FURTHER EXAMINATION OF THE RELATIONSHIP OF AUDITORY VIGILANCE TO ARTICULATORY DISORDERS

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ABSTRACT

FURTHER EXAMINATION OF THE RELATIONSHIP OF AUDITORY VIGILANCE TO ARTICULATORY DISORDERS

by Bonita M. Miller

Recently, a study was performed to investigate the relationship between auditory vigilance and articulatory disorders. Vigilance may be conceived of as an individual's readiness to respond to certain, small specified signals to which he has been alerted. Functional articulatory disorders may be conceived of as errors in the production of the standard speech sounds, these errors not being attributable to an organic defect.

The purpose of the present study was to elaborate upon the results obtained by the above mentioned study. Its design incorporated some of the changes recommended by the original investigator.

Two groups of subjects were selected. Each group was composed of thirty-one children from the first two grades of two public schools in Winnipeg, Manitoba, Canada. The experimental group was composed of children referred by their classroom teachers as having functional articulatory disorders. The control group was randomly selected by the experimenter from the same rooms from which the other children were referred. None of the children had received speech therapy.

The children listened to a thirty-minute tape recording of semi-randomly selected digits, presented at the rate of one every other second. They were required to listen for a signal, which was defined as any digit presented twice in succession. One signal was randomly inserted within each one-minute segment of the test. The level of vigilance was inferred according to the number of signals to which the children failed to respond.

The results obtained made it possible to reject three of the null hypotheses. The alternate hypotheses which were accepted are:

1. For both populations combined, there is a decrease in vigilance from the first to the last ten minutes of the thirty-minute task.
2. Children with articulatory disorders show a decrease in vigilance from the first to the last ten minutes of a thirty-minute task of auditory vigilance.
3. Children with articulatory disorders show a positive correlation between the first and the last ten minutes of a thirty-minute task of auditory vigilance.

Although the above hypotheses were accepted, it is not possible to conclude that there is any difference between children with articulatory disorders and children without articulatory disorders with regard to performance on a thirty-minute task of auditory vigilance.

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By

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CHAPTER I

STATEMENT OF THE PROBLEM

Introduction

Are children who have functional articulatory disorders likely to exhibit poor auditory attention habits or poor auditory vigilance? Recently, a research project was performed to study the relationship of auditory vigilance to articulatory disorders.[1] The purpose of that study was: "To investigate whether or not there is a difference in auditory vigilance, or the maintenance of attention, between children with articulatory disorders and children without articulatory disorders."[2] The study was designed to ". . . reveal a possible contributing factor in the development of articulatory disorders."[3] Its results, although not statistically significant, showed a difference in the expected direction, giving some support to the hypothesis.

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[1]Doris A. Schuldt, "The Relationship of Auditory Vigilance to Articulatory Disorders" (unpublished Master's thesis, Department of Speech, Michigan State University, 1963).

[2]Ibid., p. 3.

[3]Ibid., p. 4.

Schuldt, who performed the investigation, observed that numerous studies in the area of articulation have been made. A systematic review of these has been presented by Powers,[1] who reports that physical, psychological, sensory (auditory, tactile, kinesthetic, and visual), intellectual, environmental, learning, emotional, and personality variables have been studied. Schuldt found that although many auditory variables have been studied, almost no attention had been given to the possible relationship between auditory vigilance and articulatory disorders.

The surveys concerning the incidence of speech disorders indicate that functional articulatory disorders constitute by far the largest number of speech problems. Figures from the Midcentury White House Conference[2] (1952) indicate that 60 per cent of all speech disorders of school age children are functional articulatory disorders. Powers says, ". . . it is safe to say that functional articulation defectives represent between 75 and 80 per cent of all speech defectives in the school population."[3]

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[1]Margaret Hall Powers, "Functional Disorders of Articulation--Symptomotology and Etiology," Handbook of Speech Pathology, ed. Lee Edward Travis (New York: Appleton-Century-Crofts, Inc., 1957), Chapter 23, p. 730.

[2]Midcentury White House Conference, 1952, "Speech Disorders and Speech Correction," Journal of Speech and Hearing Disorders, 17 (1953), p. 129.

[3]Powers, op. cit., p. 711.

In view of the large number of functional articulatory disorders, our incomplete knowledge of their etiology, and the need for further understanding of the relationship between this speech problem and auditory vigilance, it seemed that a second study, with modifications in design would be a fruitful area of research.

Statement of Purpose of Study

Schuldt listed several implications for further research on the basis of her findings. She suggested the repetition of her study, using more subjects and a longer task. These two changes being made, and other aspects of the study being similar, a second investigation of the relationship between auditory vigilance and articulatory disorders was undertaken. The purpose was therefore to elaborate upon the results of the earlier research on which the present study was based.

Hypotheses

Twelve questions were to be investigated in this experimental study. The questions asked and the corresponding null hypotheses are as follows:

1. Will children with articulatory disorders and children without articulatory disorders perform similarly at the outset of a task of auditory vigilance?

Ho: There is no difference between children with articulatory disorders and children without articulatory

disorders with regard to the number of errors made during the first ten minutes of a thirty-minute task of auditory vigilance.

2. After part of the task has elapsed, will any difference in the performance by the two groups be evident?

Ho: There is no difference between children with articulatory disorders and children without articulatory disorders with regard to the number of errors made during the second ten minutes of a thirty-minute task of auditory vigilance.

3. Will there be any differences in performance by the end of the task of auditory vigilance?

Ho: There is no difference between children with articulatory disorders and children without articulatory disorders with regard to the number of errors made during the third ten minutes of a thirty-minute task of auditory vigilance?

4. Will there be any differences between the two groups on the over-all test performance?

Ho: There is no difference between children with articulatory disorders and children without articulatory disorders with regard to the number of errors made during a thirty-minute task of auditory vigilance.

5. Will articulatory defective children accumulate any more errors at any time during the task than the children who do not have articulatory defects?

Ho: Children with articulatory disorders will have accumulated no more errors of omission at any point in time during a thirty-minute task of auditory vigilance than will children without articulatory disorders.

6. Will the children be as vigilant at the end of the task as they were at the beginning of the task?

Ho: For the two groups combined there will be no decrease in auditory vigilance from the first to the last ten minutes of a thirty-minute task of auditory vigilance.

7. Will the children who have articulatory disorders perform as well at the end of a task of auditory vigilance as they do at the beginning of the task?

Ho: Children with articulatory disorders show no decrease in vigilance from the first to the last ten minutes of a thirty-minute task of auditory vigilance.

8. Will the children without articulatory disorders perform as well at the end of a task of auditory vigilance as they do at the beginning?

Ho: Children without articulatory disorders show no decrease in vigilance from the first to the last ten minutes of a thirty-minute task of auditory vigilance.

9. Will there be any difference between the groups regarding the change in performance from the first to the last ten minutes of the task?

Ho: Children with articulatory disorders manifest no greater decrease from the first to the last ten minutes

of a thirty-minute task of auditory vigilance than do children without articulatory disorders.

10. Will it be possible to predict the performance of children with articulatory disorders given knowledge of their performance at the beginning of the test?

Ho: Children with articulatory disorders do not show a positive correlation between the first and last ten minutes of a thirty-minute task of auditory vigilance.

11. Will it be possible to predict the performance of children without articulatory disorders at the end of the task, given knowledge of their performance at the beginning of the task?

Ho: Children without articulatory disorders do not show a positive correlation between the first and last ten minutes of a thirty-minute task of auditory vigilance.

12. Will it be possible to predict more accurately for one group than for another, given knowledge of the performance of each group at the outset of the test?

Ho: There is no difference between children with articulatory disorders and children without articulatory disorders with regard to the correlation between the first and last ten minutes of a thirty-minute task of auditory vigilance.

Importance of the Study

Because the majority of speech correctionists work with children who have functional articulatory disorders,

any information which will contribute further to their understanding of this disorder will be valuable. It is hoped that the experimental design will be such that a possible contributing factor in the development of functional articulatory disorders will be revealed.

Further, if a relationship between functional articulatory disorders and auditory attention habits can be established, implications for the modification of therapeutic techniques might be revealed. A speech therapist, knowing that members of his class may have poor auditory attention habits, could modify his techniques in order to improve auditory attention and maximize maintenance of attention.

Definition of Terms

Because the present study is a follow-up of a previous study, terms will be defined according to the definitions used in that study.

Schuldt used the definition of articulatory disorders presented by Powers.

> Functional Articulatory Disorders: an inability to produce correctly all of the standard speech sounds of the language, an inability for which there is no appreciable structural, physiological, or neurological basis in the speech mechanism or its supporting structures, but which can be accounted for by normal variations in the organism or by environmental or psychological factors.[1]

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[1] Ibid., p. 708.

Mackworth's definition of vigilance was used, which is ". . . a state of readiness to detect and respond to certain specified small changes occurring at random time intervals in the environment . . ."[1] Operationally, the level of vigilance can be inferred from the performance by the number of signals to which the listener fails to respond.[2]

"A Signal was defined as any number presented twice in succession . . . Errors of omission are defined as a lack of response when a signal is presented, and errors of commission are responses when a signal is not presented."[3]

Organization of the Thesis

Chapter I contained an introduction to the study. A statement of the problem, the hypotheses, an indication of the importance of the study and definition of terms were also presented. Chapter II will present a review of of the literature concerning vigilance, concentrating especially on theories of vigilance. Chapter III will be a discussion of subjects, equipment, and testing procedures.

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[1] N. H. Mackworth, "Some Factors Affecting Vigilance," Advancement of Science, 53 (1957), pp. 389-390.

[2] Schuldt, op. cit., p. 5.

[3] Ibid., pp. 18, 21.

The results of the study and discussion of these will be found in Chapter IV. Chapter V will contain a summary, conclusions, and implications for further research.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

In recent years, vigilance has been the subject of many investigations. There has been an upsurge in the amount of experimental work concerning the topic. It was reported in 1963 that the number of experimental studies concerning vigilance in 1960 was about five times the number reported in 1955.[1] "During the past fifteen years," says McGrath, "more than one hundred investigators have published reports on the subject of human vigilance."[2]

Study of some of these reports reveals that the term "vigilance" has been used ambiguously and that there are many different ways in which it has been interpreted. The term may be used to refer to a central process or state of the organism, usually the individual's readiness to detect and respond to randomly occurring specified

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[1]Donald N. Buckner and James J. McGrath (eds.), Vigilance: A Symposium (New York: McGraw-Hill Book Company, 1963), p. vii.

[2]James J. McGrath, "Some Problems of Definition and Criteria in the Study of Vigilance Performance," Vigilance: A Symposium, eds. Donald N. Buckner and James J. McGrath (New York: McGraw-Hill Book Company, 1963), Chapter 16, p. 227.

small changes in the environment. Mackworth[1] is one investigator to use the term in this way. Baken, who defines vigilance as ". . . the ability to sustain attention quite irrespective of what the stimuli are,"[2] also refers to the state of the organism.

"Vigilance" has also been used to refer to the performance itself. When used this way, measures of probability of detection, latency of responses, or shifts from some initial performance level may describe vigilance.[3]

It can readily be understood that with such variations in definition, investigators have not yet been able to agree upon a theoretical explanation of vigilance performance. An adequate theory of vigilance must explain the results of the many experimental studies, provide a basic understanding of vigilance and indicate the applicability of laboratory data to field situations.

Theories of Vigilance

As mentioned, there is very little agreement on a theory of vigilance, and almost every investigator of a vigilance task has his own theoretical explanation for

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[1]Mackworth, op. cit., pp. 389-390.

[2]Paul Baken, John A. Belton, and John C. Troth, "Extraversion-Introversion and Decrement in an Auditory Vigilance Task," Vigilance: A Symposium, ed. Donald N. Buckner and James J. McGrath (New York: McGraw-Hill Book Company, 1963), Chapter 2, p. 30.

[3]McGrath, op. cit., p. 228.

the obtained results. It will, therefore, be practical in this review of the literature to examine only a few of the classical and most recent theories of vigilance.

Inhibition theory.--Mackworth, one of the first investigators of vigilance considers it as the organism's readiness to respond to certain signals for which the organism must search over an extended period of time. He noted that over this period of time, the subject failed to respond to many of the signals. He explains the decrease in the number of responses to the signals by supposing that the response to the non-signal event is extinguished.[1] This extinction then generalizes to the signal which shares many characteristics with the non-signal stimuli. The point at which extinction begins to occur depends upon many physical and psychological factors. Mackworth suggests that " . . . in the absence of reinforcement of the responses, inhibition will accumulate, resulting in a systematic deterioration of the performance."[2]

Baken[3] also supports the inhibition theory but says that the reinforcing event is the detection of a signal which maintains the response of attentive behavior. In

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[1]Mackworth, op. cit., p. 391.

[2]P. D. McCormick, "A Two Factor Analysis of Vigilance," The British Journal of Psychology, 53 (1962), p. 359.

[3]Ibid., p. 359.

other words, the occurrence of signals reinforces the listening responses, and so, if the signals occur infrequently, there is little reinforcement of the listening response. The result is a tendency for these responses to be extinguished.

Broadbent has summarized the various ways in which classical conditioning theory is consistent with performance on vigilance tasks:

> (1) Responses to the infrequent stimulus became less common after a period of continuous watch. (Extinction.)
> (2) A short interval between periods of testing temporarily restored full efficiency. (Spontaneous recovery.)
> (3) A novel situation (e.g. a telephone message) [midway in the task] temporarily restored full efficiency. (Disinhibition.)
> (4) The following of every stimulus by an auditory message informing S of his performance prevented deterioration. (Continued reinforcement.)[1]

Filter theory.--Broadbent does not completely accept the classical inhibition or conditioning theory of vigilance. He proposes the Filter Theory to explain some of the facts of classical conditioning.

He assumes that the human perceptual system has a limited capacity and is incapable of analyzing simultaneously all the information received by the sense organs. The information is, therefore, filtered by some selective

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[1]D. E. Broadbent, "Classical Conditioning and Human Watck Keeping," Psychological Review, 60 (1953), pp. 336-337.

operation and only part of it is passed on to the perceptual system. Initially, this selective operation is determined by the instructions the subject receives.

The filter, however, will usually select channels which have not recently been active. Over a period of time, there is likely to be a change in the channel selected. In other words, attention wanders, and the subject may notice features of his surroundings or his own bodily discomfort, or he may simply daydream. Signals later in the task have a greater probability of falling during these moments of wandering attention, and therefore, they are missed, thus accounting for the vigilance decrement.

These short periods of non-attention have been called "blocks."[1] Broadbent interprets blocking as ". . . an interuption in the intake of information from one source owing to the intake of information from another source."[2] Broadbent goes on to say:

> As novel stimuli have a higher probability of passing the filter, these shifts in selection will not occur until the task has been continued for some time.[3]

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[1]J. A. Whittenburg, J. A. Ross, and T. G. Andrew, quoted in D. E. Broadbent's Perception and Communication (London: Pergamon Press, 1958), p. 132.

[2]Broadbent, ibid., p. 133.

[3]Ibid.

Expectancy theory.--Deese and Baker are perhaps the strongest supporters of the Expectancy Theory. The basic assumption of Deese's theory is that " . . . the maintenance of a given level of vigilance in an observer depends to some extent upon the events extrinsic to the observer."[1] Response to a signal is a function of the probability of that signal, the probability of that signal being derived from past incidence of the signal. The observer tries to average previous information in order to predict future events. Following the detection of a signal, expectancy would be low. It would increase as the average time between signals is approached, and would be quite high as the inter-signal interval grows beyond the mean.[2] It is suggested by Baker[3] that expectancy again falls to a low level as the interval grows still longer. He added that the degree to which the observer is aware of such expectancies is unknown. Baker uses the expectancy hypothesis to account for the following variables:

(1) rate of signal presentation
(2) inter-signal interval
(3) signal magnitude

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[1]James Deese, "Some Problems in the Theory of Vigilance," Psychological Review, 62 (1955), p. 359.

[2]James Deese, quoted in C. H. Baker, "Towards a Theory of Vigilance," Canadian Journal of Psychology, 13 (1955), p. 35.

[3]C. H. Baker, "Towards a Theory of Vigilance," Canadian Journal of Psychology, 13 (1955), p. 36.

(4) knowledge of results
(5) environmental factors
(6) knowledge of signal location
(7) periods of interpolated rest and activity
(8) sudden extraneous stimuli
(9) motivation.[1]

Inhibition-motivation theory.--McCormick has studied the reaction time of subjects on tasks similar to vigilance tasks. Reaction time is thought by him to be a measure of the subject's vigilance performance. He has combined aspects of each of the above theories of vigilance to form what he calls the inhibition-motivation theory. McCormick states that the theory is " . . . capable of generating predictions which are reasonably exact and free from ambiguity."[2]

According to this hypothesis, inhibition is a function of time, amount of rest received during the task, intensity of the stimuli, length of the interstimulus interval, and other unknown variables. The motivation, or drive level of the subject is a function of the degree of variability of the stimuli and other unkown variables. The performance of the subject is also affected by innate and previously acquired characteristics of the organism. Thus, these three

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[1]C. H. Baker, "Further Towards a Theory of Vigilance," Vigilance: A Symposium, eds. Donald N. Buckner and James J. McGrath (New York: McGraw-Hill Book Company, 1963), Chapter 11, pp. 127-170.

[2]McCormick, op. cit., pp. 358-359.

factors, inhibition, drive, and innate characteristics will together interact to determine the reaction time of the subject, this reaction time being considered a measure of the subject's vigilance.

Decision hypothesis.--Each of the above theories has been subject to criticisms by other vigilance theorists. The most recent, and as yet unchallenged (in the literature) theory is the Decision Model, proposed by Jerison and Pickett.[1] According to these men, their theory has the advantage of explaining the results of the many experiments and at the same time, bridging the gap between laboratory and field situations. The "decision" which they emphasize is the observer' decision about whether or not to attend to the display. The observer's behavior is analyzed into six steps to be discussed below.

a. Storage of background information. The background information enables the subject to make a fair estimate of the frequency of the signal. (This encompasses the Expectancy theory of Deese and Baker.) The information is independent of any direct experience with the display. However, with experience, an observer will have information about a signal that he gained during previous vigils and earlier in the same task.

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[1]Harry J. Jerison and Ronald M. Pickett, "Vigilance: A Review and Re-evaluation," Human Factors, 5 (1963), pp. 211-238.

b. Orientation movements. The subject must physically direct his attention toward the signals. The neuromuscular orientations involved appear to be primarily voluntary, but in some cases may be simple reflex activity.

c. Operation of sensory traducers. This includes the transformation of physical energies into neural messages.

d. Activity of neural attention units. When the system is activated, a sensory message is recorded at various neural levels. The message can be either strengthened or weakened at any of these levels. This encompasses the Filter Theory's concept of a selective operation filtering out materials to reach the perceptual system. It also provides a physiological basis for "attention" associated with arousal or alertness by moderating the intensities within the central nervous system.

e. Decision making. The observer decides whether or not to maintain a given level of alertness while observing, and decides whether or not a given observation was a signal.

f. Response required by the decision. If the decision was to observe, the response is to observe. If the decision was whether or not there was a signal, the response is a detection response.

Jerison and Pickett emphasize that an essential feature of the decision hypothesis is the cost to the observer of observing or failing to observe the display (i. e. paying attention to the signals). On the basis of the expected value of an observation, he makes one decision after another whether or not to observe. These values are determined by combining the desirability of observing or not observing with the a priori signal probability. It is thus recognized that a priori probabilities, values, and costs of correct and incorrect decisions plays an important role in the subjects' actions.

Jerison and Pickett relate their theory to various studies in vigilance, showing how it is consistent with previously obtained results and theoretical explanations. Areas examined include:

(1) the decrement function

(2) the character of individual signals (intensity, duration, quality)

(3) temporal uncertainty of the signals

(4) spacial uncertainty of signals

(5) knowledge of results

(6) individual differences

(7) work-rest cycles.

Auditory Vigilance as Related to Speech and Hearing

To this writer's knowledge, Schuldt has performed the only study attempting to relate auditory vigilance to the areas of speech and hearing. She attempted to determine the relationship of auditory vigilance to functional articulatory disorders. In the introduction to her study, she outlined in detail one reason for believing such a relationship might exist. It was noted that inattentiveness to sound differences is characteristic of many functional articulatory cases. It is also true that lack of directed attention contributes to inadequate auditory discrimination. Schuldt says:

> A young child hears, he attends, he discriminates and reproduces. If a young child is able to hear, but does not maintain attention, he may have difficulty in adequate discrimination and reproduction of sound. If such behavior persists during the early developmental years of life it appears . . . that articulatory problems will result because of insufficient attention to sound stimuli.[1]

As the review of the theories of vigilance revealed, attention is also closely related to vigilance. "Vigilance may be conceptualized," says Schuldt "as sustained attention."[2] She thus designed her study to "evaluate auditory vigilance and its relationship to articulatory disorders with a minimum of contamination by comprehension."[3] In

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[1]Schuldt, op. cit., p. 3.

[2]Ibid., p. 2.

[3]Ibid., p. 16.

testing her hypothesis that children with articulatory disorders will manifest greater deficiency in auditory vigilance than will children without such defects, she obtained results, which although not statistically significant, showed a difference in the expected direction. On the basis of her recommendation, the present study was, therefore, undertaken to determine whether or not statistically significant differences would be obtained using a larger sample and an extended version of the test.

CHAPTER III

SUBJECTS, EQUIPMENT, AND TESTING PROCEDURES

Subjects

Two groups of children were selected--children with articulatory disorders and children without such disorders. Subjects were enrolled in one of two public schools in Winnipeg, Manitoba, Canada. Subjects were in the first and second grades. Twenty-four subjects for each group were selected from Shaunnessy Heights School and seven subjects for each group from Principal Sparling School. None of the children had ever been enrolled in a speech correction class.

A group meeting of the teachers of Grades I and II at Shaunnessey Heights School was held. At this time, the experimenter was introduced to the teachers by the school principal and the director of the Speech and Hearing Department of the Winnipeg Child Guidance Clinic. The teachers received letters of introduction in which they were informed of the project. In these letters, articulatory disorders were defined according to the definition used in this study. After receiving minimal additional information regarding the study, the teachers were asked to refer to the experimeter those children who in their estimation had functional

articulatory disorders. A similar procedure was followed at Principal Sparling School, with the exception that the experimenter met the teachers individually, and answered their questions at this time.

The above procedure is not identical to the procedure used by Schuldt whose subjects had been diagnosed by a speech therapist as having articulatory problems. It was learned after the present sample had been tested that only subjects with "severe" articulatory problems were included in the Schuldt study.[1]

Teacher referral is mentioned by both Irwin[2] and Ainsworth[3] as a screening method whereby children may be obtained for speech classes. As far as this writer has been able to determine, it has not been demonstrated that referral by teachers is invalid as a procedure for selecting children with articulatory defects.

Twenty-one boys and ten girls were referred by the teachers to compose the experimental group. There were nineteen subjects in the first grade and twelve in the second grade. The mean age for this group was 7.26 years.

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[1]Personnal communication with Doris Schuldt, March 26, 1964.

[2]Ruth Beckey Irwin, Speech and Hearing Therapy (New York: Prentice-Hall Inc., 1953), p. 28.

[3]Stanley Ainsworth, Speech Correction Methods (Englewood Cliffs, N. J.: Prentice-Hall Inc., 1948), p. 29.

The control group consisted of sixteen boys and fifteen girls who did not manifest speech disorders. These children were randomly selected by the experimenter from the same classrooms from which the experimental group was taken. Nineteen subjects were in the first grade and twelve in the second. The mean age for this group was 7.13 years.

Equipment

Equipment used in this research was as follows: (1) a tape recording consisting of auditory stimulus material, see Appendix I; and (2) a model T-1515, four-track Wollensak tape recorder.

Methods

1. Auditory stimulus material.--A tape recording was made which consisted of a two-minute pre-test and the actual thirty-minute test. Each consisted of semi-randomly selected digits presented at the rate of one every other second. A signal, defined as any number presented twice in succession, was randomly inserted within each one-minute segment of both the pre-test and the test material.

There were sixty digits and two signals in the pre-test, and 900 digits and thirty signals in the actual test. This was twice the length of the similar task developed by Schuldt.

During the recording session, the tape speed was three and three-quarter inches per minute, the volume

setting was seven, and the tone dial was at "Hi-Fi." During the test situation, the tape speed was three and three-quarters inches per minute, the volume was three and one-half, and the tone dial was set at "Hi-Fi."

2. Test procedures.--Two subjects were tested during a single session. They were seated at desks which were placed equidistant from the tape recorder and in a manner which, while yielding independent performances, would facilitate the experimenter's observation and scoring.

The subjects were given the following instructions:

> You will hear many numbers. I want you to listen for any number with the same number right after it, like two, two, or five, five. When you hear any two numbers in a row, I want you to draw a stick on your paper. First, we'll listen for a short time, like a practice time, and then we'll listen for a long time. Do you have any questions?

Any questions were answered and the pre-test was given. The pre-test was intended to familiarize all subjects with the task, and to be reasonably certain that the instructions were understood. Those subjects whose performance on the pre-test indicated that they had not fully understood the instructions were given additional instructions. Five children, one from the experimental group and four from the control group, were still unable to indicate by their performance that they understood the task and were eliminated from the study.

This procedure varied somewhat from that used by Schuldt. She rejected all subjects who did not respond to

one of the two signals on the pre-test. It was felt by this writer that such elimination was not necessary because failure to respond to two signals on the pre-test does not necessarily indicate that the subject failed to understand the task.

Subjects were then administered the actual test. The experimenter recorded the responses on previously prepared score sheets. Errors of omission and commission were recorded. Results obtained from analyzing the data are contained in the following chapter.

CHAPTER IV

RESULTS AND DISCUSSION

Results

For the purpose of this study, the level of vigilance is inferred from the performance according to the number of errors made during the vigilance task. Two types of errors were made, errors of omission and errors of commission.

The total number, the mean and standard deviation of errors of omission are presented in Table 1. Table 2 contains the same data for error of commission, and Table 3 the data for errors of omission and commission combined.

TABLE 1

ERRORS OF OMISSION

Group	Total	Mean	Standard Deviation
Experimental	294	9.48	4.41
Control	293	9.45	4.79

TABLE 2

ERRORS OF COMMISSION

Group	Total	Mean	Standard Deviation
Experimental	29	.94	2.45
Control	28	.90	1.79

TABLE 3

ERRORS OF OMISSION AND COMMISSION

Group	Total	Mean	Standard Deviation
Experimental	323	10.42	5.21
Control	321	10.35	5.39

Errors of commission contributed only a very small proportion to the total number of errors (.089 for the experimental group and .087 for the control group). For this reason, errors of commission were disregarded for the remaining statistical analyses.

In review, the twelve null hypotheses under test are:

1. There is no difference between children with articulatory disorders and children without articulatory disorders with regard to the number of errors made during the first ten minutes of a thirty-minute task of auditory vigilance.

2. There is no difference between children with articulatory disorders and children without articulatory disorders with regard to the number of errors made during the second ten minutes of a thirty-minute task of auditory vigilance.

3. There is no difference between children with articulatory disorders and children without articulatory disorders with regard to the number of errors made during the third ten minutes of a thirty-minute task of auditory vigilance.

4. There is no difference between children with articulatory disorders and children without articulatory disorders with regard to the total number of errors made during a thirty-minute task of auditory vigilance.

5. Children with articulatory disorders will have accumulated no more errors of omission at any point in time during a thirty-minute task of auditory vigilance than will children without articulatory disorders.

6. For the two groups combined, there will be no decrease in vigilance from the first to the last ten minutes of a thirty-minute task of auditory vigilance.

7. Children with articulatory disorders show no decrease in vigilance from the first to the last ten minutes of a thirty-minute task of auditory vigilance.

8. Children without articulatory disorders show no decrease in vigilance from the first to the last ten minutes of a thirty-minute task of auditory vigilance.

9. Children with articulatory disorders manifest no greater decrease from the first to the last ten minutes of a thirty-minute task of auditory vigilance than do children without articulatory disorders.

10. Children with articulatory disorders do not show a positive correlation between the first and last ten minutes of a thirty-minute task of auditory vigilance.

11. Children without articulatory disorders do not show a positive correlation between the first and last ten minutes of a thirty-minute task of auditory vigilance.

12. There is no difference between children with articulatory disorders and children without articulatory disorders with regard to the correlation between the first and last ten minutes of a thirty-minute task of auditory vigilance.

The mean numbers of errors of omission made during each ten minute segment and during the entire test are shown in Table 4.

TABLE 4

BREAKDOWN OF THE MEAN ERRORS MADE ACCORDING TO TEN MINUTE SEGMENTS OF THE TEST

Group	First Ten Minutes	Second Ten Minutes	Third Ten Minutes	Total Thirty Minutes
Experimental	2.64	3.06	3.77	9.48
Control	2.94	3.03	3.48	9.45

A *t* test for unrelated measures was performed on each pair of scores in Table 4. None of the results was significant at the .05 level of confidence. On the basis of these results, the first four null hypotheses could not be rejected.

In order to test the fifth null hypothesis, a one-tailed, two-sample Kolmogerov-Smirnov test was to be performed. The information employed is displayed graphically in Figure 1. It will be noticed that the greatest difference occurs in the unexpected direction. Although the original hypothesis was not two-tailed, a two-tailed test was performed to determine if a two-tailed hypothesis could have been rejected. The results indicated that it could not have been rejected.

Null hypotheses 6, 7, and 8 were tested by a *t* test for related measures. The results of these tests are shown in Table 5.

TABLE 5

RESULTS OF *t* TEST FOR EVALUATION OF DIFFERENCES IN PERFORMANCE DURING THE FIRST AND LAST TEN MINUTES

Group	$\bar{X}_D$	Standard Deviation	df	*t*
All Subjects	.84	2.51	61	2.61*
Experimental	1.13	2.49	30	2.49*
Control	.55	2.54	30	1.19

*Significant at the .02 level of confidence.

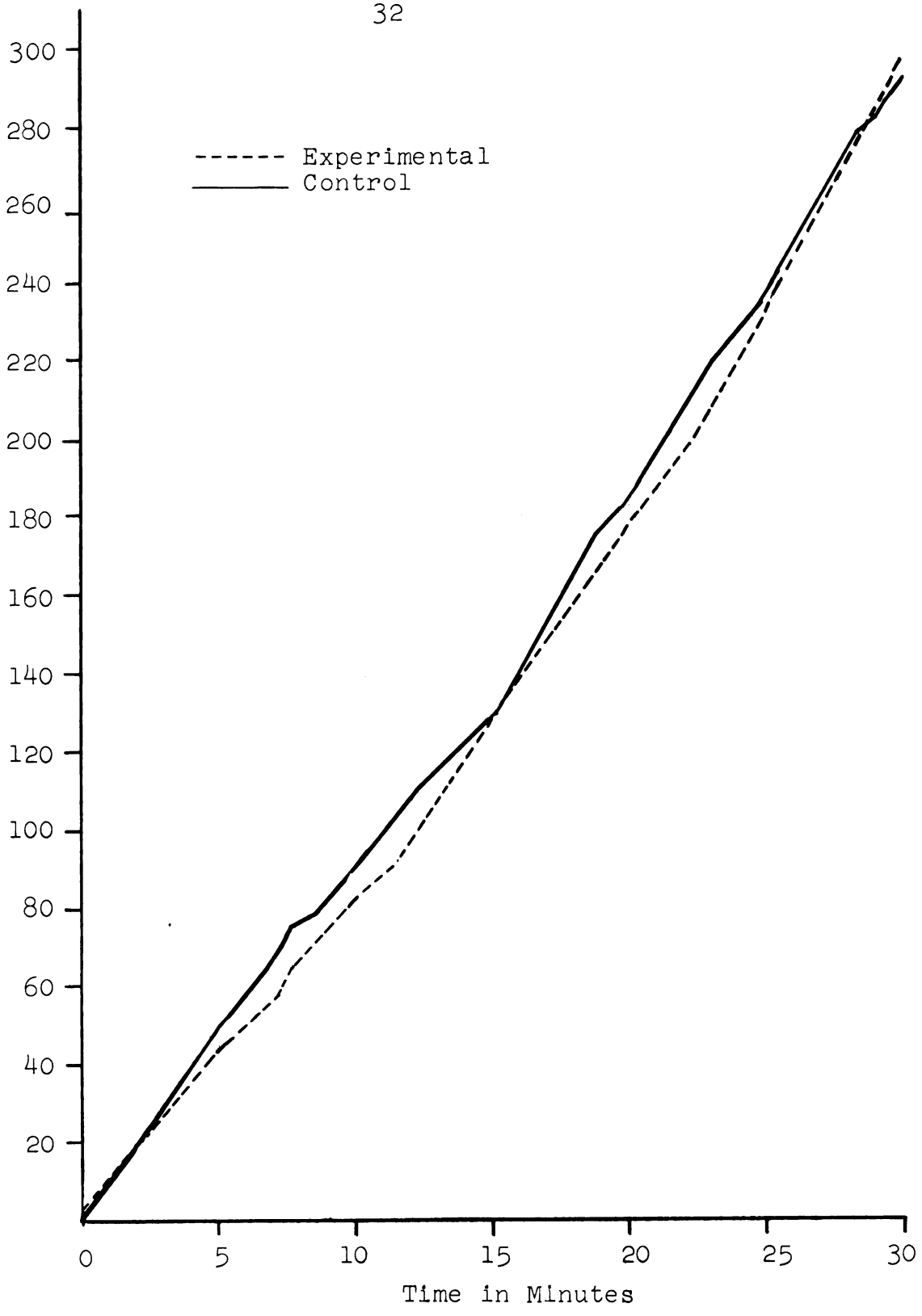

Figure 1.--The Cumulative Frequencies of Errors of Omission Made by the Experimental and Control Groups

It was possible to reject the null hypotheses 6 and 7 on the basis of these results. The alternate hypotheses were accepted:

a. For all subjects, there will be a decrease in auditory vigilance from the first to the last ten minutes of a thirty-minute task of auditory vigilance.

b. Children with articulatory disorders show a decrease in vigilance from the first to the last ten minutes of a thirty-minute task of auditory vigilance.

The ninth null hypothesis was tested by applying a *t* test for unrelated measures. The value obtained for *t* was not significant at the .05 level of confidence. The null hypotheses therefore could not be rejected.

In order to test the tenth and eleventh null hypotheses, it was necessary to find the correlation between the scores on the first and the last ten minutes of the task for each group. The correlations are presented in the first column of Table 6. Each of the *r*'s was tested to find if the correlation was significantly greater than zero. The formula used was r/σ , where $\sigma = 1/\sqrt{N - 1}$.[1] The values of r/σ which has approximately unit normal

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[1]Helen M. Walker and Joseph Lev, Statistical Inference (New York: Holt, Rinehard, and Winston, 1953), p. 252.

distribution is found in the second column of Table 6 under that heading.

TABLE 6

CORRELATIONS BETWEEN THE SCORES ON THE FIRST AND LAST TEN MINUTES OF THE TEST

Group	Correlation (r)	r/σ_r	Z
Experimental	.44	2.46*	1.01**
Control	.20	1.12**	

*Significant at the .01 level of confidence.

**Not significant at the .05 level of confidence.

In order to test the twelfth null hypothesis, it was necessary to test for the difference between the two correlations. This was done by applying a normal transformation (Z') to the values of r. The statistic,

$$Z = \frac{(Z'_1 - Z'_2) - 0}{\sigma_{Z'_1 Z'_2}} \quad \text{where}$$

$$\sigma_{Z'_1 - Z'_2} = \sqrt{\frac{1}{N_1 - 3} + \frac{1}{N_2 - 3}} \quad \text{was calculated.}[1]$$

The value obtained for Z, found in the third column of Table 6 was tested for significance according to the table for the areas under the normal curve.

[1]Hubert M. Blalock, Jr., Social Statistics (New York: McGraw-Hill Book Company, Inc., 1960), p. 310.

On the basis of the above information, it was possible to reject the tenth null hypothesis and to accept the following alternate hypothesis:

c. Children with articulatory disorders show a positive correlation between the first and last ten minutes of a thirty-minute task of auditory vigilance.

Discussion

The reader will recall that Schuldt obtained only minimum support for her hypothesis that children with articulatory disorders will manifest greater deficiency in auditory vigilance than will children without articulatory disorders. Schuldt attributed her failure to obtain significant results to a number of factors. One of these was the complete lack of studies of vigilance using children as subjects. There is, therefore, a lack of knowledge regarding the optimum length of an auditory vigilance task for children. In addition, Schuldt felt that her task was not sufficiently long.[1]

Schuldt's results suggested that the two groups of children were beginning to show a difference in performance after fifteen minutes. It seemed, therefore, that a thirty-minute task should reveal whether or not a real difference does in fact exist. The present study, however, does not

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[1]Schuldt, op. cit., pp. 24-25.

give support to the idea that there is a difference between children with articulatory disorders and children without articulatory disorders with regard to performance on a task of auditory vigilance.

In comparing the present results with those obtained by Schuldt, it must be remembered that slightly different sampling procedures were used in the two studies. Thus, the populations involved will differ to the extent that the sampling procedures differed.

Earlier studies in the area of vigilance have almost always revealed a decrement in performance on a vigilance task over a prolonged period of time. The fact that the experimental and control groups taken together showed a statistically significant decrease in vigilance from the first to the last ten minutes of the test was therefore not surprising. However, in looking at the two groups separately, it was found that only the children in the experimental group showed a significant decrease. Children without articulatory disorders, although showing a decrease, did not show a significant decrease. In addition, the difference between the decreases of the experimental and control groups was not significant.

Re-examination of Table 4 may help to clarify for the reader what took place. The control group made more errors during the first ten minutes than the experimental group,

although not significantly more. Both groups showed as increase in the number of errors made during each of the ten-minute segments, but only the experimenal group made significantly more at the end than at the beginning. The increase in the number of errors made by the experimental group was not significantly greater than the increase in errors by the control group.

There was a higher correlation between performance during the first and last ten minutes of the test for the experimental group than for the control group. The difference was not significant.

On the basis of the present study, it is only possible to speculate that there might be a difference between the two groups in auditory vigilance. There may be a difference which would be revealed by a study using more subjects. However, this difference would likely be so slight as to have little or no practical significance in planning speech therapy for articulatory defectives.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

In recent years, psychologists have begun to investigate a previously almost disregarded psychological phenomenon. This phenomenon is vigilance. Although controversy exists regarding the definition of vigilance, the term usually refers to an individual's state of watchfulness while attempting to detect infrequent, randomly occurring signals to which he has been alerted. It has been observed that over a long period of time, performance on a vigilance task decreases. Many questions can be asked with regard to this change in performance.

One question which is of particular interest to persons in the field of speech and hearing is whether or not performance on a vigilance task might be related to some of the phenomena observed in speech and hearing studies. For example, it is well known that attention to sound is essential before adequate speech can develop. Could it be that poor listening habits, revealed by poor performance on a task of auditory vigilance are related to the development of functional articulatory disorders?

The relationship of articulatory disorders to auditory vigilance was studied by Schuldt, who attempted to answer the above question. The purpose of the present study was to elaborate upon the results of the earlier study by Schuldt.

Sixty-two subjects were selected. One group, the experimental group, consisted of thirty-one children referred to the experimenter by their classroom teachers as having functional articulatory disorders. The other group, the control group, was composed of thirty-one children randomly selected by the experimenter from the same rooms from which the others were referred. All subjects were in attendance in the first two grades of two public schools in Winnipeg, Manitoba, Canada.

The children, tested two at a time, listened to a thirty-minute tape recording which consisted of semi-randomly selected digits, presented at the rate of one every other second. Upon hearing a signal, one number presented twice in succession, the children were required to draw a line upon the blank sheet of paper in front of them. There were thirty signals, one randomly inserted within each of the thirty minutes of the task.

The level of vigilance was inferred according to the number of errors made by the children. Errors were of two types: errors of omission, failure to respond when a signal was presented; and errors of commission, responding when a signal was not presented.

Conclusions

This study did not reveal any significant differences between children with articulatory disorders and children without articulatory disorders with regard to performance on a task of auditory vigilance. It therefore cannot be concluded from this study that poor auditory vigilance may be a factor in the development of functional articulatory disorders. The results obtained by statistical analyses of the data made it possible to accept the three hypotheses stated below.

1. For both populations combined, there is a decrease in vigiliance from the first to the last ten minutes of the thirty-minute task.
2. Children with articulatory disorders show a decrease in vigilance from the first to the last ten minutes of a thirty-minute task of auditory vigilance.
3. Children with articulatory disorders show a positive correlation between the first and the last ten minutes of the thirty-minute task of auditory vigilance.

This is the second of two similar studies attempting to relate the variables of auditory vigilance and functional articulatory disorders. Neither study has revealed significant differences between children with articulatory disorders and children without articulatory disorders.

Implications for Further Research

As far as this writer can determine, these studies seem to be the only ones which have been performed using children as subjects on vigilance tasks. Psychologists may be interested in carrying out further investigation using children as subjects in tasks of vigilance. For example, it might be profitable to discover if there is any change in performance on a vigilance task as a function of age. Performances of children, teenagers, young adults, and the aging could be compared on tasks of vigilance.

It seems that at some point, children's vigilance will drop off completely, so that they will fail to respond almost one hundred per cent of the time. It might be profitable to see if there is any difference between children with articulatory disorders and children without articulatory disorders regarding the time at which this point is reached. A different type of auditory vigilance task might also reveal different results.

Frequently, distractions have been introduced during vigilance tasks to find their effect upon the performance. It is possible that children with articulatory disorders would be more affected by the introduction of distractions than would children without articulatory disorders.

Thus, it can be seen that there are many possibilities for further research, both for psychologist and speech and hearing scientists. It is hoped that further research

may grow out of the present study regarding the children's performance on a vigilance task.

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APPENDICES

APPENDIX I

Pre-Test

2	1	1	5
7	3	8	9
5	9	3	6
2	1	9	6
3	5	2	1
1	8	4	7
3	4	8	4
3	5	6	5
4	8	8	1
3	2	5	2
8	4	8	6
3	7	5	4
5	9	8	8
6	8	2	7
8	4	7	6

Test

8	7	7	8	3	8	5	2	3	7	9	6	4	3	1
9	5	4	9	6	6	1	6	1	2	3	1	6	5	4
2	1	3	8	8	5	5	5	6	6	6	4	9	5	6
4	8	8	4	5	9	9	4	7	9	2	9	9	8	4
9	6	9	3	2	3	8	9	6	6	3	8	5	6	5
8	6	2	7	5	9	9	4	7	9	8	9	1	1	4
5	5	9	2	2	1	2	4	1	2	1	4	9	2	5
4	4	3	4	5	5	7	8	3	2	1	7	4	6	8
1	8	8	3	1	8	8	5	7	9	3	3	3	1	2
7	3	5	3	8	5	9	6	6	8	8	9	1	2	4
1	7	3	8	8	4	8	8	2	7	3	3	6	9	6
2	8	1	3	3	4	7	9	5	5	4	2	9	5	1
8	8	8	9	2	3	3	8	7	7	2	5	8	9	8
7	5	2	3	7	8	1	1	8	8	4	4	1	8	7
3	9	2	1	1	4	1	9	7	7	6	4	2	5	4
6	4	9	2	3	3	8	4	9	9	8	5	4	7	3
5	1	1	6	7	7	4	5	1	2	7	1	8	5	6
2	2	4	8	5	5	9	7	8	3	8	3	2	1	7
1	7	3	6	9	6	5	4	2	1	5	1	4	5	5
6	4	8	9	1	8	4	7	8	4	4	4	9	9	8
5	7	6	2	5	9	5	2	8	8	8	5	4	7	3
6	8	3	9	3	6	9	3	5	6	4	8	5	5	2
3	6	1	7	7	2	2	2	6	3	3	4	8	2	7
3	1	2	2	9	6	4	5	7	8	8	3	2	6	3
9	3	3	3	7	5	7	2	2	9	5	8	4	5	8
3	8	5	2	8	1	1	3	6	7	1	6	2	1	3
6	4	9	3	3	8	5	4	7	8	2	4	7	2	8
4	6	8	4	4	6	6	5	8	6	5	6	8	7	3
5	1	6	8	1	3	9	1	5	5	2	5	6	9	3
9	8	3	7	6	6	7	4	2	2	5	7	8	4	2

Test (continued)

6	7	8	9	7	8	3	6	9	5	6	2	6	4	5
8	8	1	5	9	5	2	7	3	2	9	7	4	9	6
9	4	4	1	4	9	2	6	9	9	6	1	3	9	2
8	9	3	7	4	5	3	2	8	8	5	3	2	1	7
2	6	4	8	8	6	5	5	6	1	1	7	5	9	9
8	9	9	6	4	8	6	3	9	8	6	1	4	6	7
3	5	9	3	1	1	2	5	2	2	5	5	6	4	5
6	1	7	9	5	7	1	2	6	7	4	8	5	8	1
8	8	2	1	9	6	5	5	2	5	1	2	9	2	8
8	6	4	7	2	9	1	4	9	4	2	7	1	5	7
3	6	3	6	5	9	4	1	6	5	5	2	1	2	4
8	5	2	3	8	3	7	3	7	5	7	3	7	7	3
7	7	6	2	3	1	8	2	8	8	9	2	8	2	9
9	2	2	9	8	4	2	6	5	7	4	7	6	4	7
1	4	7	9	1	5	7	1	7	2	7	6	4	3	4
6	6	8	6	3	7	6	2	9	6	7	1	7	2	9
8	7	2	1	9	3	3	5	5	4	1	4	3	5	9
2	5	7	6	2	4	8	4	4	8	3	5	8	3	8
7	9	6	8	6	7	4	9	1	3	7	3	1	6	1
2	6	3	6	3	8	9	8	4	1	9	8	9	7	5
6	4	5	3	1	1	2	6	1	7	2	4	2	5	1
3	5	9	9	4	8	5	5	6	2	1	5	6	1	2
8	2	7	7	1	3	3	6	2	7	2	4	8	2	6
9	3	5	3	5	6	9	7	2	9	5	3	7	6	4
1	2	3	1	3	8	1	8	5	8	2	1	5	1	2
3	4	9	9	9	2	4	8	8	3	9	1	3	7	3
1	2	3	7	8	4	1	4	6	9	8	6	5	8	2
7	3	5	6	4	8	2	7	4	1	1	3	1	7	6
9	5	1	2	9	5	8	6	3	3	6	4	4	6	9
8	2	8	6	7	6	7	8	2	1	1	7	2	2	3

APPENDIX II

Data

ERRORS MADE BY CHILDREN WITH ARTICULATORY DISORDERS

Subject Number	First Ten Minutes	Second Ten Minutes	Third Ten Minutes	Total
1	6	5	6	17
2	0	1	0	1
3	1	2	3	6
4	5	6	5	16
5	2	2	6	10
6	1	1	2	4
7	2	4	6	12
8	5	3	3	11
9	0	0	0	0
10	1	1	3	5
11	1	1	1	3
12	6	4	7	17
13	2	6	4	12
14	0	1	1	2
15	0	1	1	2
16	3	3	7	13
17	1	1	1	3
18	1	0	1	2
19	1	3	3	7
20	1	3	5	9
21	4	2	6	12
22	7	5	5	17
23	5	4	4	13
24	2	4	6	12
25	3	7	2	12
26	9	0	3	12
27	3	9	7	16
28	3	7	9	19
29	2	5	7	14
30	1	4	1	6
31	4	3	2	9

ERRORS MADE BY CHILDREN WITHOUT ARTICULATORY DISORDERS

Subject Number	First Ten Minutes	Second Ten Minutes	Third Ten Minutes	Total
32	6	5	6	17
33	0	1	0	1
34	1	2	3	6
35	5	6	5	16
36	2	2	6	10
37	1	1	2	4
38	2	4	6	12
39	5	3	3	11
40	0	0	0	0
41	1	1	3	5
42	1	1	1	3
43	6	4	7	17
44	2	6	4	12
45	0	1	1	2
46	0	1	1	2
47	3	3	7	13
48	1	1	1	3
49	1	0	1	2
50	1	3	3	7
51	1	3	5	9
52	4	2	6	12
53	7	5	5	17
54	5	4	4	13
55	2	4	6	12
56	3	7	2	12
57	9	0	3	12
58	3	9	7	16
59	3	7	9	19
60	2	5	7	14
61	1	4	1	6
62	4	3	2	9