplished by choosing the first word randomly from the revised list. The experimenter then asked another individual to choose a word from the list that may follow word one in a sentence. Word three was supplied by a second individual who, without knowing word one, chose a word from the list to follow word two. The process was continued until ten three-word and ten five-word "sentences" (sentential approximaions) were constructed by the experimenter using words from the revised list of words from ON WE GO. (See Appendix B for a complete listing of the sentential approximations and normal sentences used in this study).

An additional undistorted three-word and five-word first order sentential approximation was prepared as practice stimuli.

Recording and Stimulus Generation Procedures

The experimental stimuli were recorded onto a master magnetic tape recording by a male speaker who spoke General American speech and was trained in phonetics. The speaker

used a microphone (Electro-voice 635A) and a tape deck (Ampex AG 440-4) to record the words in a sound treated room. Conversational pitch and effort level with minimum inflection were used in making the recordings. The reason for minimum inflection was to minimize the interaction of prosodic cueing effects that might influence the data. A pause was left between words in order to facilitate the experimenter in the location of the initiation and termination of each word for splicing purposes. The speaker monitored his vocal intensity on a VU meter (which peaked between 0 and -3 dB VU) located in the recording suite. A schematic of the recording situation and equipment is shown in Figure 3.

One tape of ten three-word and ten five-word first order sentential approximations, ten three-word and ten five-word second order sentential approximations and ten three-word and ten five-word normal sentences was recorded with an interstimulus interval associated with a normal speaking rate. This tape was unaltered. Two copies were made of this tape at 7 1/2ips using an Ampex 601 and an Ampex 600 tape recorder. Two copies of the master recording of ten three-word and ten five-word first order sentential approximations, ten three-word and ten five-word second order sentential approximations, and ten three-word and ten five-word normal sentences were made at 7 1/2ips using an Ampex 601 and an Ampex 600 tape recorder. Each of these copies of the master recording was prepared as experimental

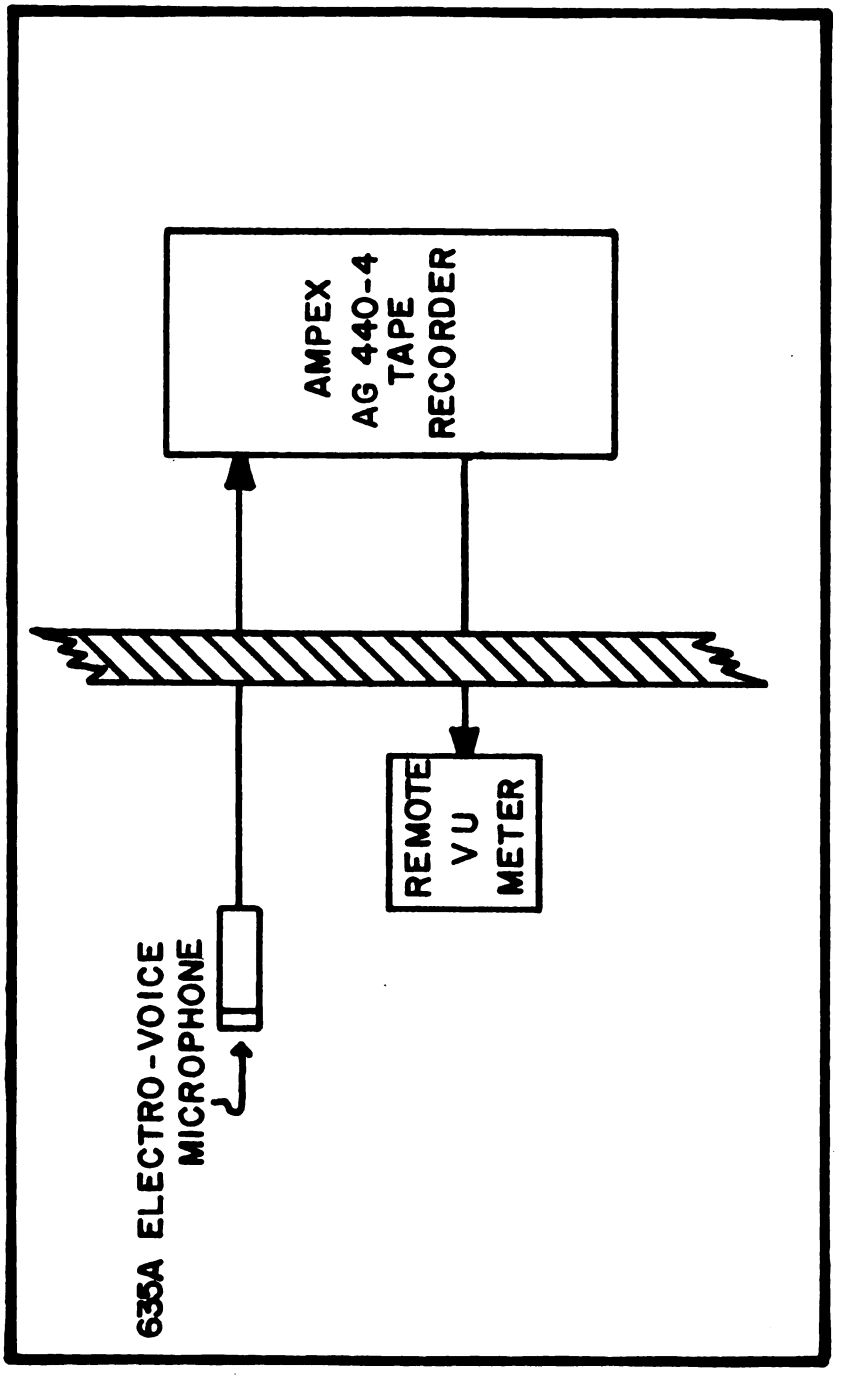

Figure 3. Schematic of Recording Situation and Equipment

stimuli by varying the size of the silent interstimulus interval (200msec and 400msec, respectively). The 200msec silent interstimulus interval tape was prepared first. The acoustic initiation and termination point of each word was aurally determined using an apparatus comprised of a play-back recorder head coupled to a pre-amplifier and amplifier/speaker. These acoustic boundaries were then marked on the tape, and the tape was cut at these boundaries. The existing interval of tape between the word was discarded. A silent interstimulus interval equal to 200msec (determined to be 1.5 inches of tape) was then spliced between each word of the 200msec copy. The same procedure was followed for the remaining interstimulus interval condition of 400msec (determined to be 3.0 inches of tape). A response time of five seconds of blank tape was spliced between each sentential stimulus and normal stimulus on the experimental tapes.

Each experimental tape was played through a high speed graphic level recorder (Bruel & Kjar 2305) (paper speed-30mm/sec; writing speed-250mm/sec; 50dB; 20Hz). The silent interstimulus intervals between words were hand measured in millimeters and converted into milliseconds. This procedure has been described elsewhere by Beasley and Shriner (1973). Any silent interstimulus interval in error by approximately $\pm$ 30 milliseconds was reprocessed.

The tape which consisted of the twenty first order sentential approximations, the twenty second order

sentential approximations, and the twenty normal sentences with an unaltered interstimulus interval between each word provided a baseline for the "sentences" whose interstimulus interval had been modified.

The carrier phrase "Number _____" (which was in fact the number of the sentence) preceded all sentences.

Presentation Procedures

Each experimental condition presented to a subgroup of twenty children, ten per grade, consisted of ten three-word and ten five-word first order sentential approximations, ten three-word and ten five-word second order sentential approximations, and ten three-word and ten five-word normal sentences with the silent interstimulus interval of 200msec and 400msec and unaltered, respectively. The total breakdown can be seen in Figure 4. The listeners were seated in chairs in a room adjacent to the principal's office at the Laingsburg Elementary School. Each child received the experimental tape binaurally at 7 1/2ips via a tape recorder (Ampex 600) and via earphones (TDH 39-10Z) housed in biscuit type cushions (MX-41/AR). The intensity level was set at 70 to 75 dB sound pressure level (SPL) (re: .0002 dynes/cm^2). There was occasional peaking at 80 dB SPL. The ambient noise level in the test room was measured at 60 to 65 dB SPL on the C scale of a sound level meter (Bruel and Kjar Type 2203) using a sound field condensor microphone (Bruel and Kjar Type 4131). This ambient

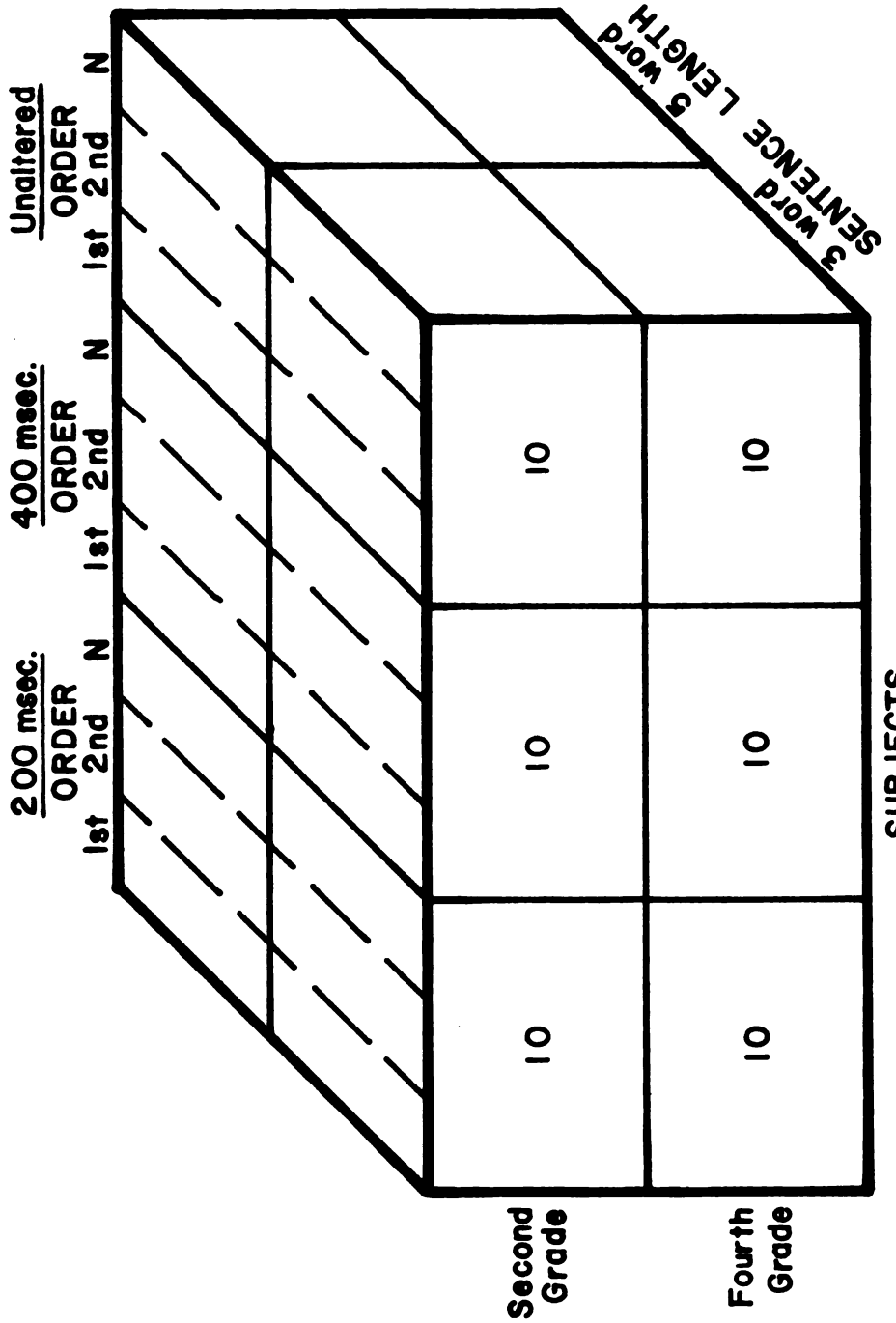

Figure 4. Experimental design.

noise level was sufficiently low as not to interfere with the subjects' listening task.

After a brief greeting period, standardized verbal instructions were given to each subject (see Appendix C). If there were questions, the instructions were repeated. No subject required more than one repetition of the instructions. Each subject was tested individually.

The responses of the subjects were written by the examiner on an answer sheet (see Appendix D). The subject's responses were also recorded via a tape recorder (Sony TC 106A) and played back at a later time in order to allow the examiner to check her original written record against the playback tape.

Analysis

The number of items correctly recalled was the score for each subject.

There were ten subjects (second and fourth grade children, respectively) per condition for a total of sixty subjects (see Figure 4). There were twenty subjects at each silent interstimulus interval size (200msec and 400msec) and twenty subjects at the unaltered interstimulus interval condition (N).

CHAPTER III

RESULTS

The results of this study support the thesis that speech perception can be investigated by imposing semantic, syntactic, and temporal constraints upon sequential stimuli. The overall results demonstrated that grade, silent interstimulus interval, order of approximation of stimuli to full grammaticality, and sentence length were important factors in auditory perception of speech and language. It was found that as order of sentential approximations to full grammatical sentences increased, recall accuracy increased. Recall accuracy scores decreased as sentence length increased from three words to five words. As the silent interstimulus interval ratios increased the number of items correctly recalled decreased. For all measures, as grade level increased, percentage correct scores improved. The mean correct score at each silent interstimulus interval size for the second and fourth grades for both orders of sentential approximations and normal sentences is presented in Table 4. These results, discussed

Table 3.--Mean number of correct responses at each interstimulus interval size for second and fourth grades and first order and second order sentential approximations and normal sentences.*

Grade Level		Interstimulus Interval Size (msec)		
		200	400	unaltered
Second	1st Order	14.5	12.8	15.5
	2nd Order	15.7	13.7	17.3
	Normal	19.4	20.0	19.9
	Total	16.5	15.5	17.6
Fourth	1st Order	14.2	13.8	17.7
	2nd Order	14.8	14.2	18.4
	Normal	19.8	19.8	20.0
	Total	16.3	15.9	18.7

*Each average represents the responses of ten subjects to sixty sentences, with a maximum possible score equal to 60.

below, can be found in Appendix E and graphically illustrated in Figures 5-8.

Effect of Interstimulus Interval

Figure 5 shows that the recall performance of the fourth grade group was substantially higher than the second grade group for all three interstimulus interval conditions (200msec, 400msec, ulaltered). For both grades there was a small difference as a function of interstimulus interval, with the unaltered conditon showing the highest recall accuracy and the 400msec condition showing the poorest recall accuracy. Figure 6 illustrates that for all three interstimulus interval conditons, both the second and fourth graders recalled three-word sentences more accurately than the five-word sentences. Figure 6 also illustrates that in the 400msec condition and the unaltered condition the fourth graders recalled five-word sentences with more accuracy than the second graders.

Effect of Sentential Order

Figure 7 shows that for both the second and fourth grades there was a small difference in performance as a function of both orders of sentential approximations and normal sentences. The highest recall accuracy was obtained on the normal sentences, whereas the first order sentential approximations showed the lowest recall accuracy. These data support the contention that increasing the order of

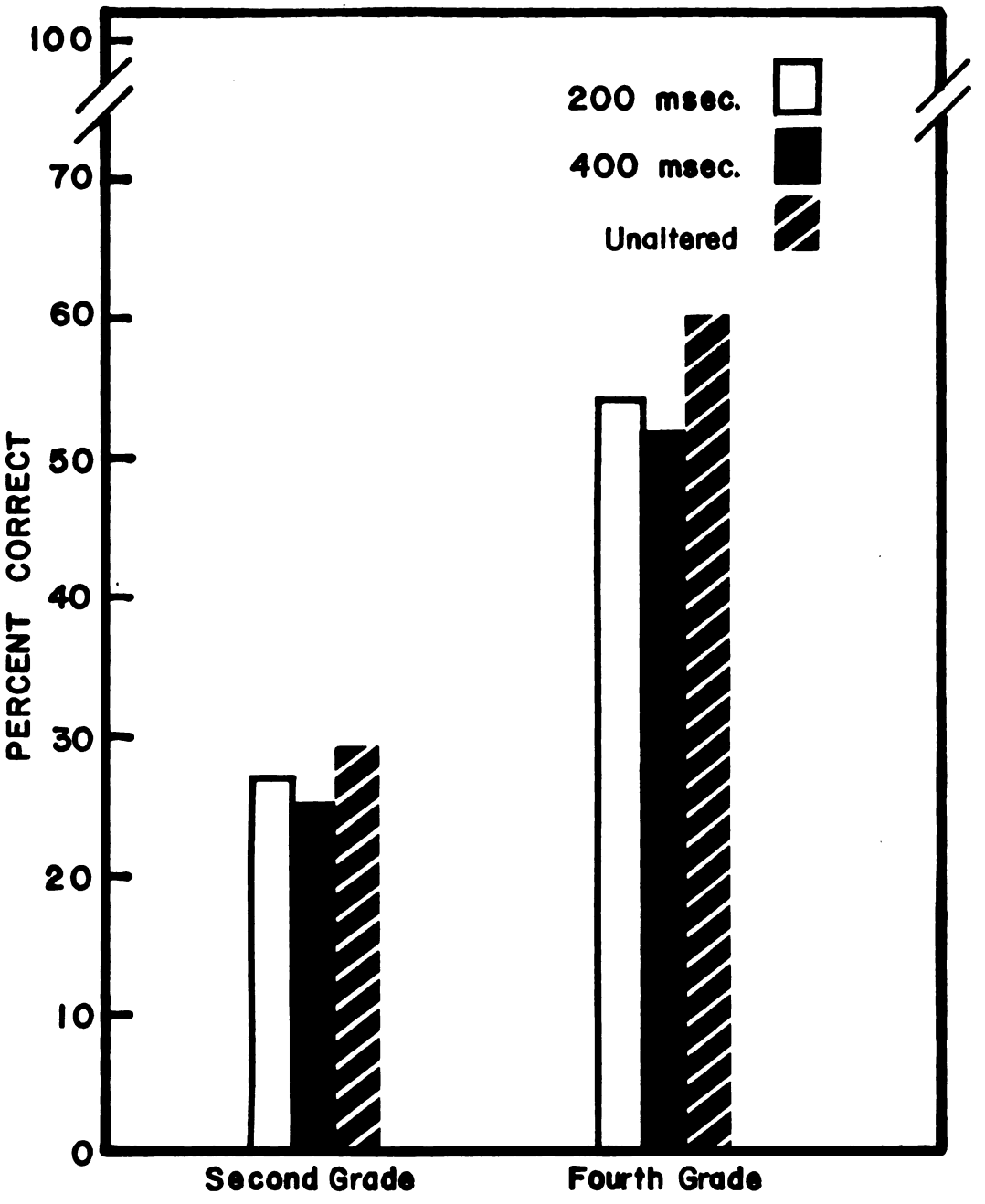

Figure 5. Mean percentage correct scores: Grade level (second grade, fourth grade) by interstimulus interval (200 msec., 400 msec., unaltered).

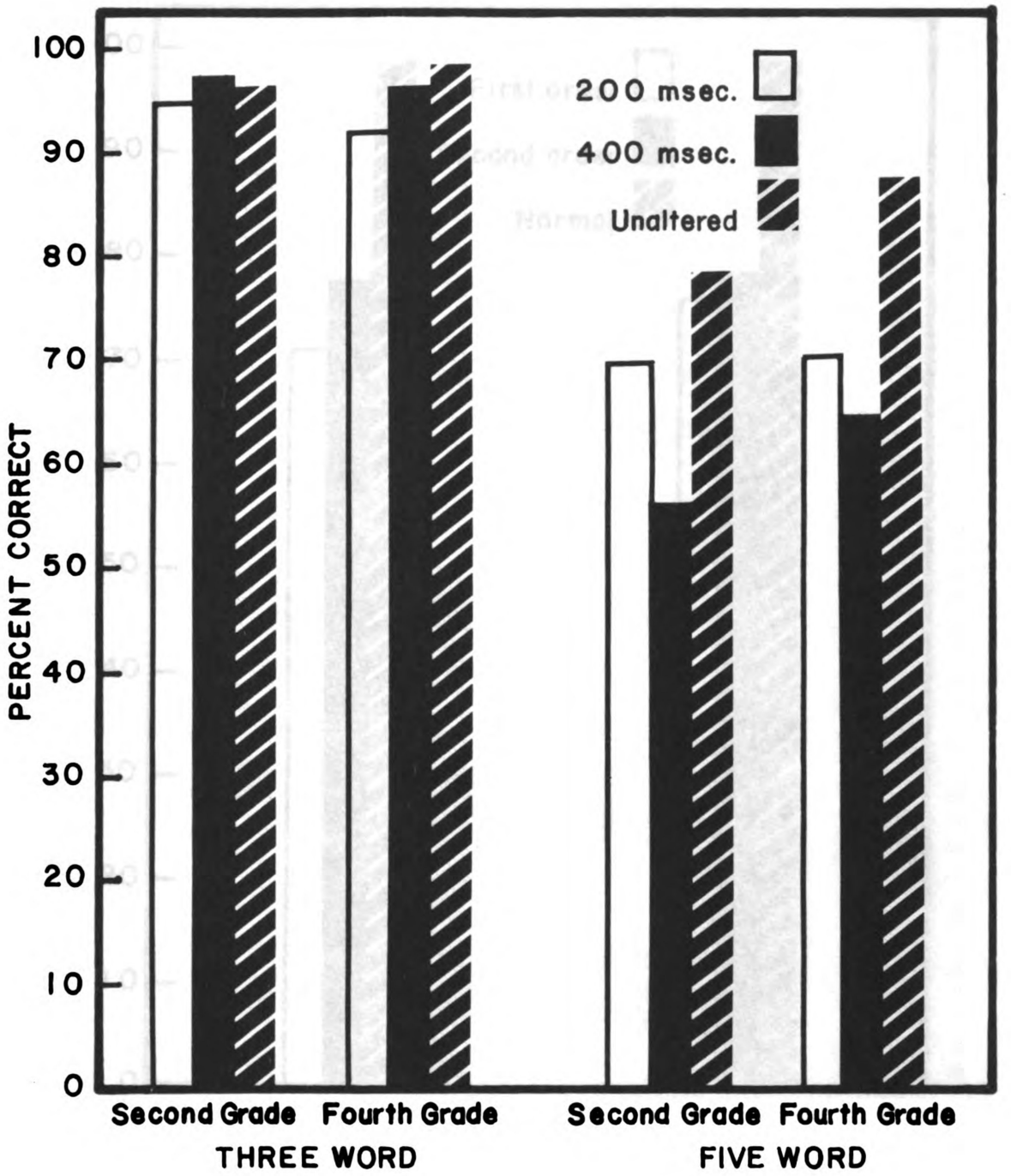

Figure 6. Mean percentage correct scores: Grade level (second grade, fourth grade) by interstimulus interval (200 msec., 400 msec., unaltered) and sentence length (three word, five word).

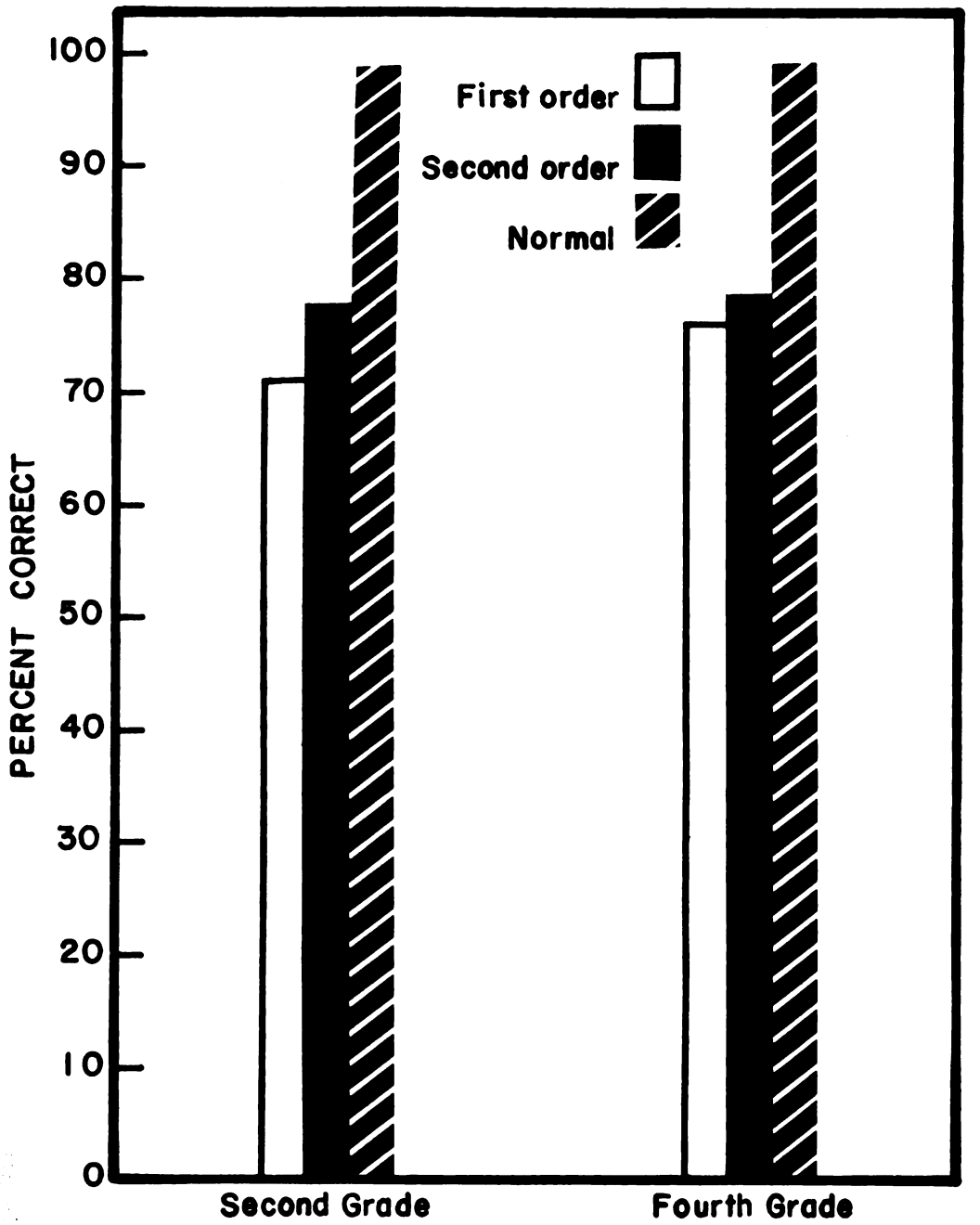

Figure 7. Mean percentage correct scores: Grade level (second grade, fourth grade) by order of sentential approximation (first order, second order, normal sentences).

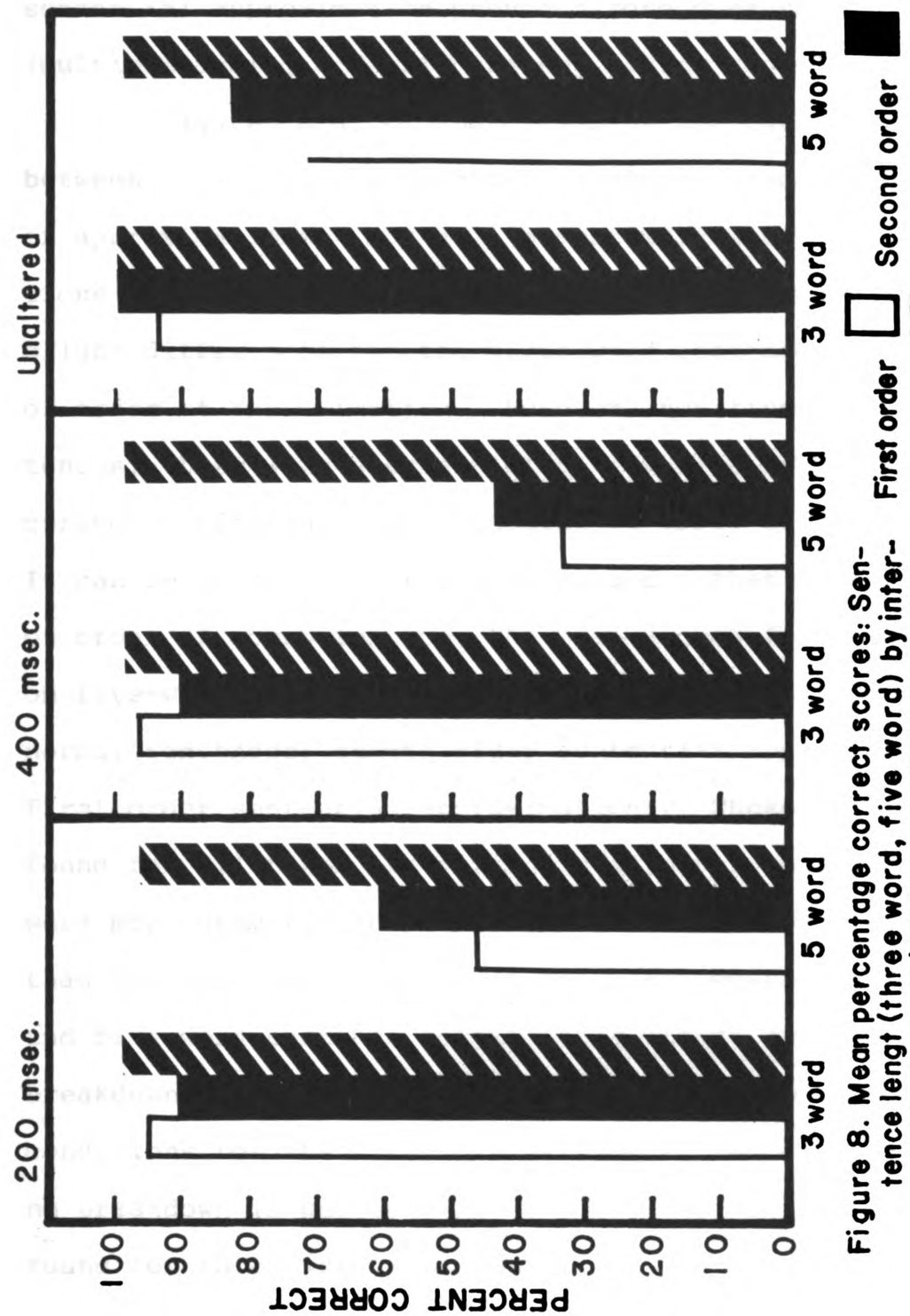

Figure 8. Mean percentage correct scores: Sentence lengt (three word, five word) by interstimulus interval (200 msec., 400 msec., unaltered) and order of sential approximation (first order, second order, normal sentences).

sentential approximation provided more cues to perception (multiple-cueing effect), thereby aiding recall.

Figures 8 a, b, and c display the interaction between interstimulus interval, sentence length, and order of approximations. For all interstimulus interval conditions (200msec, 400msec, unaltered), there were only slight differences for the three-word sentence as a function of order of approximation. However, for five-word sentences, there were substantial differences in percent correct performance as a function of order of approximation. It can be seen in Figures 8 a, b, and c that as a function of order of approximation, the mean scores for performance on five-word sentences rank highest to lowest as follows: normal sentences; second order sentential approximations; first order sentential approximations. These results were found for all three interstimulus interval conditions but were more dramatic for the 200msec and 400msec condition than for the unaltered condition. In comparing three-word and five-word sentence length, this figure demonstrates a breakdown in performance for the first and second order conditions for the five-word sentences, whereas essentially no breakdown in performance as a function of order was found for three-word sentences.

Effect of Sentence Length

Figure 6 shows the interaction between grade, interstimulus interval, and sentence length. This figure

shows that both the second and fourth grade children maintained high percentage scores for all three interstimulus interval conditions (200msec, 400msec, unaltered), at the three-word sentence length condition. However, the children in both grades showed a reduction in accuracy of performance at the five-word sentence length condition for all three interstimulus interval conditions, with the lowest mean scores associated with the 400msec condition and the highest mean scores associated with the unaltered condition. Finally, this figure shows a small difference in percent correct scores as a function of grade level for all three interstimulus interval conditions for the five-word sentence length condition. The fourth graders showed a slightly higher performance score than the second graders for the 400msec and unaltered interstimulus interval conditions. No differences were found between grades for the 200msec interstimulus interval condition.

Effect of Grade Level

The effect of grade level as it interacts with all variables has been discussed in the above text. The interactions discussed above followed the general trend for grade level comparison: as grade level increased, errors decreased.

CHAPTER IV

DISCUSSION

The results of this study indicated that grade level, silent interstimulus interval size, order of approximations to full grammaticality, and sentence length interacted at various levels. It can be seen that specific variables in certain instances took precedence over others in affecting the recall accuracy of children in this study. Earlier investigators had not studied the simultaneous interactions of these variables upon the perceptual analysis of language, especially as related to the contributions of word duration, interstimulus interval, and sentence length embedded in sentential approximations and normal sentences. These findings support implications which may be important in discussing theories of normal development of language and the applications of these theories to clinical situations.

Trends of Prior Investigation

In reviewing the variables independently of each other, the results of this study support earlier

investigations. No previous studies had combined the factors used in this study using school age children. However, the same trends have been found for preschool children and school age children for an imitative or recall task. The trend for the number of items correctly recalled to decrease as the size of the silent interstimulus interval increased supported the findings of earlier studies employing the use of silent interstimulus interval ratios (Beasley and Shriner, 1972; Beasley and Beasley, 1973). The fact that recall accuracy increased as the order of sentential approximations to full grammatical sentences increased agrees with earlier studies (Speaks and Jerger, 1965; Beasley and Shriner, 1972). The higher order sentential approximations approaching full grammaticality involve syntactic-semantic concepts (words) which provide multiple-cueing effects to aid in auditory perceptual processing.

The trend for recall accuracy to decrease as sentence length increased supports the findings of earlier studies of sentence length, item length, and short-term memory (Miller, 1965; Aaronson, 1967; Schuckers, Shriner, and Daniloff, 1971; Pantalos, Schuckers, and Hipskind, 1972). When a string of items (words or digits) has exceeded the immediate or short-term memory span of an individual, that individual tends to delete items from the string. Miller (1956) found that the short-term memory span was usually seven "items" long, plus or minus two.

The present study showed that more words were recalled incorrectly from five-word sequences than three-word sequences. Finally, recall accuracy increased as grade level increased (Beasley and Acker, 1971; Smith, 1972; Beasley and Beasley, 1973).

Interstimulus Interval and Order of Sentential Approximation

Interstimulus interval size is a major parameter in the perceptual analysis of auditory input according to Aaronson (1967). She states that as interstimulus interval increases, more time is allowed for processing.

Interstimulus interval, an artifically introduced variable, was shown to play a significant part in this study. Figure 5 shows that the number of items correctly recalled did not increase as the interstimulus interval size increased. It may be seen in Figure 5 that the unaltered interstimulus interval condition (interstimulus interval of normal speaking rate) showed the highest recall accuracy and the 400msec interstimulus interval condition showed the poorest recall accuracy. This may indicate that there is no optimal interstimulus interval ration size for syntactically and semantically constrained stimuli. It can be seen that the effect of interstimulus interval is not crucial as the stimuli approach full grammaticality. The higher order sentential approximations and normal sentences involving syntactic-semantic concepts, provide multiple-cueing effects which aid auditory perceptual processing.

Subjects have less time to analyze words separately as multiple-cueing increases. They tend to chunk the words at this level (Miller, 1962). As the order is increased, the material is analyzed in longer chunked units; and it even appears that with more familiar material (normal sentences) the listener may identify several words at a time.

The verb phrase, around which the rest of the sentence revolves (Foder, Bever, and Garrett, 1969), has been discussed as the basic unit of perception. The increase in the linguistic aspect of the stimuli increases the complexity of the sentential material. However, when linguistic constraints are increased, there are increased multiple cues used for perceptual analysis. The processing of lower order sentential material would result in a larger number of recall errors than higher orders, as the lower orders of sentential approximations are not as linguistically bound as higher orders. This concept can be seen in the results of this study. The highest recall accuracy was obtained on the normal sentences, whereas the first order sentential approximations showed the lowest recall accuracy. The interstimulus interval does not affect the ability to discriminate order if the events carry high information content (such as words in sentences). This study refutes the contention that decreasing the interstimulus interval results in a decrease in the ability of children to discriminate order as the events occur in close

succession. The results showed that poorest recall accuracy occurred at the longest interstimulus interval condition, i.e., 40msec and the highest recall accuracy occurred at the unaltered interstimulus interval, determined to be the shortest interstimulus interval condition.

It is contended that temporal factors, such as interstimulus interval, may play a dominant role in the analysis of auditory input at the lower, more peripheral neural centers. As input becomes more sentential in nature, it is analyzed at a higher more central neural level. At this point, time between elements of the stimulus material plays a less significant role. It is here that order of approximation to full grammaticality becomes a significant factor in the correct analysis of the input.

The relationship between grade and interstimulus interval size, which showed that the recall accuracy performance of the fourth graders was substantially higher than the recall accuracy performance of the second graders for all three interstimulus interval conditions, suggests perceptual processing is developmental relative to the parameters investigated. Perhaps, this performance is due to the difference in the experience of the two age groups. The older children (fourth grade) have experienced a longer period of language use and are more familiar with the language than are the younger children (second grade). These older children are therefore able to recall language (words, sentences) with more accuracy.

It is indicated from the data that the fourth graders appear to process higher order stimuli which carry syntactic and semantic cues more proficiently than the second graders. This suggests that older children are developing a more sophisticated perceptual processing system. At this time these older children are beginning to analyze the more complex stimuli in "chunked" groups as opposed to each word independently.

Sentence Length

The results indicated that recall accuracy decreased as sentence length increased. It was evident that there was a greater number of recall errors on the five-word sequences (sentential approximations and normal sentences) than on the three-word sequences. When sentence length increased to five items, the increase in number of recall errors may have indicated that short-term memory capacity and/or processing capacity had been exceeded. When immediate memory limits have been exceeded, recall becomes selective and must reflect strategies used by the listener in processing the information. Further support that five-word sequences may have exceeded short-term memory span can be seen when counting the total number of sentential approximation and normal sentence deletions. Thirty-five five-word "sentences" were completely deleted, whereas only eight three-word "sentences" were completely deleted. The strategies used by individuals in selecting

words to recall may very well be reflected by the words subjects recalled.

The relationship between grade and sentence length reflects upon a developmental process for short-term memory. The capacity of short-term memory imposed greater limits upon second graders than upon fourth graders. Thus, it appears that more efficient use of short-term memory increased with age. It appears from the data that short-term memory processing is limited at the second grade level. However, further research on older children would be necessary before it could be determined if a peaking and/or leveling for the development of short-term memory had been achieved by the fourth grade.

Grade Level

When interactions involving grade level were examined, there were no exceptions to the trend. For all measures, as grade level increased, percentage correct scores improved.

Implications for Therapy and Future Research

Language Acquisition and Development

It may be hypothesized that language acquisition is based upon the establishment of the temporal patterns of perceptual processing (Berry, 1969). The ability to analyze sequential auditory events must be firmly

established on a temporal basis in order for the language perceptual processor to function optimally. Language acquisition begins when this is made possible. It may be stated that before language acquisition could occur, the cortex would have to be at a certain level of maturation. Studies involving children with "delayed language" have suggested that delay may be related to malfunctioning "auditory memory." These children are said to have impeded memory spans, and their ability to sequence information is hampered resulting in distorted syntactic relations.

Katz (1971) has set forth the hypothesis that the problem with children displaying depressed speech and language skills may lie in the disruption of clear auditory perception. One important skill in auditory perception is phonemic synthesis. Katz refers to phonemic synthesis as "the task of remembering individual phonemes; keeping them in correct sequence; blending the individual items together and repeating the word that is formed by these elements" (p. 19). The author indicated that the reason a person might fall down in a phonemic synthesis task is that such a task taps several auditory perceptual functions of the brain.

In his research, Katz had no definite control of the parameters used in this phonemic synthesis task. It is necessary to consider the interstimulus interval and set up definite parameters to test this concept. With no such parameters (i.e., interstimulus interval) set up in this

type of task, it is difficult to determine whether the child is simply memorizing the words or perceptually synthesizing the words.

The hypothesis of interrelated perceptual-productive disorders (e.g., children with articulatory deficits have associated language difficulties) has been set forth by Shriner and Daniloff (1970). These authors noted that normal children do poorer resynthesizing "meaningless" silent interval spanned consonant-vowel-consonant words than "meaningful" consonant-vowel-consonant words. They suggest that the child applies semantic and syntactic rules to the "meaningful" stimuli but does not do so for the "meaningless" stimuli. The authors indicated that the more systems brought into play (such as syntax, semantics, etc.), the easier the task becomes for the child, facilitating short-term memory recall.

Implications for therapy and for teachers arise from the second grade limitation on short-term memory. It appears that the child is only processing shorter units effectively in any learning or recall task. This may give evidence to the difficulty younger children have in following directions. If a child is limited in his processing of longer sentences, it may follow that, with repetition, the child can eventually acquire meaning out of a longer sentence.

Language therapy should not fail to consider the experience of the child and the familiarity of the child

with regard to language acquisition. These factors may play an important role in the process of a child's developing language. They also may help indicate the sophistication of the child's perceptual processing system.

Existing in the area of mental retardation is a great need for guidance in speech and language programs. In regards to this study, a comparison should be made between the trends found in the normal population and the trends characterized by the mentally retarded population. If similar patterns are found, programs for the retarded could parallel regular language programs. However, language therapy techniques which optimally aid the retarded individual's perceptual processing and recall behavior should be employed where abnormal or no trends were found.

Audiology

It has been suggested that the use of distorted speech tests may contribute to what is known of the integrative aspects of message processing (Bocca and Calearo, 1963; Bocca, 1967). Simple psychoacoustic signals, such as pure tones, fail to elicit differential responses of the central nervous system; that is, central nervous system pathways provide enough intrinsic redundancy to allow satisfactory cortical integrative and interpretive centers to act upon these simple signals. In order to assess these higher centers, the use of distorted speech which increases the complexity of the message and reduces the extrinsic

redundancy of this complex message is advocated. When such a distorted message is passed into a damaged pathway, perceptual processing will suffer. It is also suggested that if verbal integration is to be studied, meaningful sentential stimuli must be used. This is because highly redundant messages will be least affected by peripheral lesions (middle ear, cochlear, and eighth nerve pathologies). Sentential approximations, variously modified, may serve the purpose of assessing processing of higher cortical centers. Simply distorting word lists may not be sufficient. Audiological diagnostic and prognostic testing seeks to appraise a patient's auditory perceptual processing of everyday speech. It is reported that word lists are not adequate for this purpose (Webster et al., 1965). In order to overcome these problems of assessment, it may be necessary to use verbal sequences with semantic and syntactic constraints in audiological testing. The degree of semantic and syntactic constraints placed upon the stimuli must be limited in order that the sentential sequences are not full grammatical sentences. It is known that as the sentential sequences approach that of normal language, the inherent redundancy makes the material too easy for testing purposes. Also known is that distorted stimuli require the listener to respond to an open message set, which makes the material too difficult. A compromise may be met by the use of first and second order sentential approximations. Varying the interstimulus interval size

of these sentential approximations may provide a method of assisting the differentiation of listeners who have lesions of the central nervous system from listeners with normal hearing.

Implications for Future Analysis of Present Data

In order to obtain knowledge of the interactions of the variables under investigation, it was necessary to score "sentences" as correct or incorrect. However, information about the syntactic and semantic mispercpetions may possibly be apparent from further analysis of various recall errors. For example, an analysis of item errors, namely those errors on different parts of speech may give some idea which parts of speech are developed in language first and which are recalled with the greatest accuracy. The same type of analysis could be conducted for word substitutions in relationship to semantics and order errors in relationship to syntax.

CHAPTER V

SUMMARY AND CONCLUSION

Numerous investigators have reported that the perceptual processing of auditory stimuli is influenced by temporal factors. The exact nature of this process is as yet undetermined. The current theoretical bases of short-term memory as related to time must be considered incomplete, partly because empirical investigations have failed to consider sentential stimuli adequately. It was contended that pure tones, clicks, digits, and word lists did not adequately assess higher central nervous system functioning. Rather, adequate assessment of higher order neurological functioning as related to language processing is restricted unless multiple language cues are utilized. This requires imposing semantic and syntactic constraints upon the stimuli which is accomplished through the use of first and second order approximations to full grammatical English sentences.

The purpose of this study was to explore the system involved in processing speech stimuli by imposing

semantic and syntactic constraints upon the sentential input and at the same time controlling the amount of time given to select among the sentential stimuli and normal stimuli presented. The investigation studied the effects of modified interstimulus interval ratios of sentential approximations to normal English upon the auditory perceptual processing of normal children. Hopefully, the results may be applied to the current theories and models of auditory perception, particularly in terms of the acquisition and development of language perception and comprehension.

Specifically, the following questions were investigated:

1. What would be the recall accuracy of second and fourth grade children for first order and second order sentential approximations and normal sentences?
2. What would be the recall accuracy of second and fourth grade children for three-word and five-word sentential approximations and three-word and five-word normal sentences?
3. What would be the recall accuracy of second and fourth grade children for silent interstimulus intervals of 200msec, 400msec, and unaltered, respectively?

4. What would be the effects of interactions of the above factors and their associated levels upon recall accuracy?

The overall results demonstrated that interstimulus interval, order of approximation of stimuli to full grammaticality, sentence length, and grade were important factors in auditory perception of speech and language. As the silent interstimulus interval ratios increased, the number of items correctly recalled decreased. As the order of sentential approximations to full grammatical sentences increased, recall accuracy increased. Recall accuracy scores decreased as sentence length increased from three words to five words. For all measures, as grade increased, percentage correct scores improved.

Recall performance of the fourth grade group was substantially higher than the second grade group for all three silent interstimulus interval conditions (200msec, 400msec, and unaltered).

The effect of sentential order revealed highest recall accuracy was obtained on the normal sentences and lowest recall accuracy was obtained on the first order sentential approximations.

Children in both grades (second and fourth) maintained a high level of recall performance at the three-word sentence length condition, but the children in both grades showed a reduction in accuracy of performance at the five-word sentence length condition.

Results of grade level performance indicate a need for further research. Although the total error rate differences of second and fourth graders were minimal, it is necessary to test the recall ability of older children on this present task in order to determine the grade level at which this decreasing error rate stabilizes.

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APPENDICES

APPENDIX A

REVISED WORD LIST BASAL

VOCABULARY ON WE GO

HOUGHTON-MIFFLIN

(1966)

APPENDIX A

REVISED WORD LIST BASAL VOCABULARY ON WE GO HOUGTON-MIFFLIN (1966)

1	a	red	pan	sand
2	girl	zoo	high	stop
3	cry	with	eye	was
4	all	ten	dog	late
5	boy	set	feet	jar
6	but	is	like	come
7	had	in	my	six
8	her	to	not	men
9	I	we	milk	ring
10	dot	pop	that	said
11	man	take	toy	they
12	out	will	wish	lock
13	on	me	sat	see
14	put	hot	good	snow
15	tell	the	it	food
16	see	eat	ride	dish
17	sun	do	play	go

18	two	call	wood	egg
19	of	cat	yes	know
20	here	him	no	work
21	box	up	name	word
22	big	us	end	tree
23	car	you	door	this
24	five	nest	run	time
25	day	store	one	would

APPENDIX B

FIRST AND SECOND ORDER SENTENTIAL APPROXIMATIONS AND NORMAL SENTENCES USED IN THIS STUDY

APPENDIX B

FIRST AND SECOND ORDER SENTENTIAL APPROXIMATIONS AND NORMAL SENTENCES USED IN THIS STUDY

First Order Sentential Approximations

1. go girl zoo
2. men zoo pop nest is
3. take hot girl
4. red play late I call
5. food jar wish
6. snow take play big man
7. jar sand man
8. name milk good girl sun
9. red toy us
10. time all sun pop tree
11. wish pop milk
12. snow pop dish is name
13. egg call ten
14. pop zoo cry food milk
15. up jar said
16. tree up yes me word

17. nest ring sun

18. me play wish milk nest

19. name will jar

20. dog cat high man hot

Second Order Sentential Approximations

1. men will do
2. I put up to like
3. that man of
4. here all of stop tree
5. snow time will
6. stop egg run with good
7. dog nest girl
8. feet is big ten good
9. wish with her
10. nest milk one sun said
11. man sun sat with milk
12. good girl work
13. late time to wish you
14. like food one
15. is said five feet pop
16. up end to
17. I milk pop come zoo
18. man zoo food
19. eat egg take up take
20. do hot wish

Normal Sentences

1. I will play.
2. We went to the zoo.
3. The cat played.
4. That girl is not good.
5. I know you.
6. She ran to the store.
7. Stop the car.
8. We play in the snow.
9. You work late.
10. You do like the snow.
11. I am big.
12. That boy is with me.
13. I eat here.
14. I was a good boy.
15. I like milk.
16. That boy will play here.
17. I like her.
18. Five men came to work.
19. Lock the door.
20. You take that cat out.

APPENDIX C

STANDARDIZED INSTRUCTIONS GIVEN TO SUBJECT PRIOR TO EACH EXPERIMENTAL SESSION

APPENDIX C

STANDARDIZED INSTRUCTIONS GIVEN TO SUBJECT PRIOR TO EACH EXPERIMENTAL SESSION

I want you to listen to what the man is saying on the tape recorder. He will say the number of the sentence "Number _____" and then the words. Some sentences will be longer than others. When the man stops speaking, I want you to tell me exactly what you heard him say. If you can't remember everything, repeat as much as you can remember. Do you have any questions? (Answer questions) let's try a couple together. (Play two undistorted practice sentences--one three word and one five word) Any questions? (Answer questions) Fine, let's begin.

APPENDIX D

ANSWER FORM USED TO TRANSCRIBE SUBJECTS' RESPONSES

APPENDIX D

ANSWER FORM USED TO TRANSCRIBE
SUBJECTS' RESPONSES

RESPONSE FORM

GRADE_____

CONDITION_____

First Order

1. go girl zoo _____
2. men zoo pop nest is _____
3. take hot girl _____
4. red play late I call _____
5. food jar wish _____
6. snow take play big man _____
7. jar sand man _____
8. name milk good girl sun _____
9. red toy us _____
10. time all sun pop tree _____
11. wish pop milk _____
12. snow pop dish is name _____
13. egg call ten _____
14. pop zoo cry food milk _____

15. up jar said _____

16. tree up yes me word _____

17. nest ring sun _____

18. me play wish milk nest _____

19. name will jar _____

20. dog cat high man hot _____

COMMENTS

RESPONSE FORM

GRADE_____

CONDITION_____

Second Order

21. men will do _____
22. I put up to like _____
23. that man of _____
24. here all of stop tree _____
25. snow time will _____
26. stop egg run with good _____

26a. dog nest girl _____

27. feet is big ten good _____
28. wish with her _____
29. nest milk one sun said _____
30. man sun sat with milk _____
31. good girl work _____
32. late time to wish you _____
33. like food one _____
34. is said five feet pop _____
35. up end to _____
36. I milk pop come zoo _____
37. man zoo food _____
38. eat egg take up ten _____
39. do hot wish _____

COMMENTS

RESPONSE FORM

GRADE_____

CONDITION_____

Normal Sentences

40. I will play. _____

41. We went to the zoo. _____

42. The cat played. _____

43. That girl is not good. _____

44. I know you. _____

45. She ran to the store. _____

46. Stop the car. _____

47. We play in the snow. _____

48. You work late. _____

49. You do like the snow. _____

50. I am big. _____

51. That boy is with me. _____

52. I eat here. _____

53. I was a good boy. _____

54. I like milk. _____

55. That boy will play here. _____

56. I like her. _____

57. Five men came to work. _____

58. Lock the door. _____

59. You take that cat out. _____

COMMENTS

APPENDIX E

TABLES OF MEAN PERCENTAGE CORRECT SCORES

Table 4.--Overall mean percent correct scores for Grade (second grade, fourth grade), Interstimulus Interval (200msec, 400msec, unaltered), Order of Sentential Approximation (first order sentential approximation, second order sentential approximation, normal sentences) and Sentence Length (three word, five word) across each of the other conditions.

	Second Grade	Fourth Grade	Total
Grade	41.3	42.4	41.9
Interstimulus Interval			
200 msec	27.5	54.7	41.1
400 msec	25.8	52.4	39.1
unaltered	29.3	60.4	44.9
Total	27.5	55.8	41.7
Sentence Length			
three word	95.6	96.0	95.8
five word	68.7	74.8	71.8
Total	82.2	85.4	83.8

Table 4.--Continued

	Second Grade	Fourth Grade	Total
Order of Sentential Approximation			
1st Order	71.3	76.2	73.8
2nd Order	78.2	78.7	78.5
Normal	98.8	99.3	99.1
Total	82.8	84.7	83.8
Grand Total	58.5	67.1	62.8

Table 5.--Mean percentage correct scores for Interstimulus Interval (200msec, 400msec, unaltered) by Grade (second grade, fourth grade) and Sentence Length (three word, five word).

Interstimulus Interval	Sentence Length	Second Grade	Fourth Grade	Total
200 msec	three word	95.0	92.0	93.5
	five word	70.0	70.6	70.3
Total		82.5	81.3	81.9
400 msec	three word	97.6	97.6	97.6
	five word	57.3	65.3	61.3
Total		77.5	81.5	79.5
unaltered	three word	97.3	98.6	98.0
	five word	78.3	88.3	85.9
Total		87.7	93.5	90.7
Grand Total		82.6	85.4	84.0

Table 5.--Mean percentage correct scores for Interstimulus Interval (200msec, 400msec, unaltered) by Grade (second grade, fourth grade) and Sentence Length (three word, five word).

Interstimulus Interval	Sentence Length	Second Grade	Fourth Grade	Total
200 msec	three word	95.0	92.0	93.5
	five word	70.0	70.6	70.3
Total		82.5	81.3	81.9
400 msec	three word	97.6	97.6	97.6
	five word	57.3	65.3	61.3
Total		77.5	81.5	79.5
unaltered	three word	97.3	98.6	98.0
	five word	78.3	88.3	85.9
Total		87.7	93.5	90.7
Grand Total		82.6	85.4	84.0

Table 6.--Mean percentage correct scores for Interstimulus Interval (200msec, 400msec, unaltered), by Order (first order sentential approximation, second order sentential approximation, normal sentence) and Sentence Length (three word, five word).

Interstimulus Interval	Order of Sentential Approximation	Three Word	Five Word	Total
200 msec	1st Order	95.0	48.5	71.8
	2nd Order	91.0	61.5	76.3
	Normal	99.5	96.5	98.0
Total		63.5	68.8	66.2
400 msec	1st Order	97.5	34.5	66.0
	2nd Order	90.5	44.0	67.3
	Normal	99.5	83.5	91.8
Total		98.5	59.3	77.6
unaltered	1st Order	94.0	72.0	83.0
	2nd Order	100.0	99.5	99.8
	Normal	100.0	99.5	99.8
Total		98.0	85.0	91.5
Grand Total		85.8	71.0	78.4

Table 7.--Mean percentage correct scores for Order (first order sentential approximation, second order sentential approximation, normal sentences) by Grade (second grade, fourth grade) and Sentence Length (three word, five word).

Order of Sentential Approximation	Sentence Length	Second Grade	Fourth Grade	Total
1st Order	three word	94.3	96.6	95.5
	five word	48.3	55.6	60.0
Total		71.3	71.6	71.5
2nd Order	three word	95.6	96.0	95.8
	five word	61.3	63.0	62.2
Total		78.5	79.5	79.0
Normal	three word	100.0	99.3	99.7
	five word	97.6	99.3	98.5
Total		98.5	99.3	99.1
Grand Total		82.9	83.5	83.2

APPENDIX F

SUBJECTS' RAW SCORES FOR EACH EXPERIMENTAL CONDITION

APPENDIX F

SUBJECTS' RAW SCORES FOR EACH EXPERIMENTAL CONDITION

SECOND GRADE

200 msec Interstimulus Interval Size

Subjects	1st Order	2nd Order	Normal
1	16	18	20
2	16	20	20
3	16	17	19
4	16	16	20
5	13	16	19
6	14	16	20
7	13	16	19
8	12	9	18
9	17	16	19
10	12	13	20

400 msec Interstimulus Interval Size

	1st Order	2nd Order	Normal
11	14	15	20
12	13	16	20
13	12	11	20
14	15	16	20
15	10	14	20
16	12	13	20
17	13	14	20
18	12	13	20
19	12	11	20
20	15	14	20

SECOND GRADE

	Unaltered Interstimulus Interval Size		
Subjects	1st Order	2nd Order	Normal
21	12	15	20
22	12	14	20
23	20	19	19
24	11	14	20
25	17	18	20
26	16	19	20
27	16	16	20
28	20	20	20
29	11	18	20
30	20	20	20

FOURTH GRADE

200 msec Interstimulus Interval Size

Subjects	1st Order	2nd Order	Normal
1	16	19	20
2	13	11	20
3	11	15	20
4	12	15	20
5	17	19	20
6	13	14	20
7	14	13	18
8	15	13	20
9	13	13	20
10	18	16	20

400 msec Interstimulus Interval Size

	1st Order	2nd Order	Normal
11	14	13	20
12	13	16	20
13	12	9	20
14	14	13	19
15	15	16	19
16	13	13	20
17	15	17	20
18	17	17	20
19	15	16	20
20	10	12	20

Unaltered Interstimulus Interval Size

	1st Order	2nd Order	Normal
21	16	17	20
22	18	18	20
23	19	20	20
24	17	18	20
25	19	19	20
26	15	16	20
27	20	20	20
28	19	20	20
29	18	17	20
30	16	19	20

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