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A Comparison of the Comprehension of Compressed Speech Between Normal Children and Children Exhibiting Behavioral Characteristics of Minimal Brain Damage

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A COMPARISON OF THE COMPREHENSION OF COMPRESSED SPEECH BETWEEN NORMAL CHILDREN AND CHILDREN EXHIBITING BEHAVIORAL CHARACTERISTICS OF MINIMAL BRAIN DAMAGE

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CHAPTER 1

INTRODUCTION

Sitcht (1968) has hypothesized that listening is more likely to be effective than reading in the first through fourth grades where information gathering is concerned. In effect, listening is the elementary child's most important information gathering tool(George, 1970). If, for some reason, the listening channel is distorted, a child may miss much of the information given during these first years of school. A child with minimal brain damage often exhibits a limitation in the comprehension of discerned sensory patterns, perceptual patterns, comprehension of words, verbal retention span and linguistic patterns (U.S. Department of Health, Education and Welfare, 1969). The child may also exhibit a short attention span, a lack of impulse control and distractibility (Wender,1970).

The minimally brain damaged child is unable to organize hierarchies; all aspects of his environment are given equal importance (Wender, 1970). He often will attend to unimportant factors rather than the major features of a stimulus. This is due in part to a failure of inhibition or impulse control. He is unable to separate and ignore stimuli in his environment (Bortner, 1968). Because this child is unable to fix his attention, he will respond to both external and internal stimuli (Wender, 1970). The child is unable to differentiate

between incoming stimuli, making the perception of auditory stimuli difficult (U.S. Department of Health, Education and Welfare, 1969).

Foulke and Sticht, (1967) proposed that in the minimally brain damaged child, the auditory channel capacity has been exceeded, which in turn reduces the amount of input recovered at the output. "When a word rate is too high, words can not be processed as fast as they are received with the result that some of the words and their associated meanings are lost."(Foulke and Sticht, 1967) If the auditory channel in a minimally brain damaged child is centrally affected, this channel or pathway does not become a source of continued learning. It becomes a source of distraction, discomfort and lack of control (Becker and Kirk, 1963). This line of thinking leads to the conclusion that a minimally brain damaged child would require auditory stimuli at a slower rate of presentation (Clark and Woodcock, 1968). In other words, the slower the verbal message, the more the child would comprehend.

It has been stated that a major difficulty the minimally brain damaged child exhibits is an inability to separate and ignore stimuli surrounding him (Bortner, 1968). It may be that his auditory channel capacity is exceeded by stimuli around him rather than the information presented. It could be beneficial to the brain damaged child to present the verbal information simply and rapidly. Rapid communication requires

greater concentration on the part of the listener. In the minimally brain damaged child, the increased concentration brought about by the increased speed may help eliminate distractions in his environment. This in turn would lessen the possibility of exceeding the child's attention span. Studies have shown that the presentation of material in short sentences interspersed with pauses is advantageous to the minimally brain damaged child (Wender, 1970). Because of the child's short attention span, a rapid presentation of short sentences interspersed with pauses may help decrease the environmental distractions surrounding the child. In this way, the amount of stimulation perceived by the child would be decreased, thereby decreasing the chance of overloading his capacity. However, there is a disadvantage to this method. Because of the minimally brain damaged child's short attention span, the presentation time would need to be brief. When using normal verbal communication, the amount of information presented in such a short time would be minimal. This in turn decreases the usefulness of the presentation. If the amount of information presented was increased while the time spent remained constant, this would become a more useful method of information presentation to the minimally brain damaged child. One solution to the need for decreasing the time of presentation is by increasing the rate of speech, thereby decreasing the time of presentation. This type of procedure is called accelerated or time-compressed speech (Foulke and Sticht, 1969).

Bortner (1968) felt that the minimally brain damaged child's responses to details may indicate an "incapacity to delay a response until all the data are considered." This further supports the notion of increasing the rate of presentation, thereby decreasing the amount of time required.

When the time required for information to be presented is reduced through the use of time-compressed speech, several things may occur. The rapid rate of presentation will require a greater degree of concentration on the part of the listener. This increased concentration to the verbal message will in turn decrease the distracting affect of other stimuli in the child's environment. The rapid rate of presentation will also decrease the time spent. When all the data are presented rapidly, the minimally brain damaged child may be able to inhibit his response until all of the data is presented rather than just responding to the first portion of a presentation. This rapid presentation of information is also beneficial where the child's attention span is concerned. When the presentation time is limited only to the amount of time that a minimally brain damaged child's attention span consists, the danger of exceeding this attention span will be decreased if not eliminated. The use of compressed speech in the educational environment of the minimally brain damaged child will enable the instructor to decrease the amount of time needed for the presentation of information while maintaining an equal amount of information that is presented by more conventional means.

Increased concentration may occur because of the increased rate of speech, decreasing the distractive components of other aspects of the child's environment. When used properly, compressed speech may become an important educational asset to the minimally brain damaged child.

STATEMENT OF PROBLEM

The purpose of this study was to compare the comprehension of expanded and compressed speech in normal children and in children who exhibit some of the behavioral characteristics of minimally brain damaged children. It was felt that if the amount of information presented was increased while the time spent remained constant, this would become a more useful method of information presentation to the minimally brain damaged child.

The questions to be answered were:

1. Is there a statistically significant difference between the scores for children with minimal brain damage characteristics and normal children on the Assessment of Children's Language Comprehension (ACLC) for the following rates of expansion (-) and compression (+):

   a) -40%

   b) -20%

   c) +20%

   d) +40%

   e) +60%

2. Is comprehension at the following levels of difficulty within the ACLC subtests affected differently between the two groups?

   a) 2 elements at -40% and -20% expansion and +20%

+40% and +60% compression

b) 3 elements at -40% and -20% expansion and -20%, +40% and +20% compression

c) 4 elements at -40% and -20% expansion and +20%, +40% and +60% compression

CHAPTER II

REVIEW OF THE LITERATURE

THE MINIMALLY BRAIN DAMAGED CHILD

The term minimal brain damage is used to designate a condition in children in which the neurological impairment is slight. The child's behavior and learning are affected without lowering the general intellectual capacity (Waugh and Bush, 1971). The chief characteristic of a child with a central nervous system disorder is distractibility. This may include response to an unessential stimulus, disinhibition and a short attention span. It has been determined that distractibility is a factor in the poor test performance of these children. Motor disinhibition may also be present. This involves the failure of a child to refrain from responding to any stimuli which produce a motor activity (Cruickshank, 1961). Behavioral disorders include clumsiness, awkwardness, incoordination, emotional lability and erratic behavior (Bortner, 1968). More centrally located disorders include dissociation (the inability to conceptualize a totality), figure-ground disturbance, perseveration and disturbance in self concept and body-image concept (Cruickshank, 1961). Scholastically, these disabilities may appear as disorders of memory, thinking, disorders of speech and hearing and specific disabilities in reading, writing , arithmetic and spelling (McCarthy and McCarthy, 1969).

It is apparent that the minimally brain damaged child's failure of inhibition is a serious detriment to his scholastic success. Because of this the child is unable to separate and ignore stimuli in his environment. He will respond to all aspects of his environment (Wender, 1970), thus exceeding the auditory channel capacity. This includes auditory, visual and tactile stimuli. The performance in almost any cognitive activity involves some element of attention and concentration. The minimally brain damaged child is hindered in these activities because he is unable to separate relevant and irrelevant stimuli. In order to help the minimally brain damaged child overcome his disabilities, a structured environment is needed to educate the child to exercise control from within (Bortner, 1968). In order to structure the environment properly, the surrounding stimuli should be reduced by removing all unessential stimuli. In this way the child will have an increased opportunity to attend, for necessary periods of time, to those stimuli which are essential to his learning.

Wender (1970) has shown that when material is presented in short sentences interspersed with pauses, the minimally brain damaged child is able to attend more. This child's educational environment needs to be structured not only to eliminate unnecessary stimuli but also to present information in the most effective way for each individual child. One way of providing this special type of environment is to use cubicles equipped with earphones and the necessary school equipment

(paper, pencil, books, etc.). Through the use of earphones, the teacher is able to present the verbal information to each child individually, thereby meeting each child's special needs (Bortner, 1968). Such an arrangement provides an opportunity for the use of compressed or expanded speech in an educational setting. By first determining at the rate of presentation a child comprehends best, the teacher is able to provide a consistent rate of presentation for each child. In this way, the child's educational environment can be structured to meet his individual needs.

In summary, the following behaviors seem to be generalized throughout the literature concerning the minimally brain damaged child:

1. distractibility
2. motor disinhibition
3. hyperactivity
4. incoordination
5. perseveration
6. reading, writing, spelling and arithmetic disabilities
7. short attention span

Numerous other behaviors may be caused by these basic behaviors. As the child meets failure and frustration, these behaviors may increase or other, more serious behaviors may appear. These disabilities hinder the minimally brain damaged child's educational performance both directly and indirectly. In order to adequately educate this child, it is often necessary to

decrease, eliminate and/or prevent the occurrence of the disrupting behaviors.

SPEECH COMPRESSION AND EXPANSION

Methods

There are several methods available for creating accelerated or time compressed speech. The simplest method is merely speaking rapidly, which requires no equipment. But it is limited in that only a moderate increase in the articulation rate of speech sounds is possible because of the physical limitations of the speaker. The articulators only move so rapidly and still maintain any degree of accuracy. There are also changes in identity, word inflection, and in the duration of consonants, vowels and pauses (Foulke and Sticht, 1969). A second method is the speed changing method. Here a recorded tape is reproduced at a different tape or record speed than the original one. However, serious distortions result from this method (Foulke, 1969). There is a porportional shift in the frequencies of the voice signal to the change in the tape or record speed. When the speed is doubled, the frequencies are also doubled, resulting in a pitch rise of one octave. Both of these methods tend to alter the components involved in speaking, thereby decreasing intelligibility (Foulke and Sticht, 1969).

Fairbanks, et al, (1954) published a description of an apparatus that would reproduce periodic samples of a recorded tape. The samples discarded are brief enough that the ear is

unable to detect any loss. As long as the discard interval is less than the time required for reproduction of each critical feature, it will be impossible for a critical feature to fall completely within a discarded sample (Foulke, 1969). In other words, the samples that are unreproduced are brief enough that a discarded segment will not contain a complete speech segment while the retained samples are abutted in time. With this method, all speech sounds in an original recording are sampled. The result of this is a time compressed reproduction with no alteration in vocal pitch(Foulke and Sticht, 1969). Speech is expanded by reproducing overlapping samples of the signal (Foulke, 1969). Cramer and Talambiras (1971) introduced a refinement of the Fairbanks periodic sampling method. In this machine, samples of one pitch period are removed, but every other pitch period is there. In this way plosives and stops have a better chance of being sampled adequately.

Other methods of speech compression include bandwidth reduction by harmonic compression. There is a fixed output ratio of two times the input rate with a variance of twenty percent (Breuel and Levens, 1971). In other words, the material can be compressed at twice the rate of the input within a twenty percent time accuracy. Newer methods of speech compression involve the use of computers. Informal listening has shown that the speech compressed by the computer is clearer and is free of any low frequency rumbles that are present in the Fairbanks and similar machines. With some modification, this computer could also be used for time expansion of speech

(Qureshi and Kingma, 1971).

Measurement Variables

There are various methods of measuring compressed speech. It is clear that the critical variable in the method is the speech rate of both the input and the output. The speech rate of the speaker directly affects the number of words per minute produced by speech compression or expansion. The faster the speech rate of the speaker (in words per minute) the faster the rate of compression. The slower the speech rate, the slower the rate of compression. The same holds true for expanded speech. Other variables of the speech rate are the complexity of samples and the length of words. Carroll (1967) advocated the use of syllables per minute rather than words per minute, thereby reducing some of the variability involved in speech rate measurement.

The amount of compression may also be specified by determining the percentage of the original recording time that has been saved by reproducing the message at a faster rate. Forty percent compression means that forty percent of the production time has been saved (Foulke and Sticht, 1969).

Another method of measurement is in terms of acceleration of the original word rate, tape speed or record speed.

> An acceleration of 1.5 means that the word rate after compression is 1.5 times the word rate before compression. In comparing these indices, it must be remembered that the relationship between them is not linear. For instance, whereas an increase in acceleration from 1.1 to 1.2 corresponds to an increase from 9% to 17%, an increase in acceleration from 1.9 to 2.0 corresponds to a change

in compression from 47% to 50% (Foulke and Sticht, 1969). This non-linear relationship is present because neither of the indices directly indicate the word rate of compressed speech because this rate is dependent upon the rate of speaking before compression.

Before proceeding, it is necessary to differentiate between the measurements of intelligibility and comprehension of compressed speech and expanded speech. Intelligibility involves the short term memory process (Foulke and Sticht, 1967). The index of intelligibility in compressed speech is often taken as the "ability to repeat a word, phrase or short sentence accurately." It may also be a "measurement of disjunctive reaction time" (Foulke and Sticht, 1969. Foulke (1968) and Heise (1971) found that single word intelligibility was good beyond the level of compression where the comprehension of connect speech begins to decline.

Comprehension is a continuous process, making it a more complex task than intelligibility (Foulke and Sticht, 1967). In evaluating the effects of compression upon comprehension, a selection compressed in time is presented and the listener is tested for the comprehension of the selection (Foulke and Sticht, 1969). The major factor affecting the comprehension of compressed speech is the word rate of the stimuli presented. Within the range from 125 wpm (words per minute) to 175 wpm, comprehension was unaffected with subjects of college age (Foulke, 1968); from 175 wpm to 275 wpm, comprehension was increased; from 275 wpm to 325 wpm comprehension decreased;

from 325 wpm to 375 wpm, the greatest decrease in comprehension occured. Again the subjects were individuals of college age (Reid, 1968). Foulke and Sticht (1969), found a six percent increase in comprehension between 225 wpm and 325 wpm and a fourteen percent decrease between 325 wpm and 425 wpm.

Fairbanks, et al, (1957) found that a sixty percent compression level (353 wpm) gave a maximal efficiency of comprehension score of fifty percent. At fifty percent compression (282 wpm) a score of ninety percent comprehension was received. In a study involving school age children, Shriner and Sprague (1969) found that after fifty percent compression, comprehension decreased. It was hypothesized that when a child's processing system is working at its' maximum speed, reaction time becomes an important factor as the intelligibility of the message decreases.

Sticht (1968) found no difference in reading or listening skills of men with average or low mental aptitude regardless of the level of difficulty or rate of presentation. The men with average mental aptitudes did tend to score higher although no interactions between speech rate and mental aptitude were found. Woodcock and Clark (1968) found that children with lower IQ's performed at slower rates than children with higher IQ's.

There are several other factors that seem to operate in the process of comprehending compressed speech. The difficulty of the material presented appears to be one of the most constant (Fairbanks, et al, 1957). Sticht (1968) determined that

simplified versions of the material presented resulted in a greater average comprehension ability. He found a significant relationship between grammatical complexity and comprehension of compressed speech. Both speech rate and signal distortion may affect listening comprehension although this is more noticeable with material with low redundancy (Sticht, 1969). The first 25 to 30 percent of the time segments removed from speech may be redundant. The next 20 to 30 percent may be redundant in information but require more attention and effort on the part of the listener to monitor speech (Zemlin, Daniloff and Shriner, 1968). In order to increase comprehension at high rates of speech, the original version plus reinforcing material is presented, thus giving a double presentation of the important facts in the time saved by compressing the original message (Fairbanks, et al, 1957). Sticht (1971) found that a double presentation of material compressed by fifty percent gave a slight improvement in comprehension than with a single presentation of uncompressed material.

The factor of speech rate is considered a more important determiner of comprehension of material than the factor of signal distortion. The barrier seems to be within the "information processing capacities" of the listener rather than the signal itself (Sticht, 1970). Sticht felt that the loss of comprehension appeared to be due to storage or retrieval problems rather than to misperception of distorted words. The addition of syntax and/or inflectional cues to the meaning within the materials tended to help the comprehension of the

listener. Foulke (1968) hypothesized that "the loss in comprehension from increasing the word rate (accelerated by the sampling method) is due to the degradation in word intelligibility and to the reduction in perception time needed by the listener to process incoming speech information." The process of speech comprehension entails the registration, encoding and storage of information. This entire process requires time. The listener's capacity to perform the above operations is surpassed at the higher rates of compression, thus explaining the decrease in comprehension at the higher rates (Heise, 1971).

Another factor involving the comprehension of compressed speech is the voice of the speaker. Speech is processed mentally over a period of a pitch period. "The pitch perceived is determined by the length of time between fundamental cycles irrespective of half periods added to a fundamental"(Foulke, 1968). An average male has about half the number of pitch periods in a given time as a soprano voice. Because of this redundancy in a woman's voice, she will convey half as much information in a given time as a man. Because of this it would be feasible to expect that a woman's voice would be more intelligible when compressed at high rates. With twice the pitch periods in a female voice, twice as many pitch periods can be discarded, leaving an equal number perceived as the male voice. However, a female's fundamental frequency varies much more than the male voice, causing it to compress poorly (Foulke, 1968). Heise (1971) found that vocal pitch does not affect the comprehension of compressed speech. When questioned,

the majority of normal listeners of compressed speech preferred a male voice to a female voice. They felt that the male was less difficult to understand (Zemlin, Daniloff and Shriner, 1968).

Woodcock and Clark (1968) indicated that the use of high speed listening techniques could be an effective learning medium for elementary children. Napier (1971) investigated the extended use of time compressed speech in the intermediate grades. She found that the fourth grade students' comprehension scores showed a more steady upward climb than the fifth grades. This seems to indicate that compressed speech may be a more beneficial tool in the lower grades for increasing the comprehension of presented material. Orr and Friedman (1968) noted a slight increase in comprehension scores after mass practice, indicating, to them, that comprehension of compressed speech can be improved through practice.

Woodcock (1971) demonstrated that repeated exposure of compressed speech was not that helpful, producing little improvement in performance. Only at very fast rates did there appear to be an advantage to listening twice. He also found that while the highest test scores received were between 75 wpm and 125 wpm, the most efficient listening took place between 250 wpm and 300 wpm. Speech compression rates of 228 wpm to 328 wpm were more efficient for learning and retention rather than the normal rate of 178 wpm. The performance curves in these studies displayed a secondary peak just prior to the final drop in performance at very high listening rates

(Woodcock and Clark, 1968). It was interesting to note that the performance curves were similar although the level of performance differed for the different mental abilities (Woodcock, 1971).

It is apparent that there may be some value in developing appropriate training procedures for listening to the higher rates of compressed speech. It may be possible to increase the comprehension of higher rates of speech compression through the use of training procedures (Foulke, 1971). Shriner and Sprague (1969) found that speeds slower than normal (expanded speech) do not add to the comprehension of material, but up to twice as much as normal did not detract very much from the comprehension of the material.

Educationally, the time saved through the use of speech compression can be utilized in many productive outlets. Parker's study (1971) of the comprehension of junior college students indicated that an aural presentation of compressed speech plus an appropriate visual presentation resulted in better comprehension. This is in agreement with Wender's (1970) results in that a combined presentation of visual and aural produces the best comprehension.

Speech compression with appropriate training can be used with children who must place a great deal of reliance on speaking and listening in order to communicate. This would include the child without visual impairment but who has serious reading problems that do not yield to remedial efforts (Foulke, 1971). The time save by using speech compression

can be used to repeat the message although this has not been shown to improve learning. This time gained can also be used to present additional material, instruct other groups or have individual instructions (Sticht, 1971). While the educational implications of speech compression are extensive, it should be remembered that each child is an individual. As in anything else, there are large individual differences in the comprehension of compressed speech; there is not one optimum speed (Shriner and Sprague, 1969). If this basic stipulation is remembered, the use of rate controlled speech can become a valuable tool to the elementary classroom teacher.

In summary, the methods of compressing speech include the Fairbank's sampling technique, bandwidth reduction by harmonic compression and the use of computers. Measurement variables to be concerned with are the speech rate of the input and output, the complexity of samples and the length of words. When investigating the comprehension of compressed speech, it is important to differentiate between intelligibility and comprehension of speech. Comprehension is a complex, continuous process as opposed to intelligibility which involves a short term memory process (Foulke and Sticht, 1969). After forty percent compression, comprehension delcines sharply (Fairbanks, 1957). Apparently forty percent compression is the highest speech rate that produces ninety percent comprehension. The factors that affect the comprehension of compressed speech include the difficulty of material presented

(Fairbanks, 1957), speech rate, signal distortion (Sticht, 1968), redundancy of material presented (Zemlin, Daniloff and Shriner, 1968) and, to some extent, the voice of the speaker.

CHAPTER III

PROCEDURES

Subjects

Ten children were used in this study, five normal children and five children who exhibited the characteristics demonstrated by minimally brain damaged children. These children were drawn from the second and third grades. Two tests were used to determine the presence of behavioral characteristics of brain damage. The Bender-Gestalt Test of Motor Performance was administered according to the instructions provided in the manual. A behavior list was given to the second and third grade teachers to aid in the classification of minimal brain damage behaviors. The child must exhibit at least fifteen of the twenty behaviors to be used in this study. The twenty behaviors listed were taken from the listings of Clements (1966), who presented possible behavioral, physical and neurological characteristics of the minimally brain damaged child. The behavior list used in this study can be found in Appendix I. All ten subjects were of normal hearing, having passed a screening examination of the frequencies 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz and 8000 Hz presented at 15 dB in both the right and the left ear.

Stimuli

The Assessment of Children's Language Comprehension (ACLC) was presented as the stimuli. A brief test of comprehension was required in this study. Listening to a paragraph and then answering appropriate questions is a typical test of comprehension. However, this may be too complex for the subjects being tested. The ACLC requires no verbalizations, the subject is merely to point to the appropriate picture. The phrases are brief, but the individual must comprehend the entire phrase to respond correctly. The separations of the levels of difficulty enables the examiner to chart each level of comprehension rather than depend upon overall estimates of the child's ability to comprehend at various speeds.

A pre- and post-test was presented at normal speed. Sections B,C, and D were then played again at varying amounts of compression and expansion. Two phrases from each section were randomly selected through the use of a table of random numbers to be presented at one of the given expansion or compression levels. The total number of phrases presented at each level of expansion and compression was six. Three different forms of the ACLC were presented. These were developed by randomly selecting the verbal directives for each item. In this way each verbal directive was presented only once. Each verbal directive of the three forms was randomly assigned a compression or expansion level according to the guidlines mentioned earlier (page 23). The order of presentation of each test was randomly selected, again through the use of a

table of random numbers. In order to facilitate administration, the examiner used three ACLC forms. The instructions were the same as recommended for the administration of the ACLC.

The expanded and compressed speech was described in terms of the percent of compression and expansion. All of the possible measurement techniques had their drawbacks in ease of measurement and/or degree of variability. In this study, the shortness of the phrases limited the accuracy of a word per minute measurement. Because of this, it was decided to describe compressed speech just in terms of the percent of compression and expansion in order to give a meaningful measurement (Foulke and Sticht, 1969).

The majority of studies concerning speech compression have used three degrees of compression - twenty percent, forty percent and sixty percent. Comprehension seems to drop off after forty percent compression, indicating that the results would probably be the same after sixty percent compression. Through listening to expanded speech, it was felt that the values of twenty percent and forty percent expansion represented more difference than lesser values. In summary, the expanded levels of twenty percent and forty percent and the compressed levels of twenty percent, forty percent and sixty percent were used.

Administration

All instructions were presented on tape by tape recorder. The child was shown the volume control on the tape recorder and

how to adjust the loudness level. In this way, he was able to determine the most comfortable listening level for him. The examiner controlled the pause length between the stimuli through the use of the editing control on the tape recorder. The appropriate test form was placed in front of the child. The ACLC vocabulary subtest was presented first and scored. A score of 100 percent was required before proceeding. The pre-, experimental and post-test was then presented with a brief pause between each. The child was asked to point to the appropriate picture on the ACLC plates. In the experimental portion, an item could be repeated upon the child's request.

Scoring

The results of the ACLC were graphed in order to compare inter- and intra-group performance. This included a comparison of levels of difficulty for each level of compression and expansion. A test of significant difference of percentage scores (Mann Whitney U) was run to determine how much of a difference in the results of the two groups is significant.

Equipment

A Wollensak Model 1500 tape recorder was used as the playback machine. The Tempo Regulator speech compressor at the Center for Rate-Controlled Recordings at the University of Louisville, Kentucky, under the supervision of Dr. Emerson Foulke, was used to compress the stimulus material. The time compressed and expanded material was recorded from the speech compressor at 7.5 ips, full track on a Crown tape recorder,

model 800 (George, 1970). The speaker was an adult male.

Data Analysis

A. The Mann Whitney U was calculated to determine if there was a significant difference between the scores of the children with minimal brain damage characteristics and the normal children for the following levels of compression (+) and expansion (-): -40%, -20%, +20%, +40% and +60%.

B. The Mann Whitney U was calculated to determine if there was a significant difference between the comprehension of the subtests of the ACLC of the two groups. Two, three and four critical elements at the compression (+) and expansion (-) levels of -40%, -20%, +20%, +40% and +60% were analyzed.

CHAPTER IV

RESULTS AND DISCUSSION

The Bender-Gestalt Test of Motor Performance was administered as a diagnostic aid in the identification of behavioral characteristics of the minimally brain damaged children. A behavioral checklist, compiled by the experimenter, of twenty of the most frequently occuring behaviors of minimally brain damaged children was also used as an aid in the identification of the behavioral characteristics of brain damage. The following table contains the scores received from the Bender-Gestalt and the behavior list.

TABLE 1

SUMMARY OF SCORES RECEIVED ON THE BENDER-GESTALT AND THE LIST OF TWENTY BEHAVIORS

Subject	Bender-Gestalt	Behavior List
1E	7	20
2E	3	15
3E	10	17
4E	9	18
5E	14	17

A complete listing of the behaviors of the list and the Bender-Gestalt can be found in Appendix I.

The Mann Whitney U, a non-parametric test of statistical

difference was administered to determine significant differences posed by the questions presented (Downey and Heath, 1965: Siegal, 1956). An .05 level of confidence was set. For clarity of discussion, the term experimental group will be used to designate the children who exhibit behavioral characteristics of the mininally brain damaged child while the term control group will be used to designate the normal children. Although neither group was an experimental group in the true sense, for the purpose of facilitating readibility, the terms control and experimental will be used.

Amount of Compression

Two questions were posed at the onset of this study. The first question concerned the difference between the scores for the experimental group and the control group on the ACLC for the following rates of expansion (-) and compression (+); -40%, -20%, +20%, +40% and +60%. In answering the question, a one-tailed test was employed since it was hypothesized that the control group would score higher than the experimental group. The Mann Whitney U was used to evaluate the statistical significance of this data because of the small sample size. A summary of these findings can be found in Table 2. The compression level of +60% was found to be statistically significant at the .05 level of confidence. The levels of -40%, -20%, +20% and +40% were found to be nonsignificant at the .05 level of confidence.

TABLE 2

SUMMARY OF THE COMPARISON OF THE COMPRESSION AND EXPANSION BETWEEN THE EXPERIMENTAL AND THE CONTROL GROUP

Items Compared	U Value	Significance
-40%	10.0	nonsignificant
-20%	7.5	nonsignificant
+20%	7.5	nonsignificant
+40%	5.5	nonsignificant
+60%	2.5	significant

The scores of the control group were higher than the scores of the experimental group at sixty percent compression. This would seem to indicate that normal children are able to comprehend compressed speech at higher rates than are the children with minimal brain damage characteristics.

Syntactic Complexity

The second question posed concerned the difference in comprehension of the three levels of difficulty within the ACLC subtests between the two groups. Each critical element level was analyzed at the following levels of expansion (-) and compression(+): -40%, -20%, +20%, +40% and +60%. A one-tailed test was again employed since it was hypothesized that the control group would score higher than the experimental group. The Mann Whitney U was used to evaluate the statistical significance of this data. A summary of these findings can be found in Table 3. The four critical element level of difficulty was found to be significant at the .05 level of confidence. This feature of syntax accounted for the specific grammatical

comprehension differences between the experimental and control groups. Two critical element and three critical element levels of difficulty were found to be non-significant at the .05 level of confidence.

TABLE 3

SUMMARY OF THE COMPARISON OF THE COMPREHENSION OF THE THREE LEVELS OF DIFFICULTY IN THE ACLC SUBTESTS

Items Compared	U Value	Significance
2 critical elements	5	nonsignificant
3 critical elements	5	nonsignificant
4 critical elements	2	significant

Again the scores of the control group were higher than the experimental group. This seems to indicate that normal children are able to comprehend larger units of syntax at a high rate of speed than the children with minimally brain damaged characteristics.

Effects of Exposure to Compressed and Expanded Speech

The Mann Whitney U was used to evaluate the statistical significance of the following data:

a. pre-test experimental vs pre-test control

b. post-test experimental vs post-test control

c. $\sim X$ experimental vs $\sim X$ control

d. pre-test experimental vs post-test experimental

e. pre-test control vs post-test control

These analyses were computed to determine a) if a difference in the comprehension of the normal rate of presentation between the experimental and the control group was exhibited, b) if a difference in the comprehension of compressed and expanded speech between the two groups was exhibited ($\sim$X test) and c) if learning did take place as a function of the number of presentations. The symbol $\sim$X will be used to describe the ACLC presentation that is expanded and compressed. A summary of the findings of these analyses can be found in Table 4.

TABLE 4

SUMMARY OF THE COMPARISONS OF THE FOLLOWING DATA

Items Compared	U Value	Significance
pre-test E vs pre-test C	7	nonsignificant
post-test E vs post-test C	9	nonsignificant
$\sim$X E vs $\sim$X C	2	significant
pre-test E vs post-test E	7	nonsignificant
pre-test C vs post-test C	8	nonsignificant

A significantly significant difference was found between the $\sim$X experimental and the $\sim$X control. Nonsignificant differences were found in the comparisons between the pre-test experimental and the pre-test control, the pre-test experimental and the post-test experimental, the post-test experimental and the post-test control, and the post-test control and the pre-test control.

These results indicate that the experimental and the

control groups performed relatively the same on all but the ~X tests. Apparently the use of expanded and compressed is a differentiating factor between these two groups.

Control Group

In order to evaluate fully the results of this study, one must analyze the individual results of the subjects. Figures one through five represent the number of correct responses for each of the five control subjects as a function of the amount of compression. Forty percent compression seems to be the crucial point in these results. In three of the five subjects, the number of correct responses dropped at the forty percent compression level and remained down at the sixty percent compression level. In all five cases the number of the correct responses dropped at the sixty percent level of compression. This is in agreement with earlier research findings in that after fifty percent compression, comprehension sharply decreased (Shriner and Sprague, 1969). Fairbanks (1957) found that at sixty percent compression a maximal efficiency of comprehension score of fifty percent was received. At fifty percent compression a score of ninety percent comprehension was achieved. The control group did not show any improvement as a function of increased compression but this may be due to their original high level of performance. If a more varied representation of comprehension skills were employed, some improvement may be shown that is a function of the level of compression. A child with a lower comprehension score on the pre-test and post-test may show

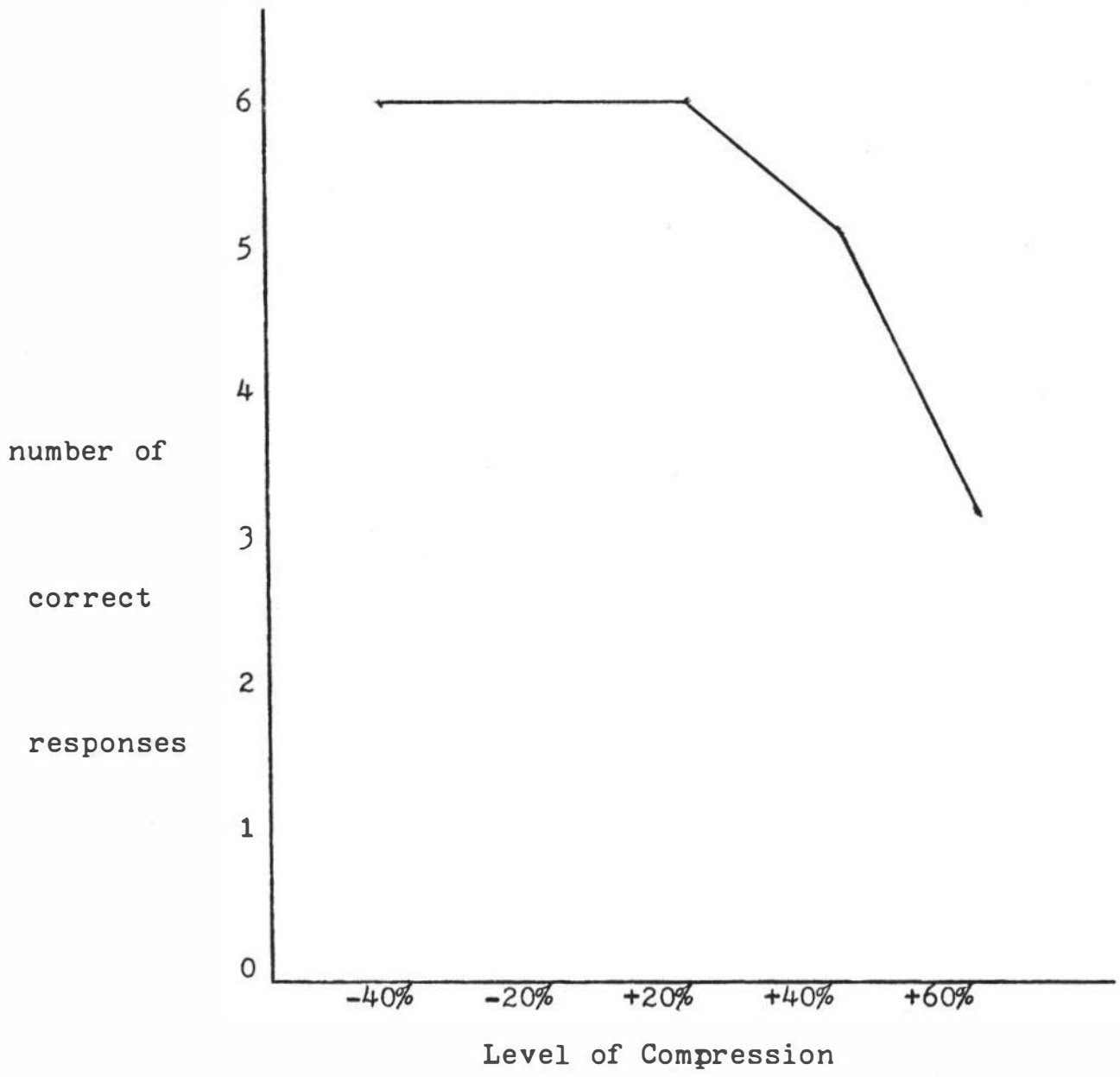

Figure 1. Number of correct responses as a function of the level of compression for control subject one (1C).

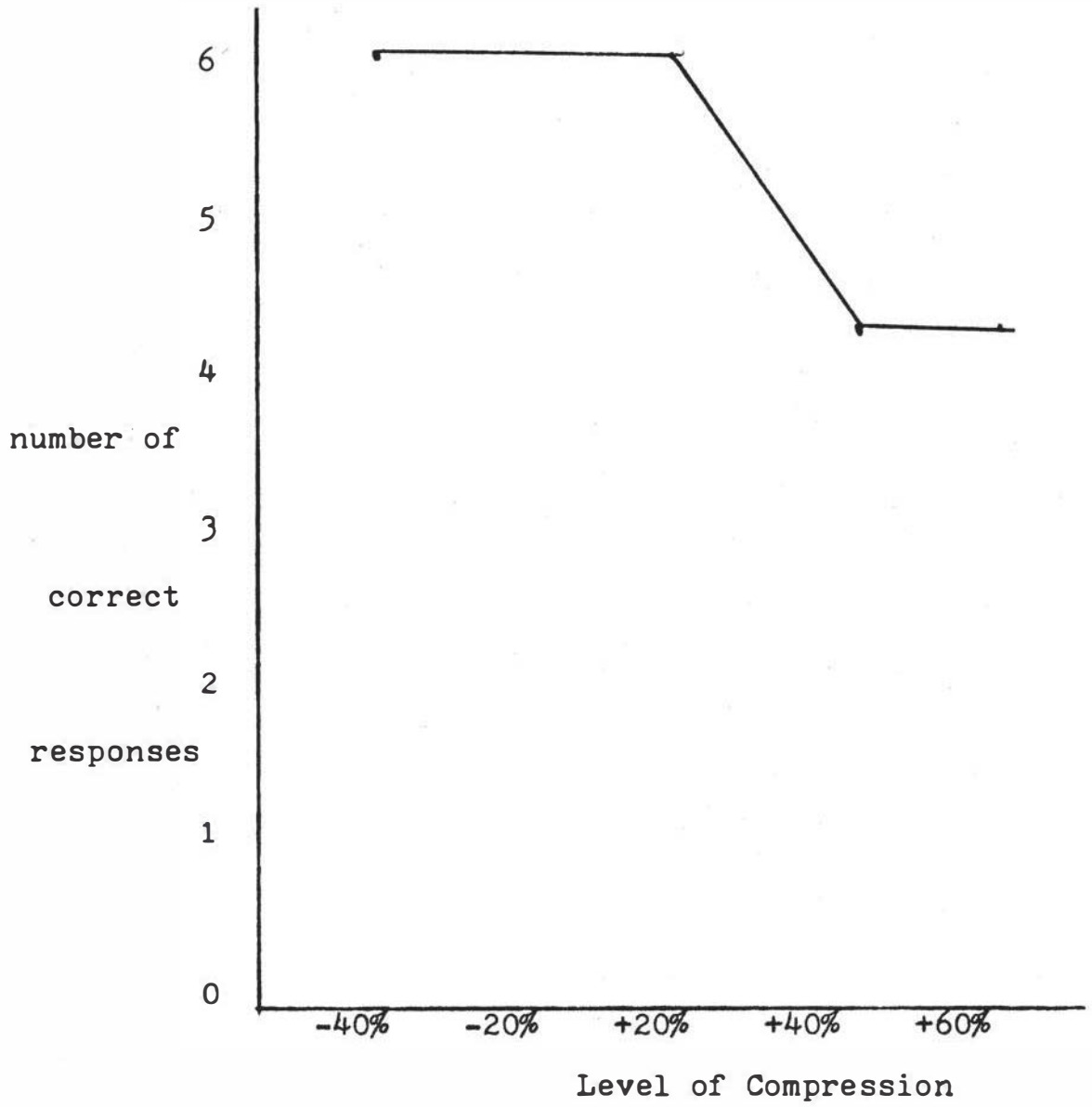

Figure 2: Number of correct responses as a function of the level of compression for control subject two (2C).

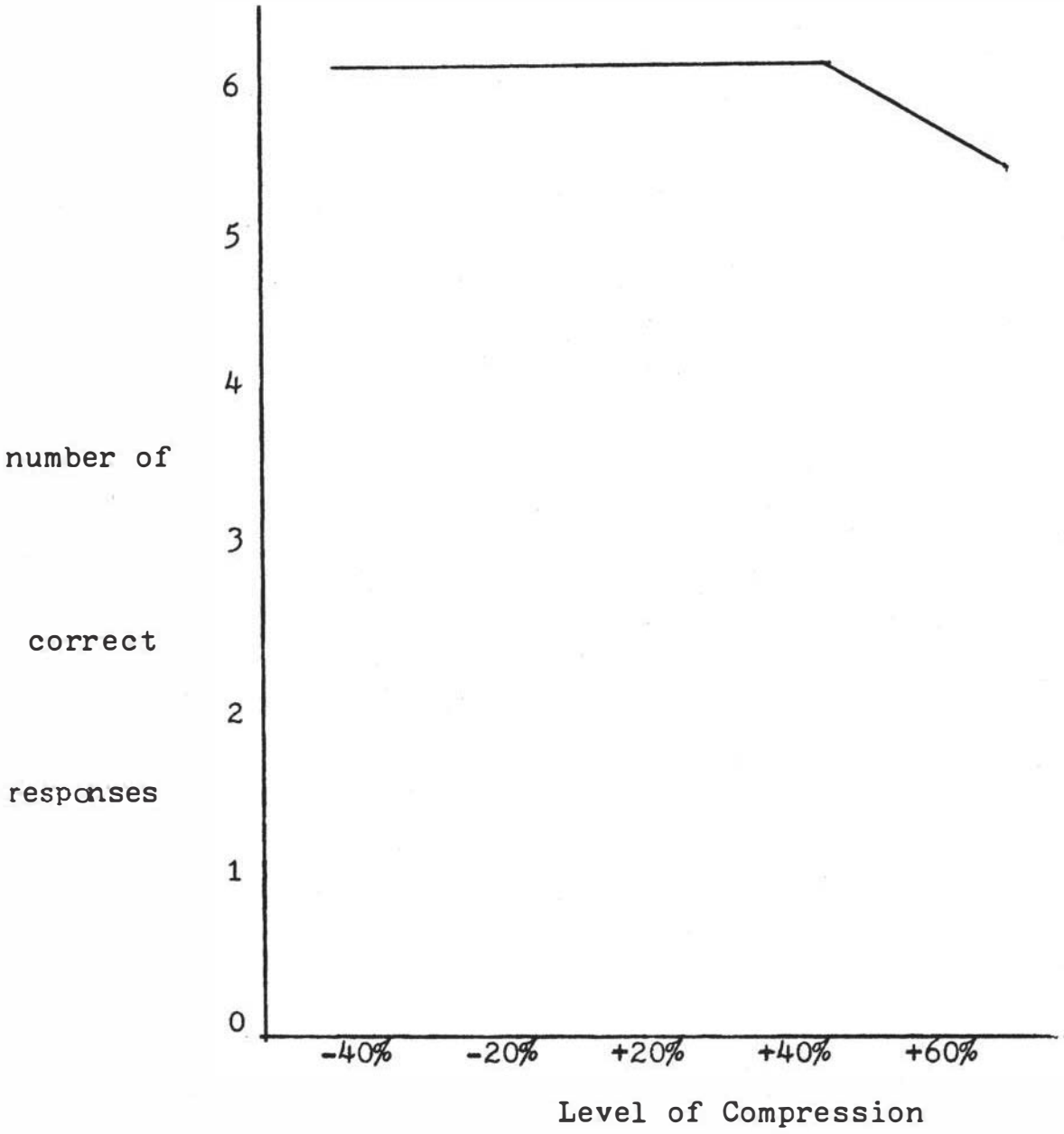

Figure 3. Number of correct responses as a function of the level of compression for control subject three (3C).

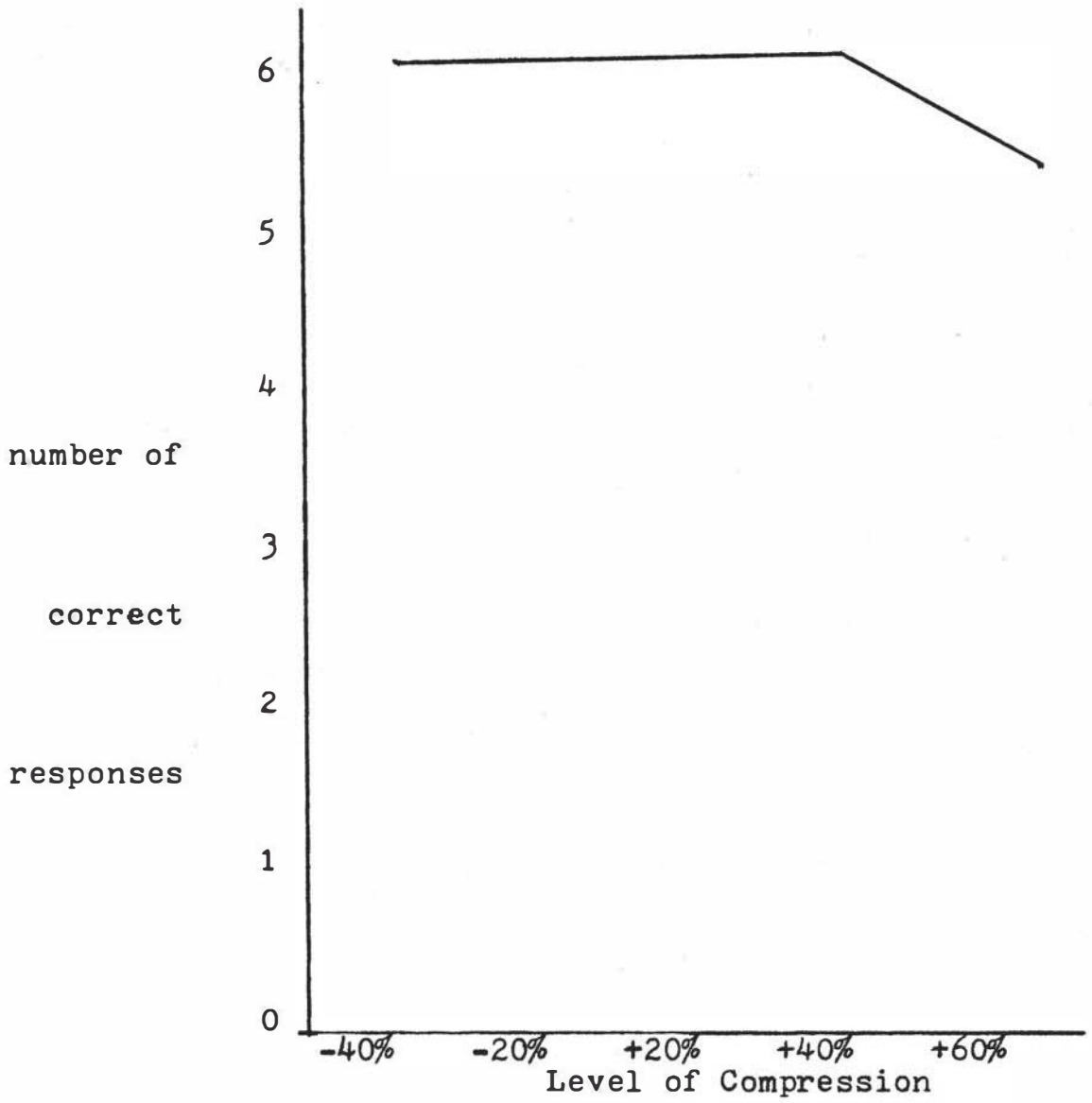

Figure 4. Number of correct responses as a function of the level of compression for control subject four (4C).

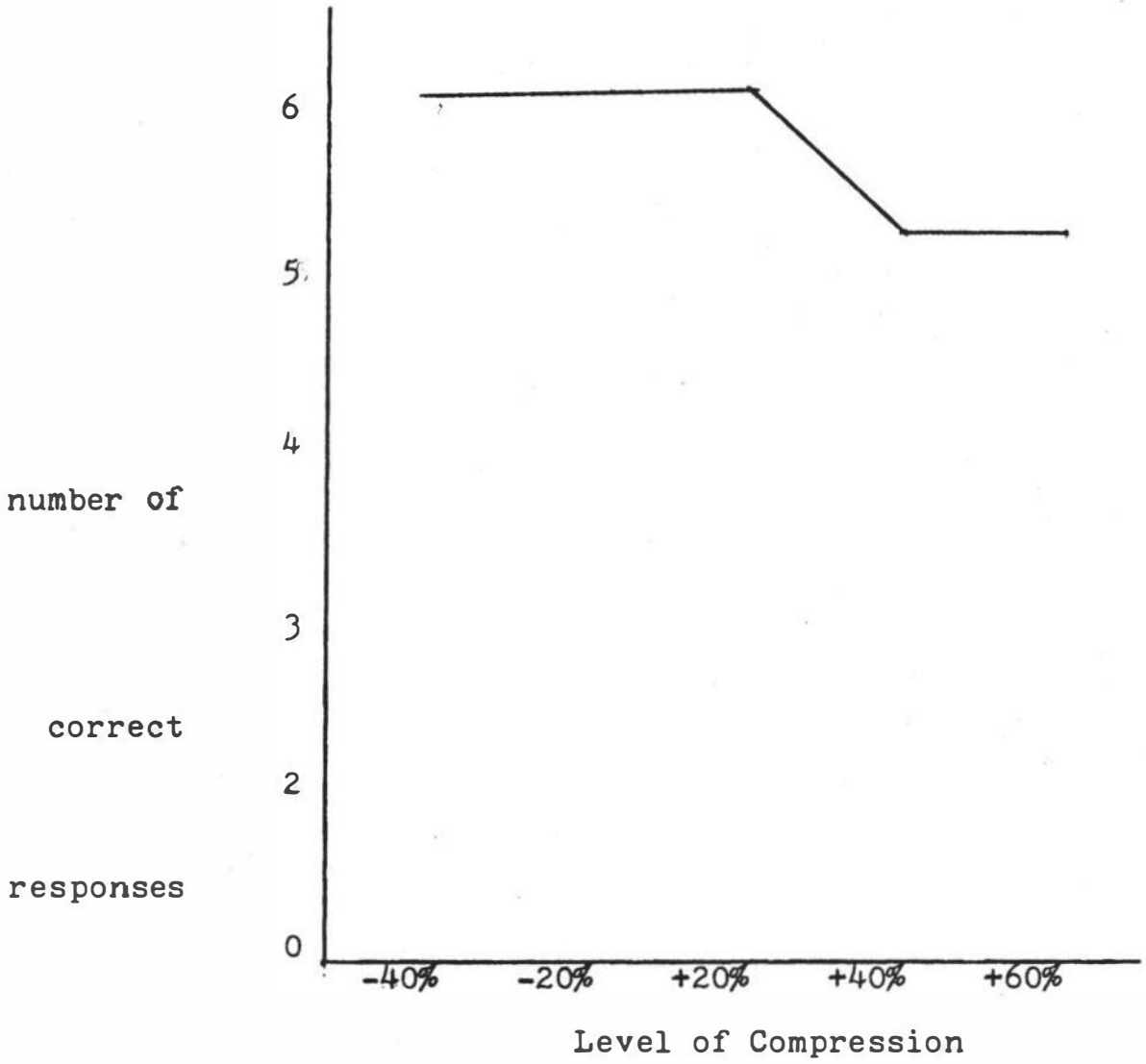

Figure 5. Number of correct responses as a function of the level of compression for control subject five (5C).

more improvement due to the level of compression then will a child with high comprehension scores.

Experimental Group

Figures six through ten represent the number of correct responses for each of the experimental subjects as a function of the amount of compression. It can be seen that there is some variation in the pattern of the responses between the experimental and the control group, although this difference is not significant. It is interesting to note that three of the five experimental subjects missed one response at one of the two levels of expansion. It has been hypothesized that a slower rate of presentation would increase the chance of other environmental stimuli overloading the child's channel capacity. The results of this study show some indication that this may indeed be the case for some of the children with minimal brain damage characteristics. This is another area that requires further research.

Four of the five experimental subjects received a score of six (one hundred percent) at twenty percent compression. The fifth subject received a score of six (one hundred percent) at forty percent compression. The results of this study suggest that the twenty percent level of compression is the optimum rate of presentation for the experimental group. After twenty percent compression (and in one case forty percent compression) the scores drop rapidly. This decrease in comprehension at the higher rates of compression is a sharper

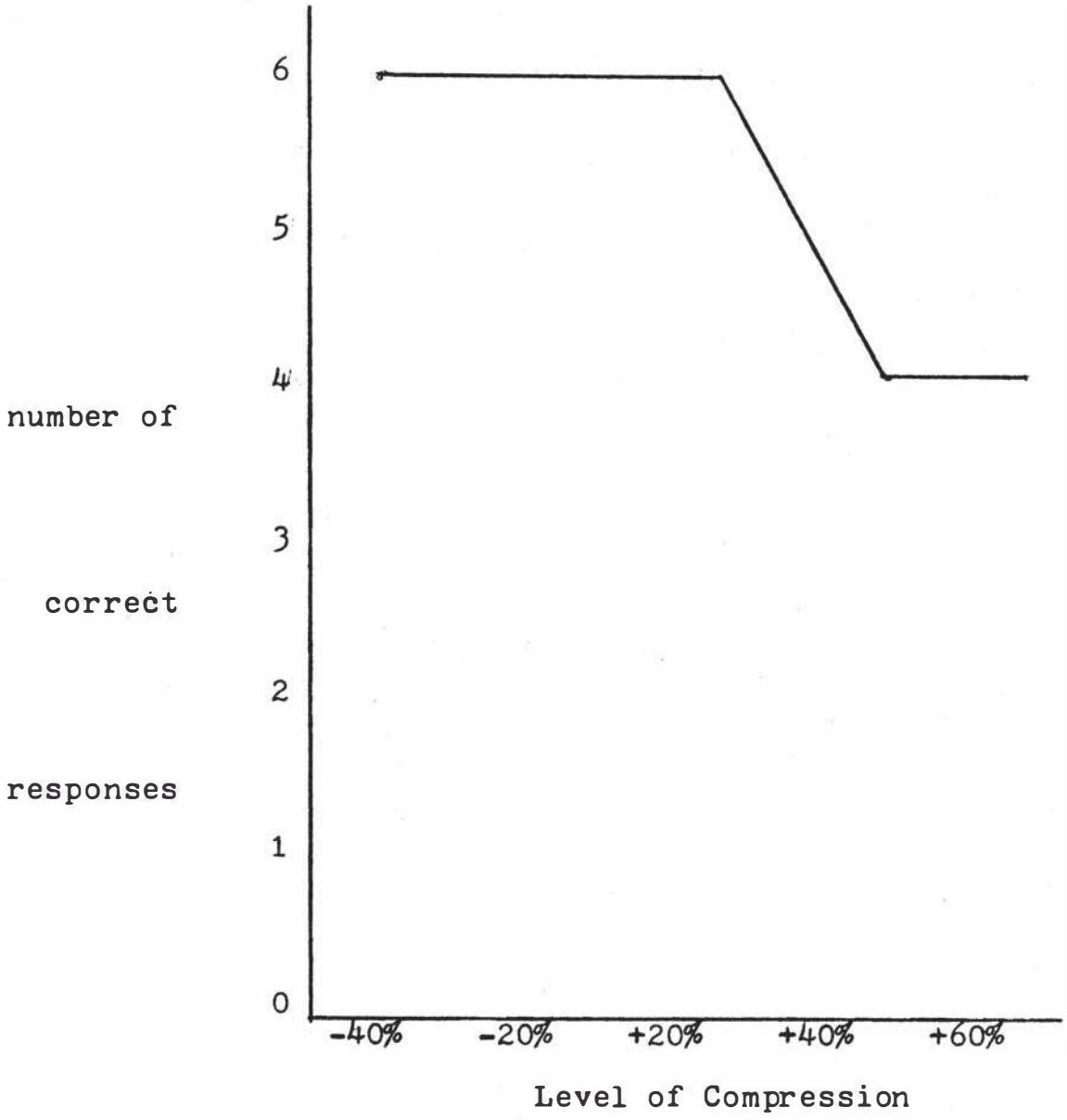

Figure 6. Number of correct responses as a function of the level of compression for experimental subject one (1E).

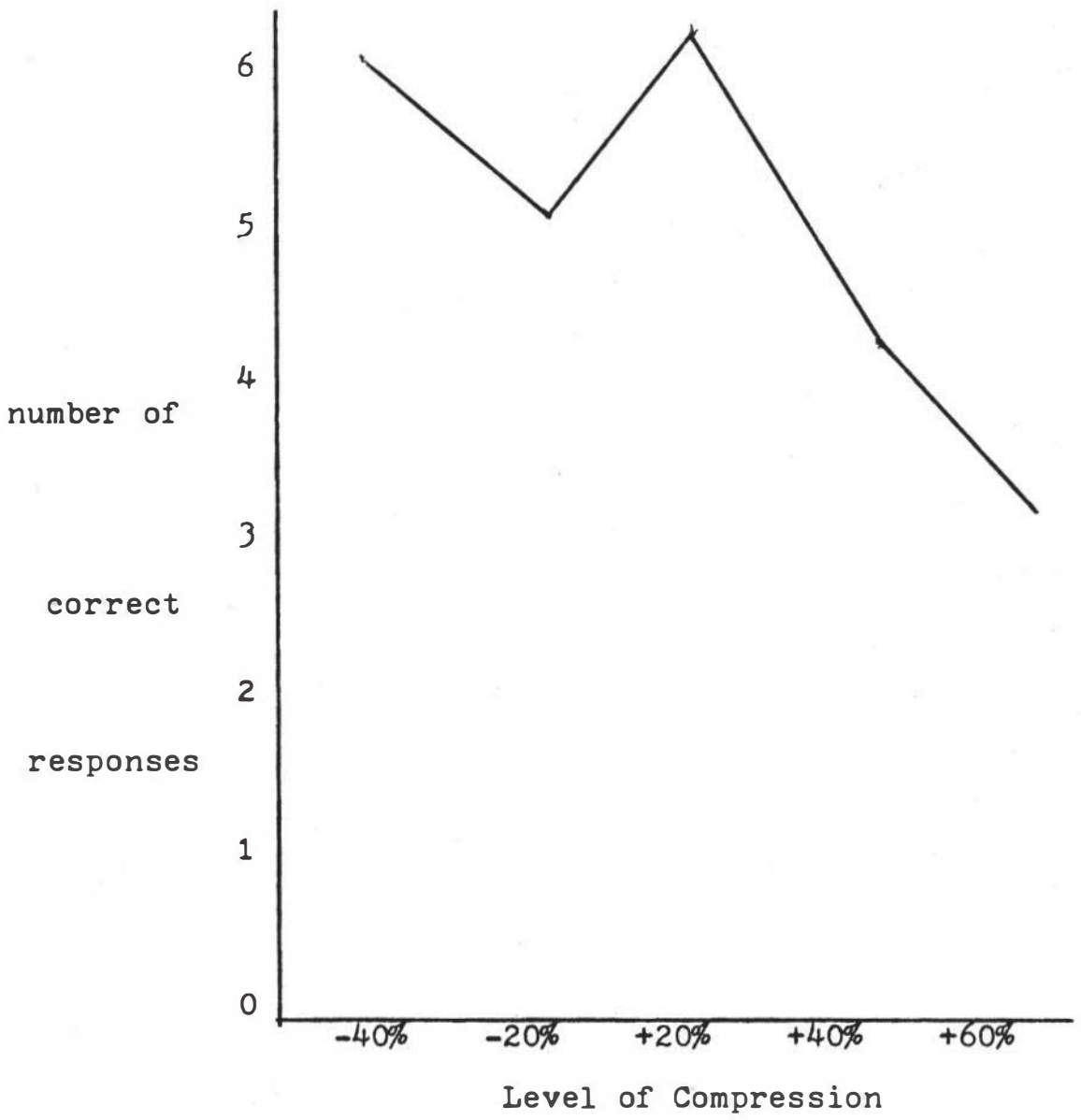

Figure 7. Number of correct responses as a function of the level of compression for experimental subject two (2E).

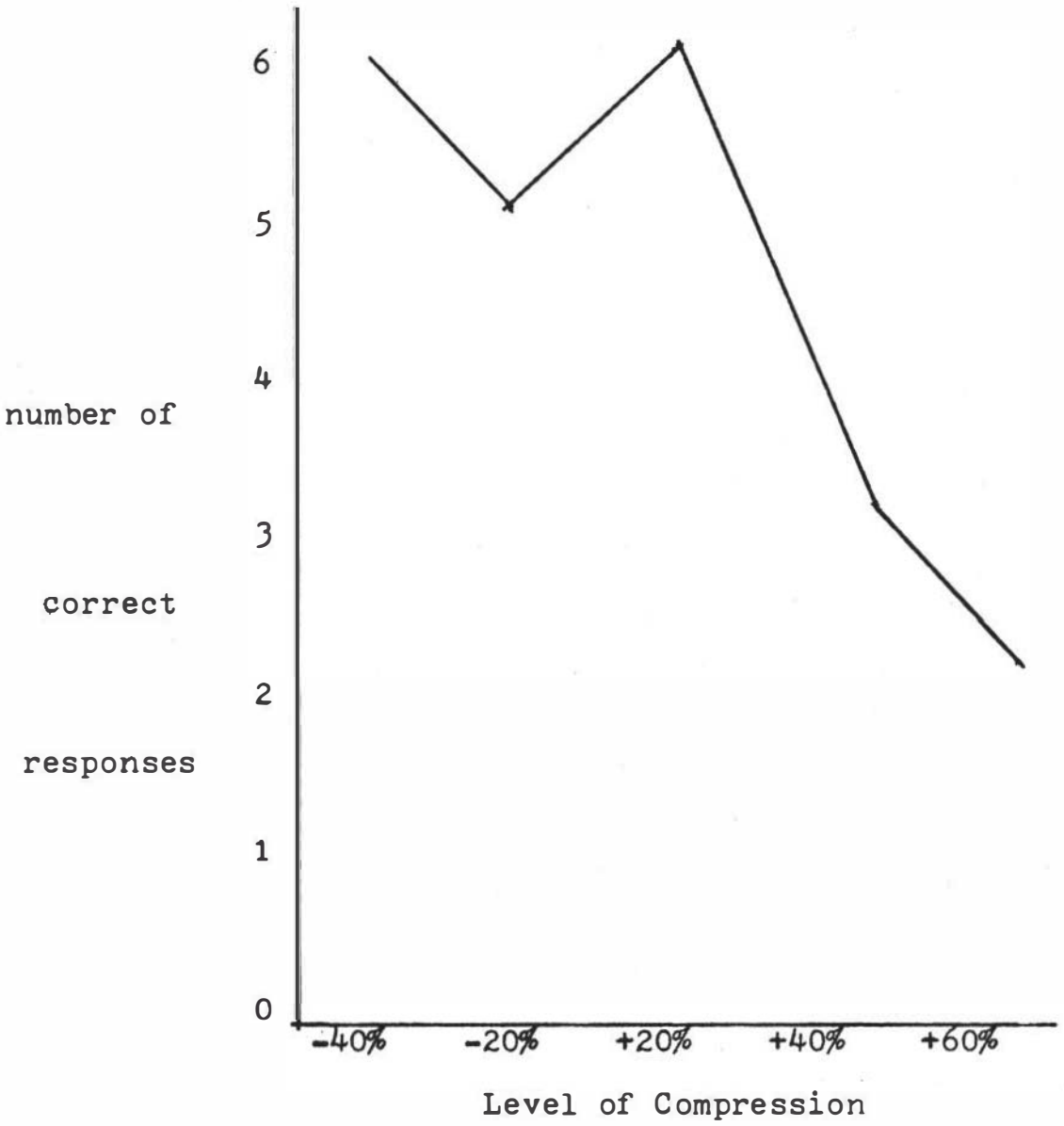

Figure 8. Number of correct responses as a function of the level of compression for experimental subject three (3E).

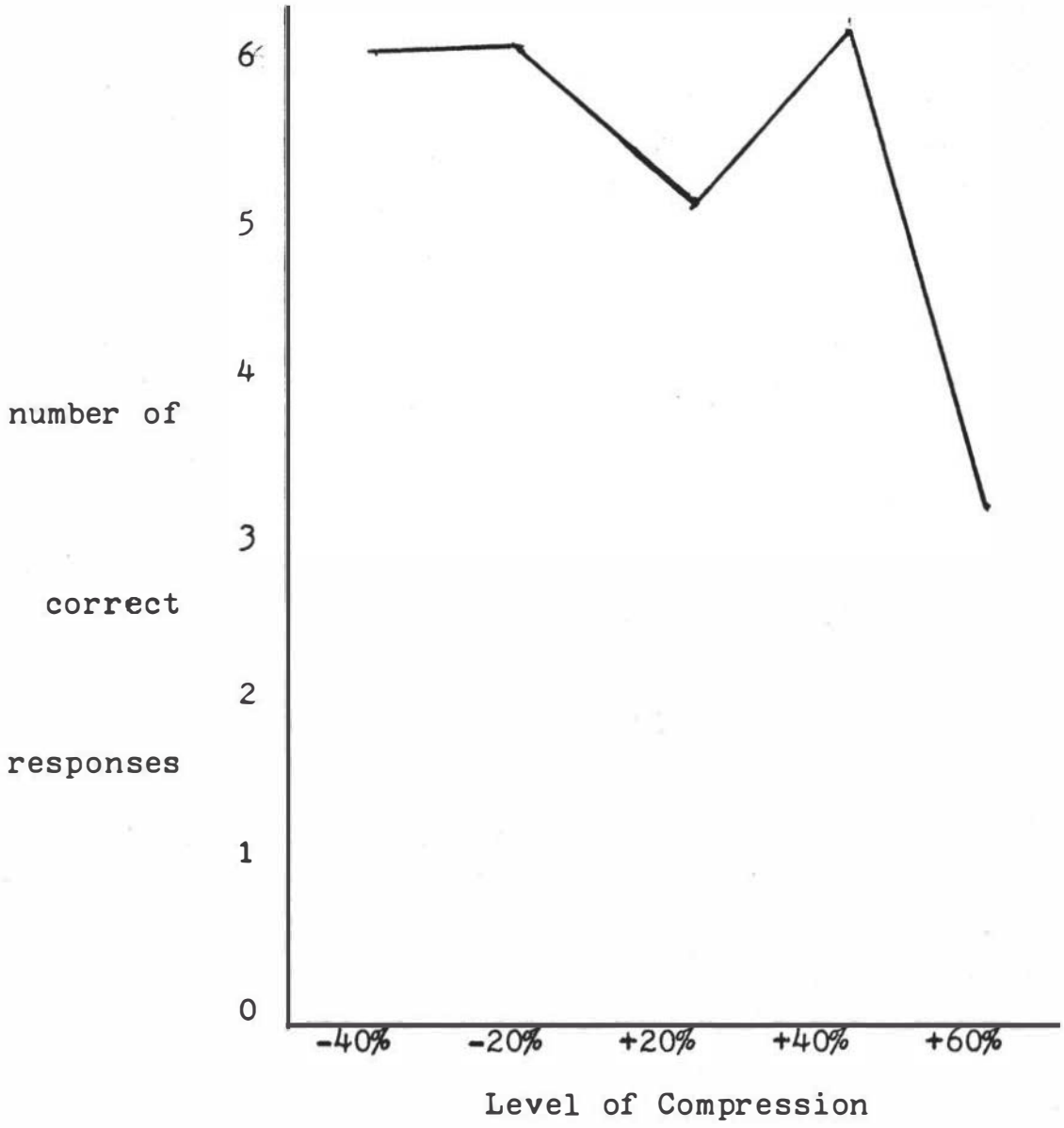

Figure 9: Number of correct responses as a function of the level of compression for experimental subject four (4E).

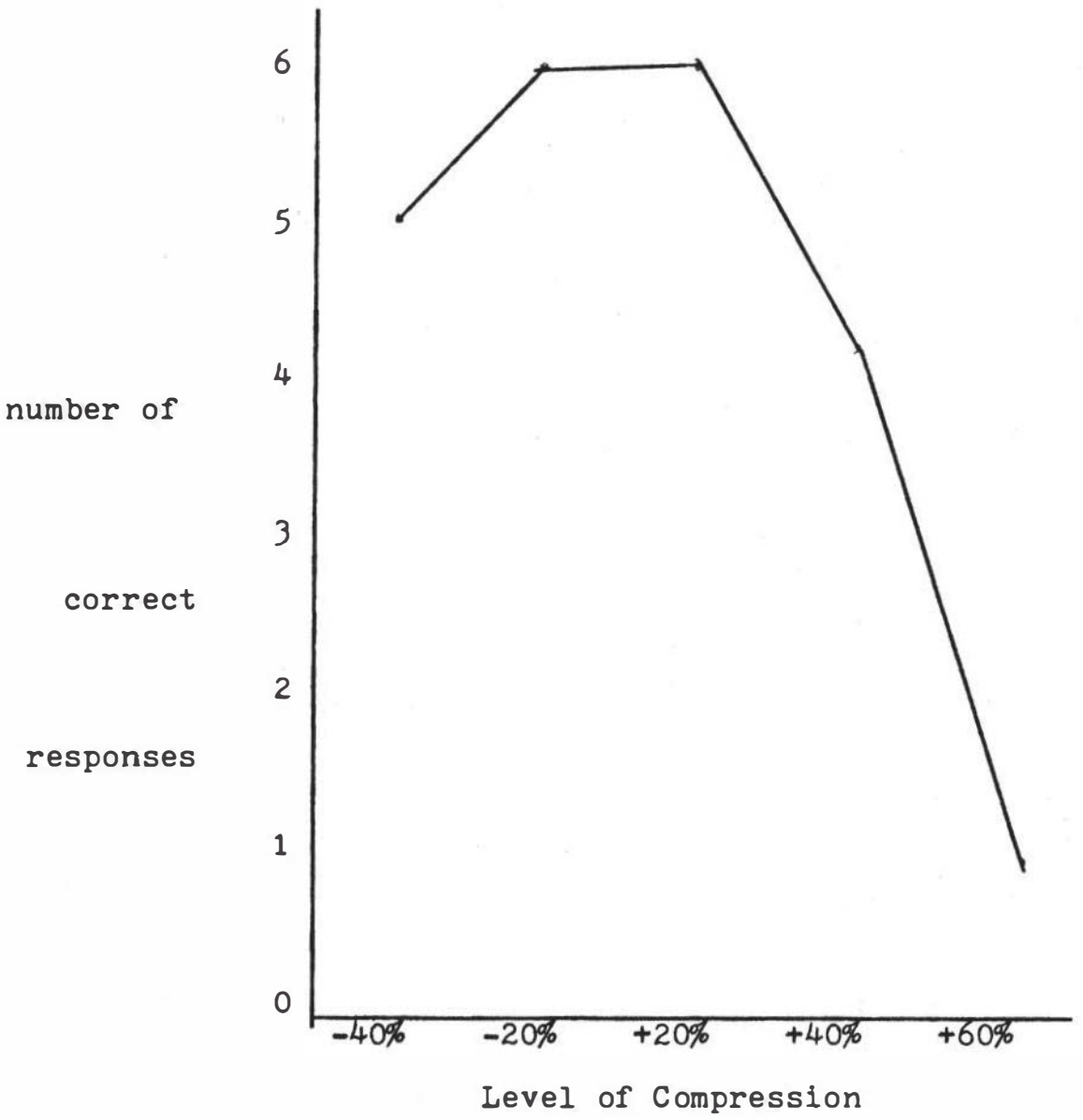

Figure 10. Number of correct responses as a function of the level of compression for experimental subject five (5E).

decline than that evidenced by the control group. It is apparent that the experimental and the control groups differ significantly from each other as a function of their performance on this portion of the test. The expansion and compression rates appear to affect the experimental group more than the control group. The comprehension scores of the control group appear to be more consistent then those of the experimental group. Some of this increased variation may be due to the fact that a minimally brain damaged child's performance is a variable in itself. This must be taken into account when comparing the experimental group to the control group. The control groups' responses are probably a more accurate representation of their abilities than the responses of the experimental group, because of the behavioral indications of distractibility and short attention span. Table 5 summarizes the test results of the two groups.

TABLE 5

SUMMARY OF THE NUMBER OF CORRECT RESPONSES AS A FUNCTION OF THE LEVEL OF COMPRESSION FOR THE ~X TEST FOR BOTH THE EXPERIMENTAL AND THE CONTROL GROUP

Compression Level	Number of Correct Responses Experimental					Control				
	1E	2E	3E	4E	5E	1C	2C	3C	4C	5C
-40%	6	6	6	6	5	6	6	6	6	6
-20%	6	5	5	6	6	6	6	6	6	6
+20%	6	6	6	5	6	6	6	6	6	6
+40%	4	4	3	6	4	5	4	6	6	5
+60%	4	3	2	3	0	3	4	5	5	5

Pre- vs Post-Test Scores

As stated earlier, no significantly significant difference was found between the scores of the pre- and post-test for either the experimental or the control group. Figures 11 and 12 represent the scores of the pre- and post-test of the experimental and control group respectively. There were no definite trends noted. Table 6 summarizes the number of correct responses of the pre- and post-test for both the experimental and the control group.

TABLE 6

A SUMMARY OF THE NUMBER OF CORRECT RESPONSES ON THE PRE- AND POST-TESTS FOR BOTH THE EXPERIMENTAL AND CONTROL GROUPS

Experimental			Control		
	Pre-Test	Post-Test		Pre-Test	Post-Test
1E	28	30	1C	30	29
2E	29	28	2C	28	30
3E	29	30	3C	30	30
4E	29	30	4C	29	30
5E	28	26	5C	29	30

Syntactic Complexity

Although a statistically significant difference was found only in the comparison of the four critical element level of difficulty, there are distinct but nonmeaningful differences present at the other levels of difficulty. Figures 13 though

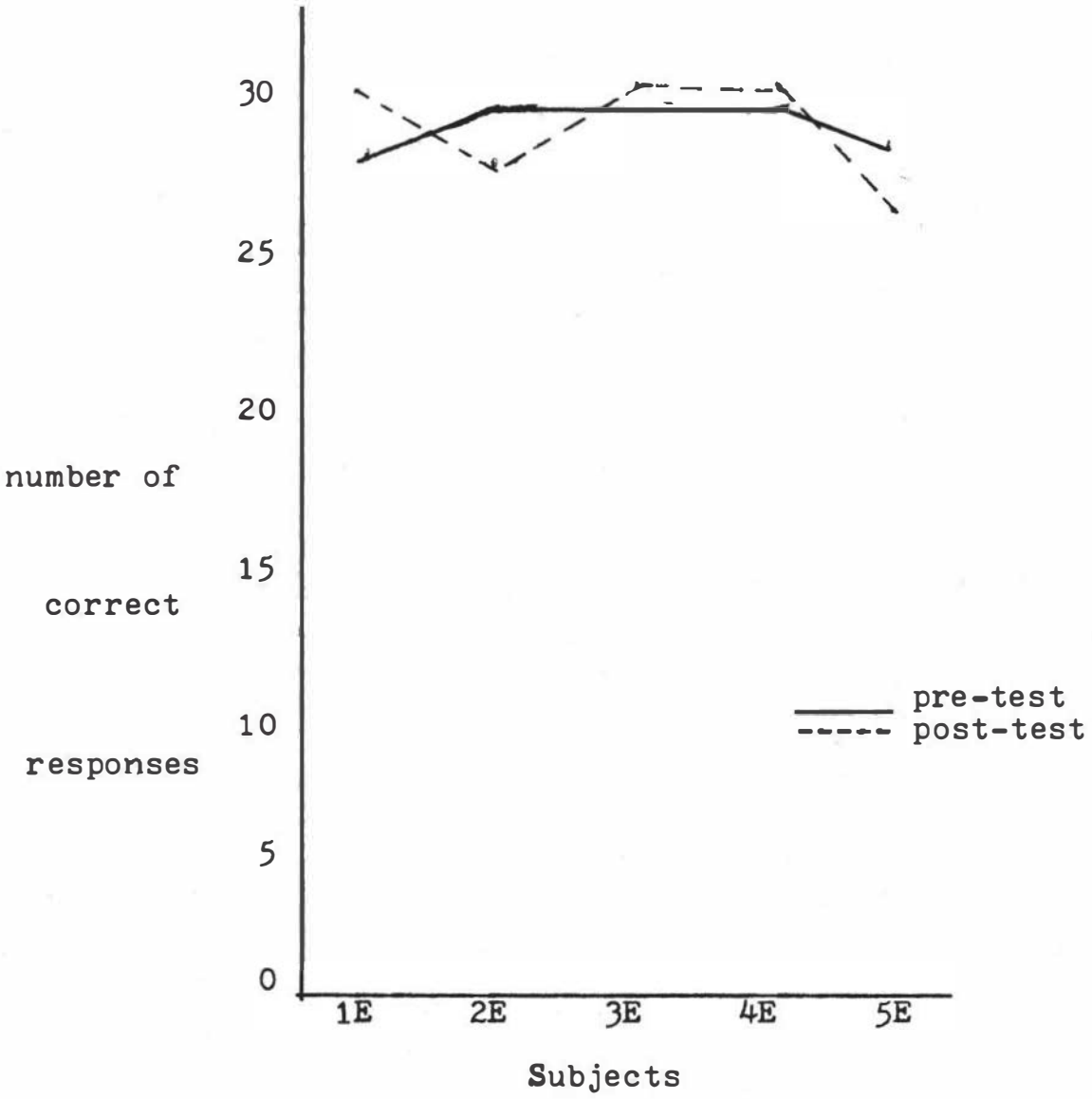

Figure 11. Number of correct responses on the pre-test vs the post-test for the experimental group.

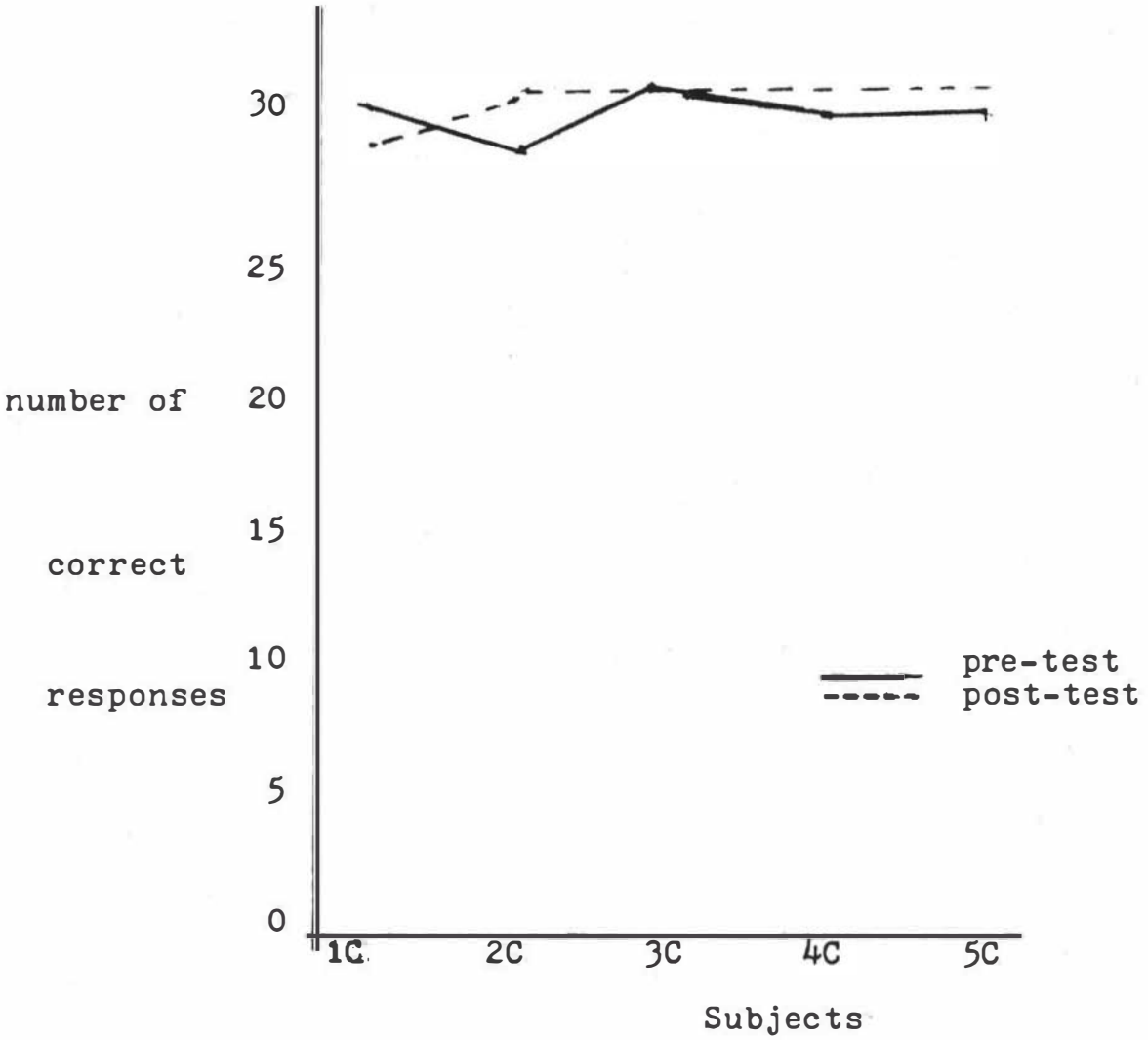

Figure 12. Number of correct responses on the pre-test vs the post-test for the control group.

15 represent the comparison of correct scores as a function of the critical elements for the experimental and the control groups. An analysis of Figure 13 (two critical elements) shows that while the two groups received the same score at the compression level of twenty percent and the expansion level of twenty percent, the experimental group scores fell below the control group on all other levels of compression and expansion. At forty percent and sixty percent compression levels, only sixty percent of the experimental group responded correctly while one hundred percent of the control group responded correctly. These results indicate that the child with the behavioral characteristics of the minimally brain damaged does not function as well at the two critical element level of difficulty as do the normal children.

At the three critical element level of difficulty little difference in the scores of the two groups was observed. The scores of the experimental group were higher at the three critical element level of difficulty than at the two critical element level of difficulty. This higher level of difficulty seems to be the optimum level for the use of expanded and compressed speech with minimally brain damaged child. Comprehension did fall to seventy percent correct at sixty percent compression but all other levels of expansion and compression remained at one hundred percent. In the control group, all were correct through twenty percent compression. At forty percent compression the scores fell to eighty percent correct and at sixty percent rose to ninety percent correct.

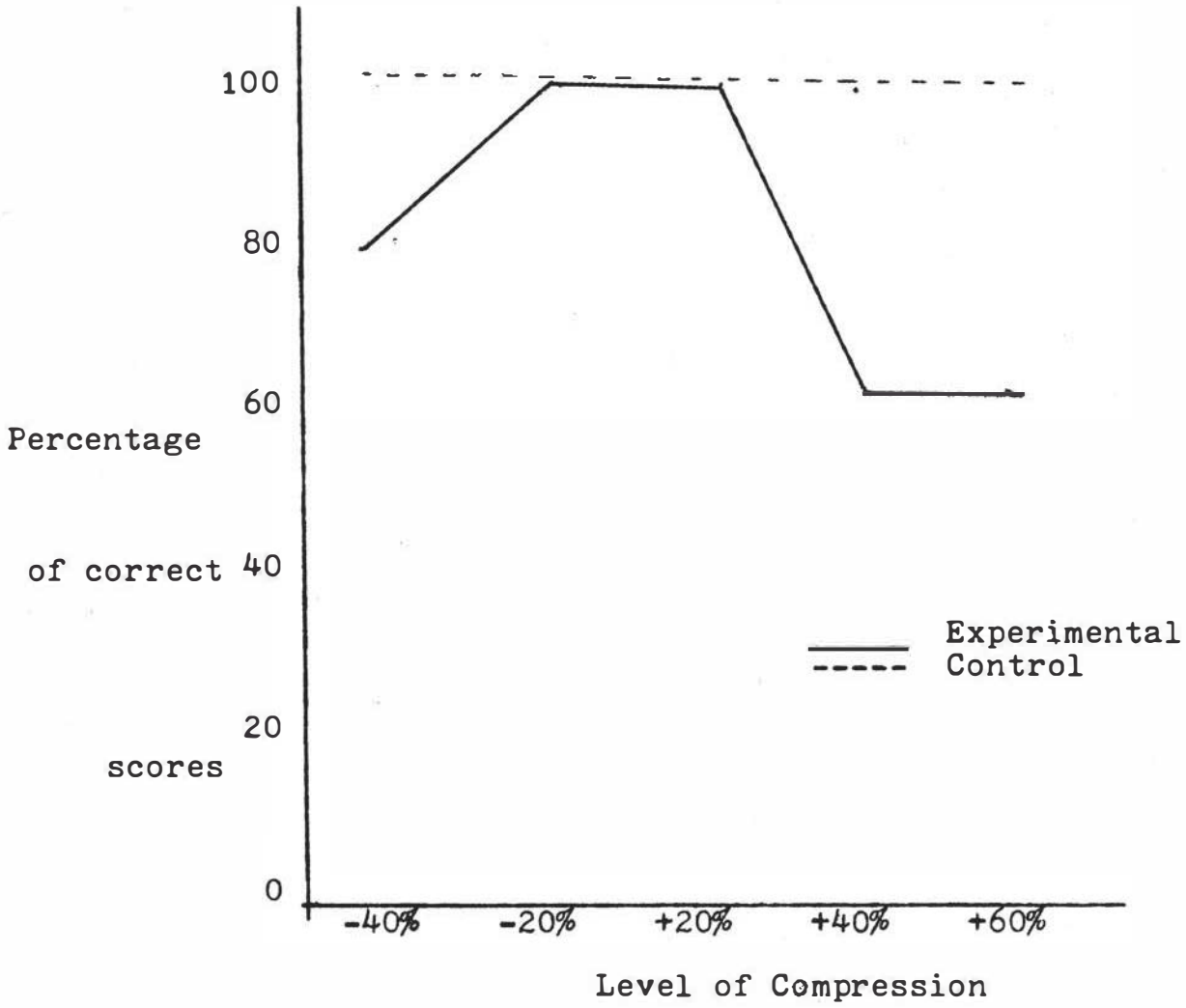

Figure 13. A comparison of the percentage of correct scores as a function of two critical elements for the experimental and control groups.

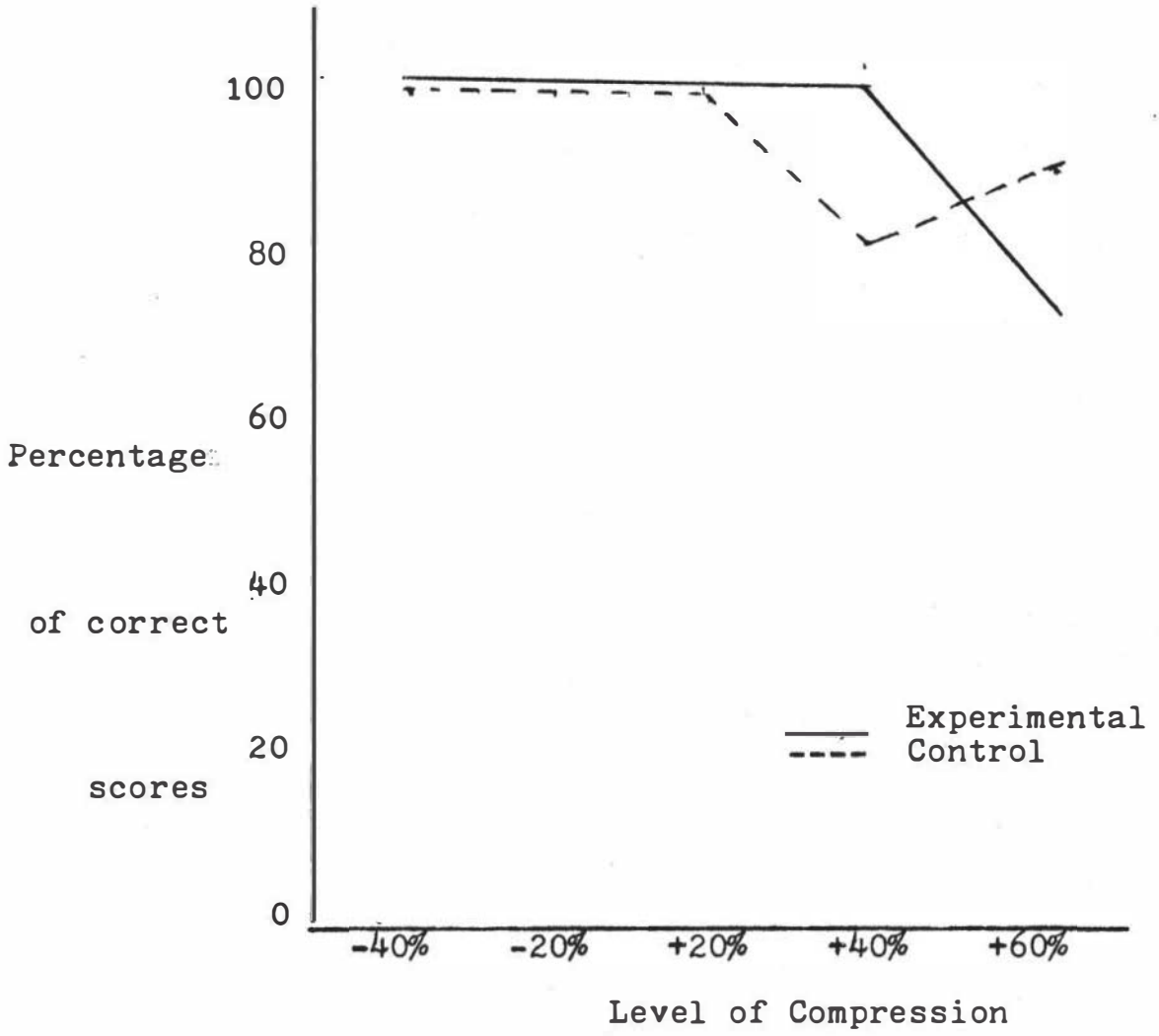

Figure 14. A comparison of the percentage of correct scores as a function of three critical elements for the experimental and control groups.

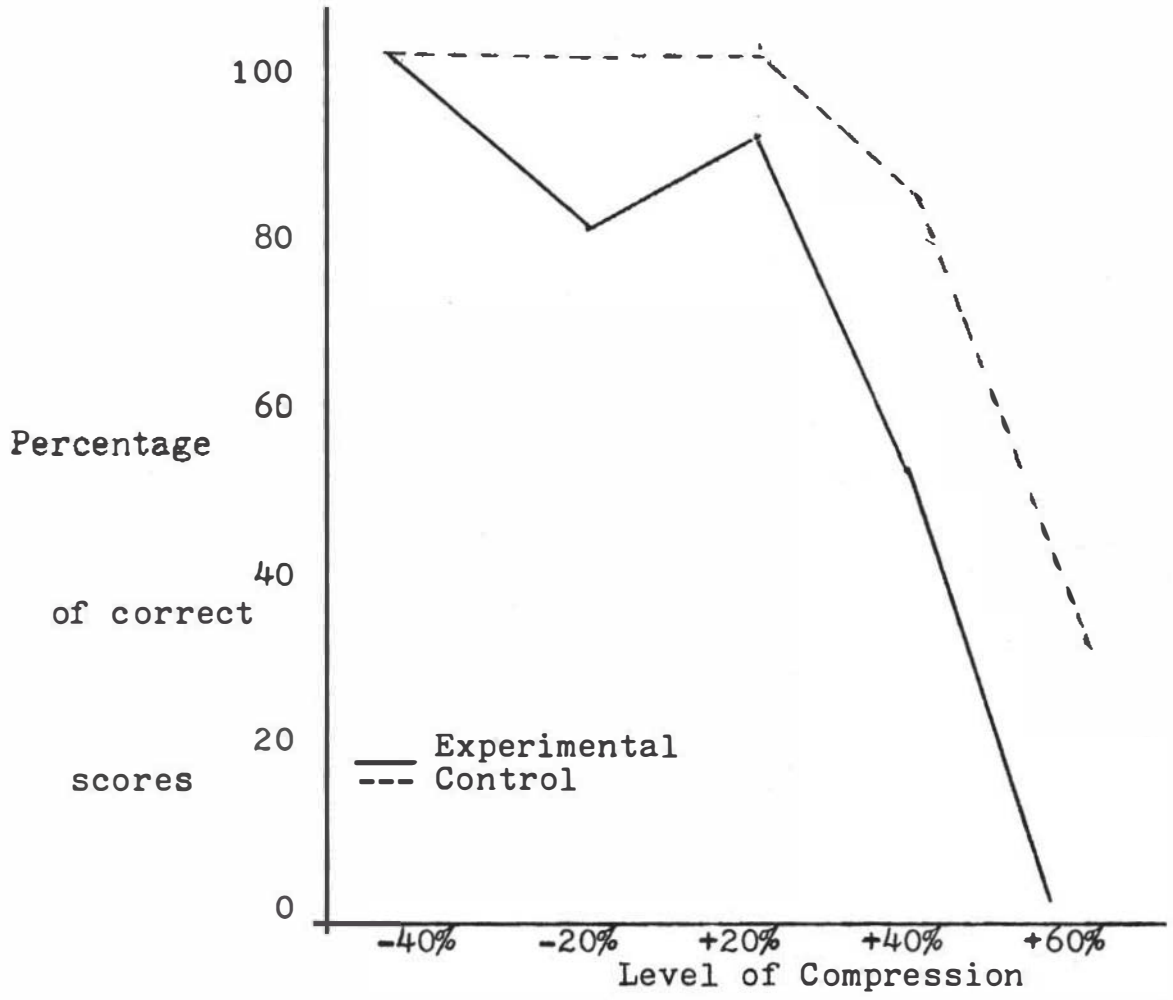

Figure 15. A comparison of the percentage correct scores as a function of four critical elements for the experimental and control groups.

The dip at forty percent compression (below the scores of the experimental group) is unexplainable. It is not known what would cause the control group to act differently on just this one item. The factor of maintaining attention may be involved.

At the four critical element level of difficulty, the two groups' performance were parallel with the control group receiving a higher percentage of correct responses. The control group remained at one hundred percent through twenty percent compression. It fell to fifty percent correct at forty percent compression and then sharply fell to thirty percent correct at sixty percent compression. The experimental group's scores began to fall after forty percent expansion. There was a sharp decrease in percentage correct after twenty percent compression, falling from ninety percent correct to fifty percent correct at forty percent compression and zero percent correct at sixty percent compression. It is apparent that the four critical element level of difficulty results in the poorest performance of the three levels of difficulty for the use of expanded and compressed speech. The results for both groups at this level follow closely the results reported in earlier research. Because of this, it would be feasible to assume that the results of the two groups would still follow the same pattern if a sentence or paragraph comprehension test was used. Table 7 summarizes the percent of correct responses as a function of the level of difficulty for the control and experimental groups.

TABLE 7

A SUMMARY OF THE PERCENT OF CORRECT RESPONSES AS A FUNCTION OF THE LEVEL OF DIFFICULTY FOR THE CONTROL AND THE EXPERIMENTAL GROUP

Level of Difficulty	Level of Compression									
	Experimental Group					Control Group				
	-40%	-20%	+20%	+40%	+60%	-40%	-20%	+20%	+40%	+60%
2 Critical Elements	80%	100%	100%	60%	60%	100%	100%	100%	100%	100%
3 Critical Elements	100%	100%	100%	100%	70%	100%	100%	100%	80%	90%
4 Critical Elements	100%	80%	90%	50%	0%	100%	100%	100%	80%	30%

Lexical Units

In order to evaluate fully the differences between the two groups, an indepth analysis of the percent of correct responses as a function of the number of critical elements was done. Figures 16 through 18 represent the comparison of the scores of the control group as a function of the number of critical elements. Figure 16 represents the two critical element level of difficulty. All responses at both the first and the second critical element level were correct. This is also demonstrated in Figure 13.

Figure 17 represents the three element level of difficulty. One incorrect response was made in the first critical element and two errors were made in the second critical element. No

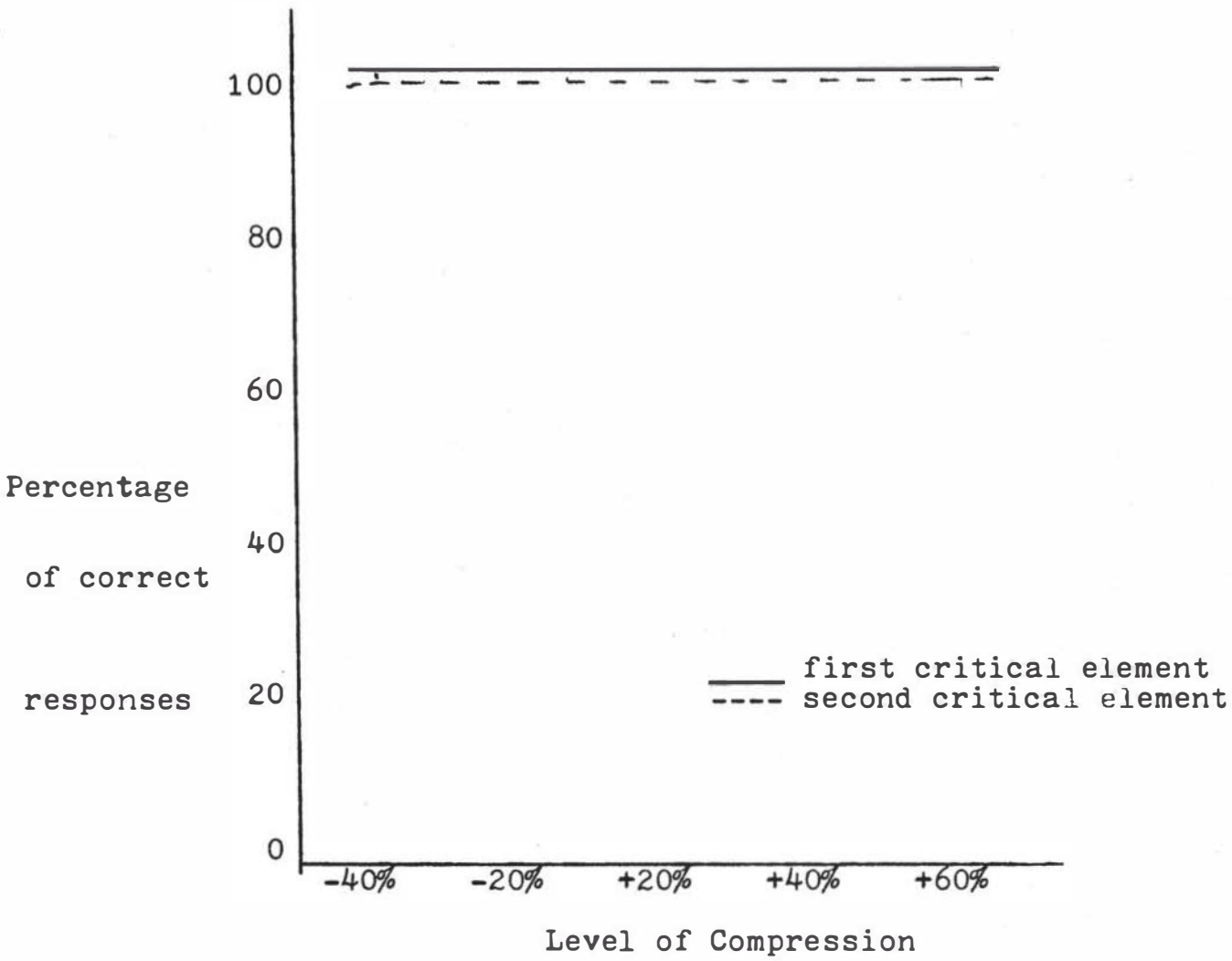

Figure 16. A comparison of the scores of the control group as a function of the number of critical elements at the two critical element level of difficulty.

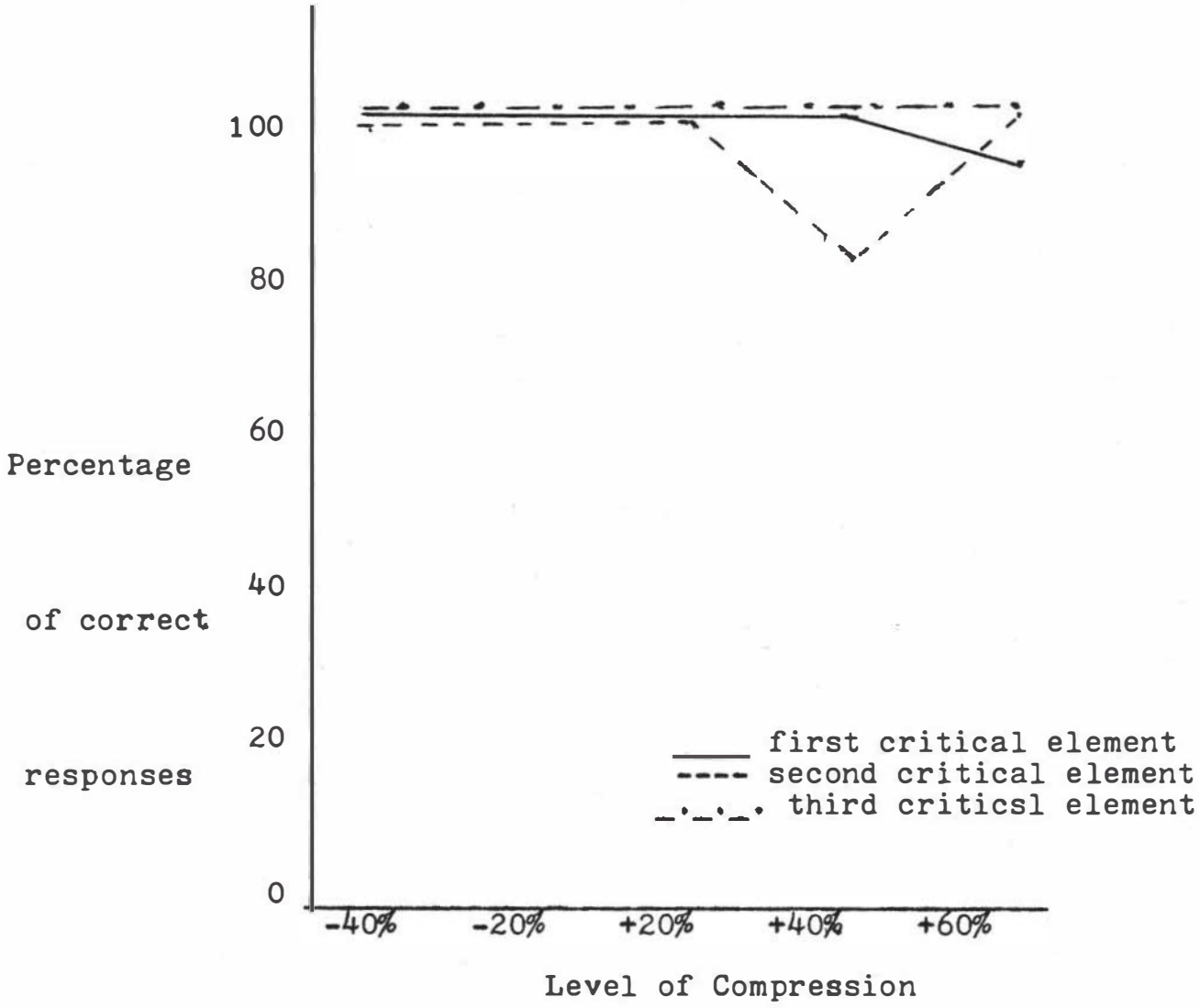

Figure 17. A comparison of the scores of the control group as a function of the number of critical elements at the three critical element level of difficulty.

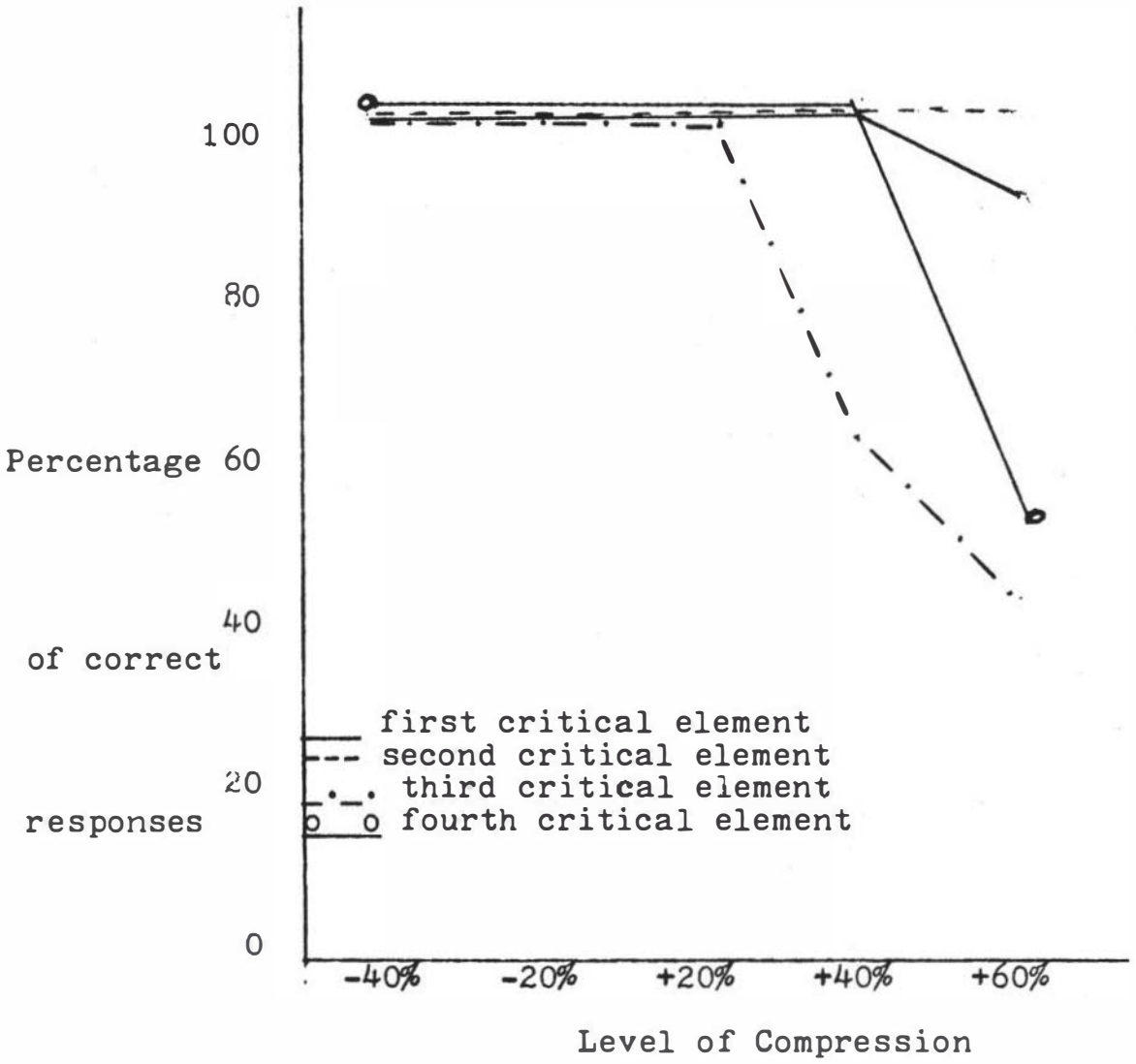

Figure 18. A comparison of the scores of the control group as a function of the number of critical elements at the four critical element level of difficulty.

errors were made in the third critical element. Here is some evidence of the big dip found at the forty percent level of compression at the three critical element level of difficulty. The segment presented at this point was "Show me ball on the table." The second critical element in this phrase is 'on.' It may be that this is too short of a unit to be compressed adequately. But this does not explain why the experimental group received a higher score at this forty percent compression level.

Figure 18 represents the four critical element level of difficulty. The first critical element was identified correctly through forty percent compression. At sixty percent compression, ten percent of the critical elements were missed. The second critical element was responded to correctly through all levels of expansion and compression. The third critical element was responded to correctly through twenty percent compression. At forty percent compression, twenty percent of the third critical elements were missed while at sixty percent compression sixty percent of the third critical elements were missed. The fourth critical element was responded to correctly through forty percent compression, while at sixty percent compression fifty percent of the fourth critical elements were missed. It is interesting to note that the third critical element gave the poorest scores of the four critical elements involved. The structure of the fourth critical element level of difficulty is either noun-verb-

preposition-noun or modifier-noun-preposition-noun. In either case, the third critical element is a preposition. Of these, four are one syllable and four are two syllable words. There is a strong chance that a discard interval at the higher rates of compression may discard the message bearing consonant, thereby distorting or eliminating the meaning of the word compressed.

Figures 19 through 21 represent the comparison of the scores of the experimental group as a function of the number of critical elements. These graphs were made in the same manner as the ones for the control group (Figures 16 through 18). Figure 19 represents the two critical element level of difficulty. The first critical element was responded to correctly ninety percent of the time at the forty percent level of expansion. It was responded to correctly one hundred percent of the time at twenty percent expansion and twenty percent compression. Forty percent of the first elements were missed at forty percent compression and ten percent were missed at sixty percent compression. At the second critical element all were responded to correctly until sixty percent compression where thirty percent were missed. It is obvious that at the two critical element level of difficulty, the first critical element is the discriminating factor. In comparison with Figure 13, it can be seen that the pattern of the first critical element roughly parallels that of the total score for the two critical element level of difficulty.

At the three critical element level of difficulty (Figure 20), the first critical element was responded to correctly

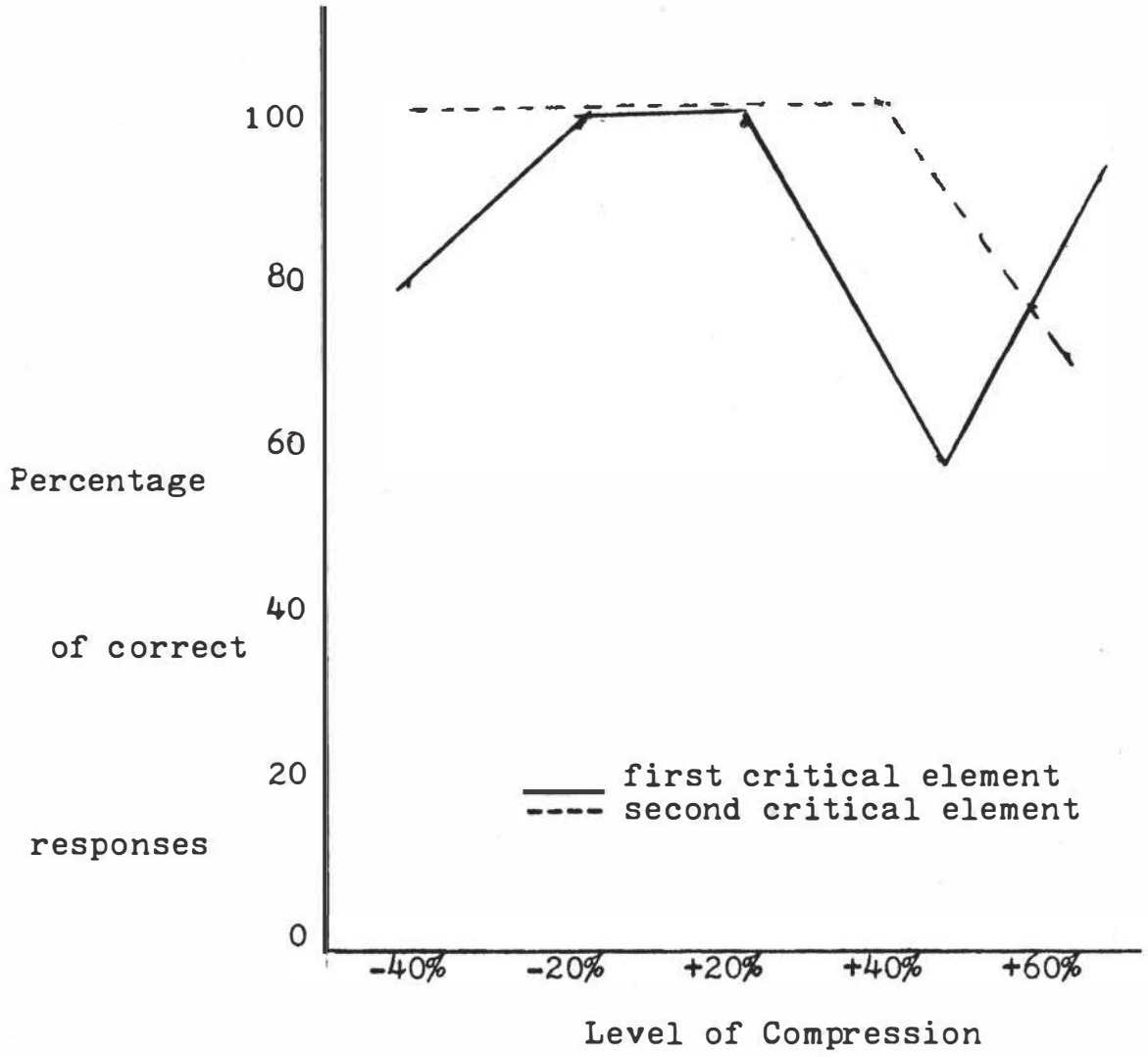

Figure 19. A comparison of the scores of the experimental group as a function of the number of critical elements at the two critical element level of difficulty.

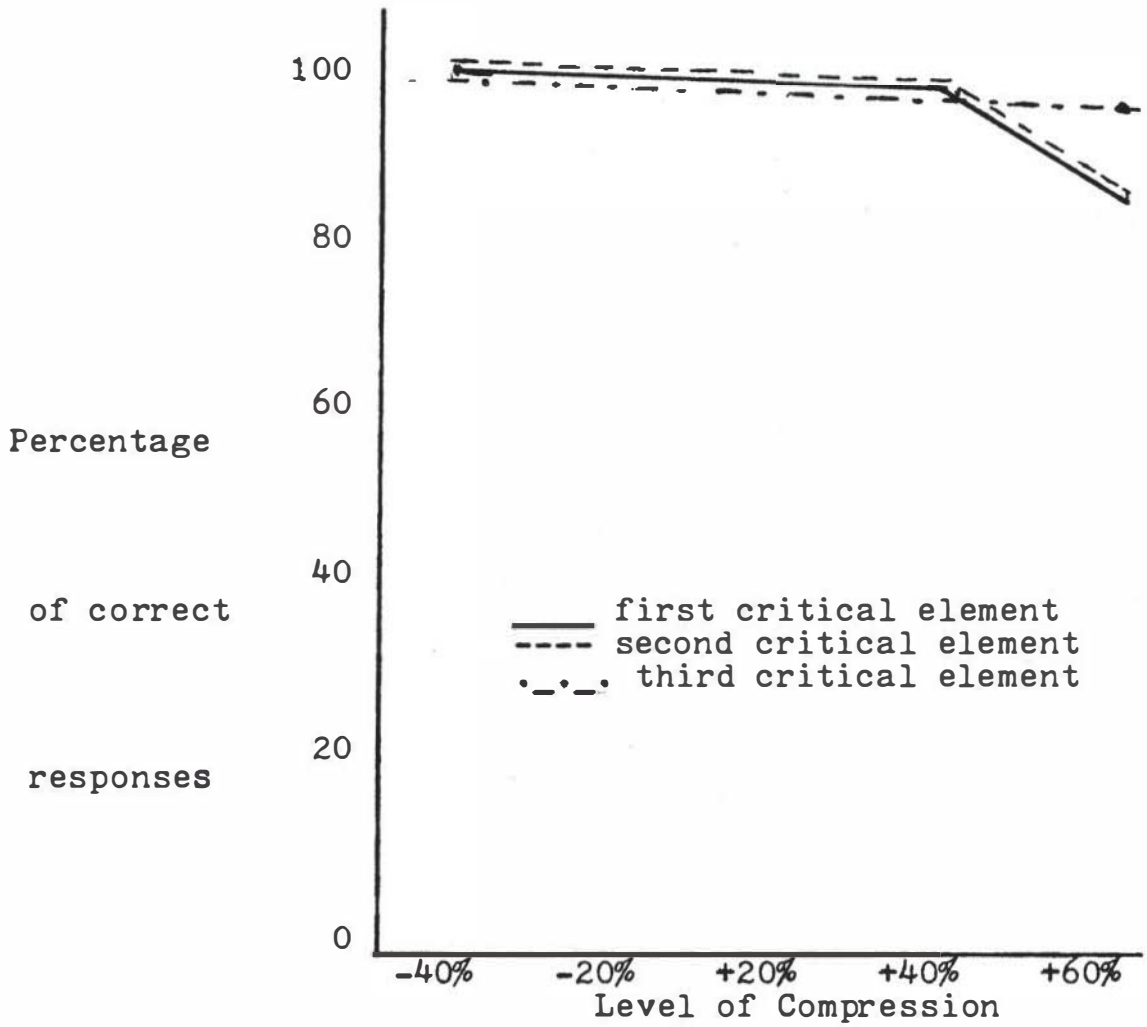

Figure 20. A comparison of the scores of the experimental group as a function of the number of critical elements at the three critical element level of difficulty.

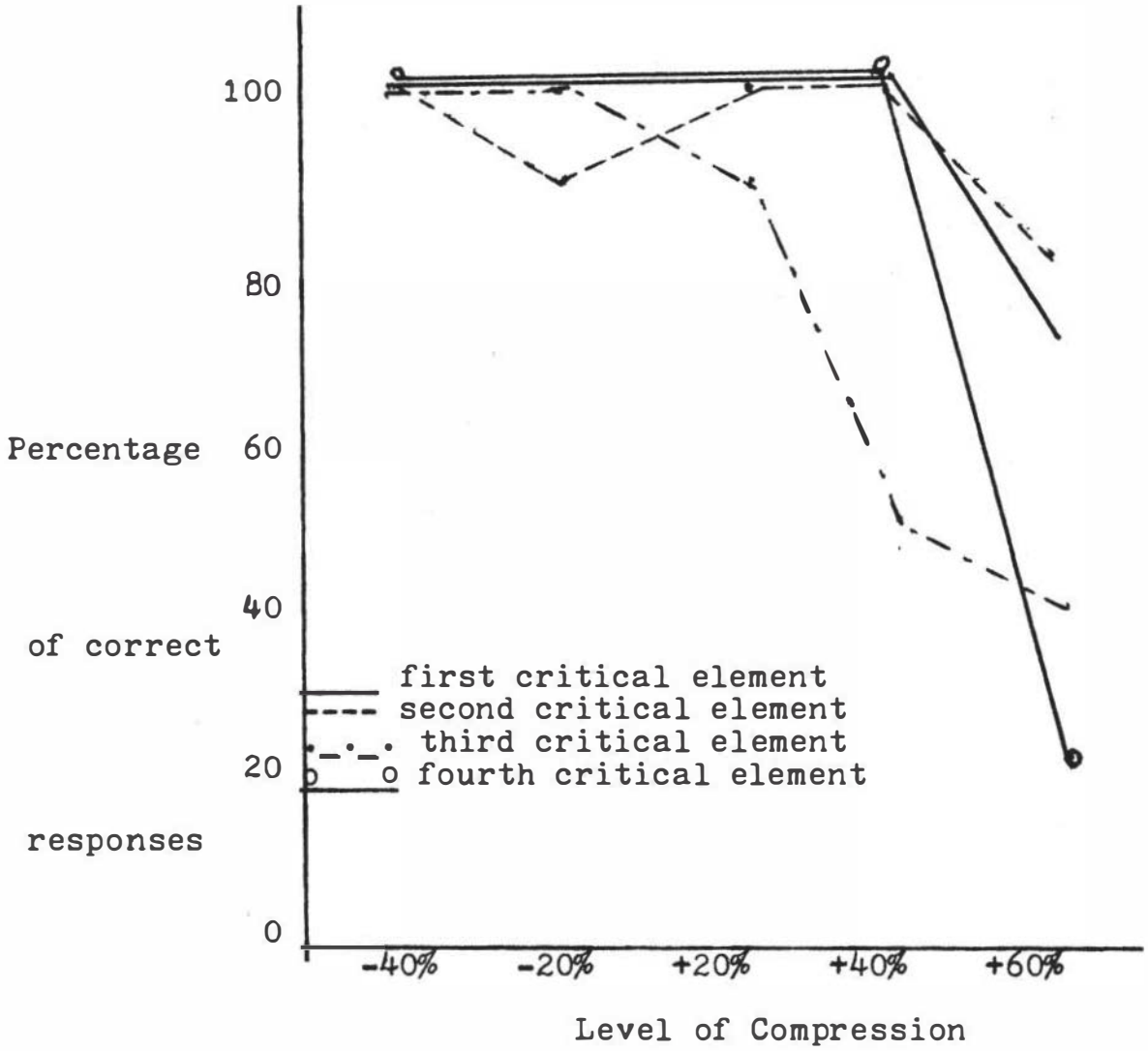

Figure 21. A comparison of the scores of the experimental group as a function of the number of critical elements at the four critical element level of difficulty.

through forty percent compression; at sixty percent compression twenty percent of the first critical elements were missed. The second critical element dipped to ninety percent correct at twenty percent expansion and than rose again to one hundred percent correct through forty percent compression. At sixty percent compression the number of correct responses fell to eighty percent correct. . The third critical element responses fell from ninety percent correct at twenty percent compression to fifty percent correct at forty percent compression and forty percent correct at sixty percent compression. The fourth critical element was responded to correctly through forty percent compression and then falls to twenty percent correct at sixty percent compression. As with the control group, the third critical element gave the poorest overall scores. The response pattern of the third critical element most closely parallels the pattern of the total response scores (Figure 15).

At the two critical element level of difficulty, the experimental group demonstrated a great deal of fluctuation. As mentioned earlier, the first critical element appears to be the differentiating factor. There are several statements that can be hypothesized concerning this occurrence. The factor of the child's attention is an important consideration. If a child becomes distracted, the time spent returning his attention to the verbal stimulation may include the first critical element,hence losing one-half of the message. With the first element of the segment lost, the child has a fifty percent

chance of giving the correct response. This is further evidenced by the higher average score of the second critical element.

Another hypothesis concerns the method of speech compression. When the sampling method of compression is employed, a one syllable word has a greater chance of having the information carrying elements of the word discarded than does a two syllable word. Eight of the ten first elements are one syllable words while only three of the ten second critical elements are one syllable words. It may be that a method of speech compression that does not involve an interval discard would give a better production of all elements of the recorded sample. This may be an active factor in the resultant lower scores for the first critical element.

A third hypothesis involves the concept of a learning affect. The pre- and post-test scores indicated that no learning occured in either group as a function of repeated exposure to similar stimuli. Because of this, the hypothesis concerning a learning affect need only be concerned with the ~X test of the study. At the higher rates of compression, the minimally brain damaged child may require a longer adjustment time. At the two critical element level of difficulty this adjustment time may involve the first critical element at the higher rates of compression. By the occurrence of the second critical element, the adjustment has been made and the child is attending to the stimulus. In the context of this hypothesis, the dip at sixty percent compression would occur because the

adjustment time of some of the children exhibiting minimal brain damage characteristics exceeded the brief time the compressed segment was presented. Here again the number of syllables per word becomes an important factor. The more syllables per element, the longer that critical element will be. A two syllable word has less chance of being lost in the adjustment period.

These hypotheses require further investigation before a definite causal affect can be determined. In summary, the hypotheses were:

1. Attention of the child is a causal factor in the difference in the scores of the first and second critical elements.

2. The method of speech compression (in this case the sampling method) may distort the message by discarding the information carrying elements of the word.

3. The adjustment time of the child may be a causal factor in the difference in the scores of the first and the second critical elements.

4. The number of syllables per word is an active factor occuring in the first three hypotheses.

At the three critical element level of difficulty, the experimental group's responses were almost identical to the control group's responses. The first and second critical elements remained constant at one hundred percent through forty percent compression. The first critical element then fell to eighty percent correct and the second critical element fell

to ninety percent correct. The third critical element remained at one hundred percent correct throughout all levels of expansion and compression. The hypothesis of the attention ability of the child is relevant here. At sixty percent compression, a total of thirty percent incorrect responses were made at the first and second critical element levels while no incorrect responses were made at the third critical element level. The child's attention may not be completely gained until the third critical element. At this level of difficulty the child has an extra bit of information to use in forming his response. Even if he missed the first element, the second and third or even just the third element may give him the information needed to make a correct response. This may be why the three critical element level of difficulty received the highest scores. The extra element gives the child an extra chance at comprehending enough to respond correctly while not adding enough complexity to confuse the child. The results of this study indicate that the third critical element level of difficulty is the optimum level for the use of expanded and compressed speech with children exhibiting behaviors common in minimally brain damaged children. Further research is needed before a causal factor can be determined, but the factors mentioned in connection with two critical element of difficulty can be applied to the three critical element level of difficulty. Briefly these factors are the attention of the child, the method of speech compression, the adjustment time of the child and the number of syllables per word.

Figure 21 demonstrated how the four critical elements were related to each other. The first and fourth critical elements remained constant at one hundred percent through forty percent compression. The first critical element then fell to seventy percent correct while the fourth critical element fell to twenty percent correct. The second critical element fell to ninety percent correct than returned to one hundred percent correct through forty percent compression. At sixty percent compression, it fell to eighty percent correct. The third critical element remained at one hundred percent through twenty percent expansion, then fell to ninety percent at twenty percent compression, fifty percent correct at forty percent compression and to twenty percent correct at sixty percent compression. It is interesting to note that while the first, second and fourth critical elements follow the same basic pattern of response, the third critical element radically departed from this pattern. The third critical element began a sharp decline at twenty percent compression while the other three elements did not begin their decline until forty percent compression. Obviously the third critical element is the differentiating factor at the four critical element level of difficulty for the experimental group. Of the several hypotheses that can be made concerning this occurrence, the most important factor is the structure of the segments presented. As stated before, the structure of the fourth critical element level of difficulty is either noun-verb-

preposition-noun or modifier-noun-preposition-noun. The third critical element is a preposition in both types of structure. Of these, four are one syllable and four are two syllable. At the higher rates of compression, discard intervals have a strong chance of discarding the information carrying elements of the one syllable word. If this has happened, the child would only be hearing half of the segments in their entirety, the other half would be missing the third critical element. In the experimental group, the decline begins with the first level of compression (twenty percent) indicating that, at least for this group, the method of compression may indeed be an important factor to consider.

This factor of the compression level may be present at the other critical elements at this level of difficulty. The majority of the words contained in these segments are one syllable, many in the form of consonant-vowel-consonant. If the discard interval removes or distorts one of the consonants, the word may become distorted or be mistaken for another word. The consonants are the information carrying elements in these words. Because of their brevity (in comparison with vowels), there is more chance of the consonants being discarded. In further research a different method of compression may eliminate this factor.

The hypotheses of attention ability and adjustment time do not seem to apply here because all but the second and third critical element were correct through the forty percent level of compression. The hypothesis concerning syllable length of

words has been presented in conjunction with the hypothesis concerning the method of compression. At the fourth critical element level, the sixty percent compression level received the lowest score of correct responses (twenty percent correct). This seems to be in agreement with the proposition that in the child exhibiting behavioral characteristics of the minimally brain damaged child, the auditory channel capacity may have been exceeded by the four critical element level of difficulty. This in turn would reduce the amount of input recovered at the output. "When a word rate is too high, words can not be processed as fast as they are received with the result that some of their words and their associated meanings are lost." (Foulke and Sticht, 1967). At the higher rates of compression the fourth critical element may have been lost because the auditory channel capacity has been exceeded.

Summary

In summary, the following statistical results were found:

1. Nonsignificant differences were found inthe following comparisons:

   a. expansion levels of -40%, -20% and compression levels of +20%, +40% and +60% - E vs C.

   b. two critical elements - E vs C

   c. three critical elements - E vs C

   d. pre-test E vs pre-test C

   e. post-test E vs post-test C

f. pre-test E vs post-test E

g. pre-test C vs post-test C

2. Significant differences were found in the following comparisons:

a. compression level of +60% - E vs C

b. four critical elements - E vs C

c. ~X E vs ~X C

The use of expanded and compressed speech differentiated between the two groups tested. The control group consistently received higher scores on all aspects of the test presented at the various levels of expansion and compression (~X). The pre- and post-tests of the two groups ware not statistically different, although the control group did have a tendency to score higher. In the analysis of the levels of compression, the sixty percent level of compression received low scores for both groups although the experimental group received lower scores. The number of critical elements was also a differentiating factor between the two groups. The second critical element level of difficulty received the best scores from the control group while the three critical element level of difficulty received the best score from the experimental group. This difference may be due to several factors. The minimally brain damaged child may require more time to regain his attention and adjust to the rate of speech between segments. The three critical element level of difficulty allows this time required to overlap into the first or even the second element while still retaining enough information in the third critical element to enable the child

to attempt a correct response. This extra element may be needed for the minimally brain damaged child to effectively process compressed and expanded speech. At four critical elements, the channel capacity of this child may be overloaded, causing a loss in the message. The fourth critical element level of difficulty in both groups received the poorest scores.

As far as the comprehension is concerned, the optimum level for the control group is twenty to forty percent compression throughout the three levels of difficulty. In the experimental group, the twenty percent level of compression appears to be the optimum level in the two and the four element level of difficulty. In the three element level of difficulty, either twenty or forty percent compression are optimum. This gives further support to the statement that the three critical element level of difficulty is the optimum level for the use of compressed speech with the child with behavioral characteristics of the minimally brain damaged child.

The interpretations of this study have been made in the form of hypotheses. Because of the small number of subjects, little meaningful statistical analyses could be performed. Although it was shown that the two groups under investigation performed differently on the compressed and expanded portions of the tests, no other statements can be statistically supported. Because of this, all other analyses of these results have been trends observed and should not be taken as constant factors.

Improvements upon this research study could be made in the following ways. A larger, more varied population of both normal children and children who exhibit behavioral characteristics of the minimally brain damage children would enable the examiner to assess more adequately the affect of speech compression and expansion upon the listener. By increasing the number of segments compressed or expanded at each level of difficulty, a more indepth analysis of the comprehension of expanded and compressed speech as a function of the level of difficulty could be made. A method of compression other than the sampling method would eliminate the possibility of the distortion or loss of a word due to the discard interval.

Implications for Further Research

The following hypotheses should be investigated before any definite causal relationships can be determined:

1. The attention ability of the child is a causal factor in the difference in the scores of the two groups as a function of the critical elements involved.

2. The method of speech compression (in this study, the sampling method) may distort the message by discarding the information carrying elements of the word.

3. The adjustment time of the child may be a causal factor in the difference in scores of the two groups as a function of the critical elements involved.

4. The number of syllables per word is an active

factor occuring in the first three hypotheses.

5. The word structure of the segments presented may directly affect the performance of the subjects on the various levels of compression and expansion.

6. An analysis of the functions of each critical element at each level of difficulty and the relationship of this to each level of compression and expansion.

7. The relationship between the auditory channel capacity of the individual child and the number of critical elements involved at each level of compression and expansion.

8. The order of presentation may have a positive effect upon the learning of the child. In other words, the more exposure to the compressed and expanded speech, the more the child is able to comprehend.

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this study was to compare comprehension of expanded speech and compressed speech in normal children and in children exhibiiting behavioral characteristics of minimally brain damaged children. It was hypothesized that if the amount of information presented was increased while the time spent remained constant, this would become a more useful method of information presentation to the child with behavioral characteristics of the minimally brain damaged child.

The questions posed at the onset of this study were as follows:

1. Is there a statistically significant difference between the scores for children exhibiting behavioral characteristics of minimally brain damaged children and normal children on the ACLC for the following rates of compression (+) and expansion (-).

   a. -40%

   b. -20%

   c. +20%

   d. +40%

   e. +60%

2. Is comprehension at the following levels of difficulty with the ACLC subtests affected differently between the two groups?

a. 2 critical elements at -40%, -20%, +20%, +40% and +60%.

b. 3 critical elements at -40%, -20%, +20%, +40% and +60%.

c. 4 critical elements at -40%, -20%, +20%, +40% and +60%.

Ten children were used in this study, five normal children and five children exhibiting behavioral characteristics of the minimally brain damaged child drawn from the second and third grades. Two test were used to determine the presence of brain damage characteristics. The Bender-Gestalt Test of Motor Performance was administered to the five children suspected of minimal brain damage. A behavior list was given to the second and third grade teachers to aid in the classification of minimal brain damage. The child had to exhibit at least fifteen of the twenty behaviors to fit in this category.

The Assessment of Children's Language Comprehension (ACLC) was presented as the stimuli for this study. The separation of difficulty enabled the examiner to chart each level of comprehension rather then depend upon an overall estimate of the child's ability to comprehend at various levels of expansion and compression. A pre- and post-test was presented at normal rate of speech. Sections B,C and D were then played again at

varying amounts of compression and expansion. Two phrases from each section were randomly selected through the use of a table of random numbers to be presented at one of the given expansion or compression levels. The six phrases were presented at each level of expansion and compression. Three different forms of the ACLC were presented. These were developed by randomly selecting the verbal directives for each item. In this way each verbal directive was presented only once. The order of presentation of each of the three tests forms was randomly selected through the use of a table of random numbers. All instructions were presented by tape. The child was shown the volume control on the tape recorder and was allowed to adjust it to his preference.

The Mann Whitney $\underline{U}$ was calculated to determine if there was a statistically significant difference between the scores of the experimental and control group for the expansion levels of -40% and -20% and the compression levels of +20%, +40% and +60%. It was also calculated to determine whether there was a statistically significant difference between the comprehension of the ACLC of the two groups. The two, three and four critical elements at the expansion levels of -40% and -20% and the compression levels of +20%, +40% and +60& were analyzed.

CONCLUSIONS

The statistical analyses as outlined above resulted in the following conclusions concerning the compression and expansion

of speech:

1. In the comparison of the scores of the ACLC between the experimental and control group the following results were obtained:

a. The compression levels of +20% and +40% and the expansion levels of -40% and -20% were found to be nonsignificant.

b. The compression level of +60% was found to be significant at the .05 level of confidence.

2. In the comparison of the differences of comprehension as a function of the level of difficulty between the experimental and control group, the following results were obtained:

a. The comprehension of the two critical element level (eg. cat walking) was nonsignificant.

b. The comprehension of the three critical element level (eg. chicken in the basket) was nonsignificant.

c. The comprehension of the four critical element level (eg. happy little girl jumping) was significant.

3. The following statements represent trends noted in the analysis of the data received. No statistical analyses were performed.

a. The method of compression appeared to distort the one syllable prepositions. At times this distortion may have resulted in an error response.

b. The third critical element level of difficulty received the highest overall scores for the experimental group. This is an indication that this is the optimum

level of difficulty for the experimental group.

c. The second and the third critical element level of difficulty received the highest scores for the control group.

d. The number of syllables per word seems to be an active factor in the comprehension of compressed and expanded speech.

e. The analysis of comprehension as a function of the number of critical elements is a meaningful method of measurement.

f. The overall comprehension of the two groups followed the curves reported in earlier research.

g. The scores of the experimental group were consistently lower than those of the control group.

h. Twenty percent compression was the best achieved level of comprehension for both groups for either the two or the three critical element level.

i. Four critical element level of difficulty appears to be too complex for optimum comprehension of the higher levels of compressed speech.

In summary, the twenty percent level of compression appears to be the optimum level of compression for both the control and the experimental groups. Further research is needed before any definite statements as to the educational applicability of expanded and compressed speech can be made.

APPENDIX I

ACLC VOCABULARY

Trial Items

fish
book
dress
hand
door

Plate 1

shoe
ball
boat
cat
baby

Plate 2

lady
apple
bird
chair
bed

Plate 3

table
horse
boy
car
dog

Plate 4

chicken
girl
horn
wagon
can

Plate 5

sleeping
jumping
sitting
standing
blowing

Plate 6

on
under
over
in
behind

Plate 7

little
happy
dirty
broken
big

Plate 8

box
men
house
fence
tree

Plate 9

monkey
cup
basket
clown
balloon

Plate 10

eating
pulling
walking
riding
washing

BENDER-GESTALT TEST OF MOTOR PERFORMANCE RESULTS

Subject 1E

Figures A, 7, 8 - distortion of shape
Figures 3*, 4*, 5* - rotation
Figure 6** - perseveration
Total points = 7

Subject 2E

Figures 7,8* - distortion of shape
Figure 7 - rotation
Total points = 3

Subject 3E

Figures A*, 7, 8* - distortion of shape
Figure 3*- shape lost
Figures 4*, 5*, 7* - rotation
Figures 4*, 6*, 7* - integration
Total points = 10

Subject 4E

Figures A, 7, 8 - distortion of shape
Figure 1** - perseveration
Figure 3* - loss of design
Figure 5 - continuous line for dots
Figure 6* - angles for curves
Figure 7 - rotation*, distortion of size
Total points = 9

Subject 5E

Figures A*, 8* - distortion of shape
Figures 1*,3* - circles for dots
Figures 3*, 7* - rotation
Figure 3* - shape of design lost
Figure 5** - continuous line for dots
Figure 6** - straight line
Figure 7 - distortion of size*, integration*
Figure 8* - angle distortion
Total points = 14

BEHAVIOR LIST

	Behaviors	1E	2E	3E	4E	5E
1.	Reading disabilities	X	X	X	X	X
2.	Arithmetic disabilities	X	X	X	X	X
3.	Spelling disabilities	X	X	X	X	X
4.	Poor printing or writing ability	X	X	X	X	X
5.	Variability in performance from day to day	X	X	X	X	X
6.	Poor ability to organize work	X	X	X	X	X
7.	Slowness in finishing work	X	X	X	X	X
8.	Frequent confusion about instructions, yet success with verbal tasks	X	X	X	X	X
9.	Thinking frquently disorganized	X	X	X	X	X
10.	Poor short and long term memory	X	X	X	X	X
11.	Impulsive behavior	X		X	X	
12.	Poor emotional and impulse control	X			X	X
13.	Low tolerence for frustration	X	X	X	X	X
14.	Reckless and uninhibited - impulsive then remorseful	X				
15.	Overexcitable in normal play with other children	X		X	X	X
16.	Poor adjustment to environmental change	X	X			
17.	Short attention span	X	X	X	X	X
18.	Overly distractible for age	X		X	X	X
19.	Impaired concentration ability	X	X	X	X	X
20.	Impaired ability to make decisions, particularly from many choices	X	X	X	X	X
	Total	20	15	17	18	17

PRE-TEST

Verbal Directive: "Show me . . ."

Two Critical Elements

horse standing
chair and basket
dirty shoe
cat walking
good boat
car and balloon
man running
big tree
happy lady
dog sleeping

Three Critical Elements

cat under the table
happy lady eating
cat behind the table
cat and dog eating
baby painting the wagon
girl blowing the horn
boy pulling the horse
bird over the house
eggs in the basket
man washing the car

Four Critical Elements

happy little girl jumping
cat standing under the bed
apple and shoe on the table
monkey sitting on the chair
big ball under the chair
big dog over the fence
clown eating the little apple
dog sleeping behind the chair
boy standing on the house
broken wagon on the table

EXPERIMENTAL TEST (~X)

Verbal Directive: "Show me . . ."

Two Critical Elements

-40% expansion level
clean box
sad lady

-20% expansion level
horse sitting
boy and balloon

+20% compression level
broken boat
dog eating

+40% compression level
woman running
fence and horn

+60% compression level
horse lying
little car

Three Critical Elements

-40% expansion level
baby pulling the boat
sad lady sleeping

-20% expansion level
girl holding the horn
bird and dog eating

+20% compression level
balloon over the house
chicken in the wagon

+40% compression level
ball on the table
man washing the dog

+60% compression level
boy riding the horse
ball behind the bed

Four Critical Elements

-40% expansion level
little basket under the chair
mouse standing under the bed

-20% expansion level
dog sitting behind the chair
clown eating the big apple

+20% compression level
apple and shoe on the can
sad little girl jumping

+40% compression level
boy standing in the house
monkey sitting off the fence

+60% compression level
little cat infront of the fence
broken boat on the floor

POST-TEST

Verbal Directive: "Show me . . ."

Two Critical Elements

bird lying
chair and horn
clean shoe
horse walking
broken cup
boy and wagon
woman sitting
little tree
happy boy
boy eating

Three Critical Elements

ball under the bed
happy lady sleeping
cat behind the bed
child and bird eating
dog pulling the wagon
dog blowing the horn
boy riding the bicycle
balloon over the bed
chicken in the basket
man driving the car

Four Critical Elements

happy big girl sitting
cat sitting under the bed
boat and shoe on the can
boy sitting on the fence
big basket under the chair
little cat over the box
clown holding the big apple
mouse sleeping behind the chair
dog standing in the house
broken boat on the table

PRE-TEST SCORES OF THE CONTROL GROUP

Verbal Directive: "Show me . . ." CR = Correct Response		Subjects					
		CR	1C	2C	3C	4C	5C
1*	big ball under the chair	5	5	5	5	5	5
2.	broken ball under the table	3	3	3	3	3	3
3.	cat and dog eating	2	2	2	2	2	2
4.	eggs in the basket	4	4	4	4	4	4
5.	man running	2	2	2	2	2	2
6.	dirty shoe	1	1	1	1	1	1
7.	cat standing under the bed	5	5	4	5	5	5
8.	clown eating the little apple	2	2	2	2	2	2
9.	big tree	1	1	1	1	1	1
10.	baby painting the wagon	4	4	4	4	4	4
11.	cat under the table	2	2	2	2	2	2
12.	dog sleeping behind the chair	3	3	3	3	3	3
13.	happy lady eating	3	3	3	3	3	3
14.	chair and basket	2	2	2	2	2	2
15.	happy lady	4	4	4	4	4	4
16.	apple and shoe on the table	4	4	1	4	1	4
17.	car and balloon	1	1	1	1	1	1
18.	cat behind the table	3	3	3	3	3	3
19.	boy pulling the horse	3	3	3	3	3	3
20.	happy little girl jumping	1	1	1	1	1	1
21.	man washing the car	1	1	1	1	1	1
22.	monkey sitting on the chair	1	1	1	1	1	1
23.	bird over the house	3	3	3	3	3	3
24.	good boat	2	2	2	2	2	2
25.	big dog over the fence	1	1	1	1	1	1
26.	dog sleeping	4	4	4	4	4	4
27.	cat walking	4	4	4	4	4	4
28.	boy standing on the house	1	1	1	1	1	1
29.	horse standing	3	3	3	3	3	3
30.	girl blowing the horn	3	3	3	3	3	3
	Total Correct Responses		30	28	30	29	29

* items listed in order of presentation

EXPERIMENTAL TEST SCORES OF THE CONTROL GROUP

Verbal Directive: "Show me . ." CR = correct response	CR	Subjects 1C	2C	3C	4C	5C
1* baby pulling the boat (-40%)	2	2	2	2	2	2
2. clean box (-40%)	3	3	3	3	3	3
3. sad lady sleeping (-40%)	1	1	1	1	1	1
4. girl holding the horn (-20%)	1	1	1	1	1	1
5. bird and dog eating (-20%)	3	3	3	3	3	3
6. little cat in front of the fence (+60%)	5	4	4	4	2	2
7. chicken in the wagon (+20%)	2	2	2	2	2	2
8. sad lady (-40%)	3	3	3	3	3	3
9. horse sitting (-20%)	2	2	2	2	2	2
10. balloon over the house (+20%)	4	4	4	4	4	4
11. apple and shoe on the can (+20%)	1	1	1	1	1	1
12. horse lying (+60%)	4	4	4	4	4	4
13. broken boat (+20%)	4	4	4	4	4	4
14. dog sitting behind the chair(-20%)	1	1	1	1	1	1
15. dog eating (+20%)	2	2	2	2	2	2
16. little basket under the chair (-40%)	1	1	1	1	1	1
17. little car (+60%)	2	2	2	2	2	2
18. boy riding the horse (+60%)	1	1	1	1	1	1
19. sad little girl jumping(+20%)	4	4	4	4	4	4
20. ball on the table (+40%)	1	1	4	1	1	4
21. mouse standing under the bed(-40%)	1	1	1	1	1	1
22. woman running (+40%)	4	4	4	4	4	4
23. boy standing in the house (+40%)	4	1	5	5	5	5
24. broken boat on the floor (+60%)	2	1	4	2	2	2
25. man washing the dog (+40%)	3	3	3	3	3	3
26. boy and balloon (-20%)	3	3	3	3	3	3
27. fence and horn (+40%)	4	4	4	4	4	4
28. monkey sitting off the fence(+40%)	2	2	3	2	2	2
29. clown eating the big apple(-20%)	3	3	3	3	3	3
30. ball behind the bed (+60%)	4	2	4	4	4	4
Total Correct Responses		26	26	29	29	28

* items listed in order of presentation

POST-TEST SCORES OF THE CONTROL GROUP

Verbal Directive: "Show me . ." CR = correct response		Subjects				
	CR	1C	2C	3C	4C	5C
1* clown holding the big apple	1	3	1	1	1	1
2. little tree	3	3	3	3	3	3
3. dog pulling the wagon	3	3	3	3	3	3
4. boy sitting on the fence	5	5	5	5	5	5
5. cat behind the bed	2	2	2	2	2	2
6. little cat over the box	4	4	4	4	4	4
7. clean shoe	4	4	4	4	4	4
8. dog blowing the horn	4	4	4	4	4	4
9. balloon over the bed	1	1	1	1	1	1
10. happy big girl sitting	5	5	5	5	5	5
11. happy lady sleeping	2	2	2	2	2	2
12. woman sitting	3	3	3	3	3	3
13. happy boy	1	1	2	2	2	2
14. dog standing in the house	3	3	3	3	3	3
15. bird lying	2	2	2	2	2	2
16. broken cup	3	3	3	3	3	3
17. horse walking	3	3	3	3	3	3
18. child and bird eating	1	1	1	1	1	1
19. mouse sleeping behind the chair	4	4	4	4	4	4
20. boy eating	1	1	1	1	1	1
21. big basket under the chair	4	4	4	4	4	4
22. chicken in the basket	3	3	3	3	3	3
23. boy riding the bicycle	2	2	2	2	2	2
24. cat sitting under the bed	4	4	4	4	4	4
25. broken boat on the table	4	4	4	4	4	4
26. man driving the car	2	2	2	2	2	2
27. chair and horn	3	3	3	3	3	3
28. boy and wagon	2	2	2	2	2	2
29. ball under the bed	3	3	3	3	3	3
30. boat and shoe on the can	5	5	5	5	5	5
Total Correct Responses		29	30	30	30	30

* items listed in order of presentation

PRE-TEST SCORES OF THE EXPERIMENTAL GROUP

Verbal Directive: "Show me . ." CR = correct response		Subjects				
	CR	1E	2E	3E	4E	5E
1* big ball under the chair	5	5	5	5	5	5
2. broken wagon on the table	3	3	3	3	3	3
3. cat and dog eating	2	2	2	2	2	2
4. eggs in the basket	4	4	4	4	4	4
5. man running	2	2	2	2	2	2
6. dirty shoe	1	1	1	1	1	1
7. cat standing under the bed	5	5	5	4	5	2
8. clown eating the little apple	2	2	2	2	2	2
9. big tree	1	1	1	1	1	1
10. baby painting the wagon	4	4	4	4	4	4
11. cat under the table	2	2	2	2	2	2
12. dog sleeping behind the chair	3	1	3	1	3	3
13. happy lady eating	3	3	3	3	3	3
14. chair and basket	2	2	2	2	2	2
15. happy lady	4	4	4	4	4	4
16. apple and shoe on the table	4	4	1	4	4	1
17. car and balloon	1	1	1	1	1	1
18. cat behind the table	3	3	3	3	3	3
19. boy pulling the horse	3	3	3	3	3	3
20. happy little girl jumping	1	2	1	1	4	1
21. man washing the car	1	4	1	1	1	1
22. monkey sitting on the chair	1	1	1	1	1	1
23. bird over the house	3	3	3	3	3	3
24. good boat	2	2	2	2	2	2
25. big dog over the fence	1	1	1	1	1	1
26. dog sleeping	4	4	4	4	4	4
27. cat walking	4	4	4	4	4	4
28. boy standing on the house	1	1	1	1	1	1
29. horse standing	3	3	3	3	3	3
30. girl blowing the horn	3	3	3	3	3	3
Total Correct Responses		28	29	29	29	28

* items listed in order of presentation

EXPERIMENTAL TEST SCORES OF THE EXPERIMENTAL GROUP

Verbal Directive: "Show me . ." CR = correct response		Subject				
	CR	1E	2E	3E	4E	5E
1* baby pulling the boat(-40%)	2	2	2	2	2	2
2. clean box (-40%)	3	3	3	3	3	3
3. sad lady sleeping (-40%)	1	1	1	1	1	1
4. girl holding the horn	1	1	1	1	1	1
5. bird and dog eating(-20%)	3	3	3	3	3	3
6. little cat in front of the fence (+60%)	5	4	1	4	4	4
7. chicken in the wagon(+20%)	2	2	2	2	2	2
8. sad lady (-40%)	3	3	3	3	3	3
9. horse sitting (-20%)	2	2	2	2	2	2
10. balloon over the house (+20%)	4	4	4	4	4	4
11. apple and shoe on the can(+20%)	1	1	1	1	2	1
12. horse lying (+60%)	4	4	3	2	4	3
13. broken boat (+20%)	4	4	4	4	4	4
14. dog sitting behind the chair (-20%)	1	1	3	3	1	1
15. dog eating (+20%)	2	2	2	2	2	2
16. little basket under the chair (-40%)	1	1	1	1	1	1
17. little car (+60%)	2	2	2	2	2	2
18. boy riding the horse	1	1	1	4	3	4
19. sad little girl jumping(+20%)	4	4	4	4	4	4
20. ball on the table (+40%)	1	1	1	1	1	1
21. mouse standing under the bed (-40%)	1	1	1	1	1	1
22. woman running (+40%)	4	4	4	2	4	2
23. boy standing in the house(+40%)	5	1	1	1	5	5
24. broken boat on the floor (+40%)	2	5	5	3	1	1
25. man washing the car (+40%)	3	3	3	3	3	3
26. boy and balloon (-20%)	3	3	3	3	3	3
27. fence and horn (+40%)	4	4	3	3	4	4
28. monkey sitting off the fence (+40%)	2	3	2	2	2	3
29. clown eating the big apple(-20&)	3	3	3	3	3	3
30. ball behind the bed (+60%)	4	4	4	4	4	4
Total Correct Responses		26	24	22	26	22

* items listed in order of presentation

POST-TEST SCORES OF THE EXPERIMENTAL GROUP

Verbal Directive: "Show me . ." CR = correct response		Subject				
	CR	1E	2E	3E	4E	5E
1.* clown holding the big apple	1	1	3	1	1	3
2. little tree	3	3	3	3	3	3
3. dog pulling the wagon	3	3	3	3	3	1
4. boy sitting on the fence	5	5	5	5	5	5
5. cat behind the bed	2	2	2	2	2	2
6. little cat over the box	4	4	4	4	4	4
7. clean shoe	4	4	4	4	4	4
8. dog blowing the horn	4	4	4	4	4	4
9. balloon over the bed	1	1	1	1	1	1
10. happy big girl sitting	5	5	5	5	5	5
11. happy lady sleeping	2	2	2	2	2	2
12. woman sitting	3	3	3	3	3	3
13. happy boy	1	1	1	1	1	1
14. dog standing in the house	3	3	3	3	3	3
15. bird lying	2	2	2	2	2	4
16. broken cup	3	3	3	3	3	3
17. horse walking	3	3	3	3	3	3
18. child and bird eating	1	1	1	1	1	3
19. mouse sleeping behind the chair	4	4	4	4	4	4
20. boy eating	1	1	1	1	1	1
21. big basket under the chair	4	4	4	4	4	4
22. chicken in the basket	3	3	3	3	3	3
23. boy riding the bicycle	2	2	2	2	2	2
24. cat sitting under the bed	4	4	4	4	4	4
25. broken boat on the table	4	4	4	4	4	4
26. man driving the car	2	2	2	2	2	2
27. chair and horn	3	3	3	3	3	3
28. boy and wagon	2	2	2	2	2	2
29. ball under the bed	3	3	3	3	3	3
30. boat and shoe on the can	5	5	5	5	5	5
Total Correct Responses		30	29	30	30	26

* items listed in order of presentation

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