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Development of an Automated Program to Teach Auditory Discrimination

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DEVELOPMENT OF AN AUTOMATED PROGRAM TO TEACH AUDITORY DISCRIMINATION

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TABLE OF CONTENTS

CHAPTER PAGE

CHAPTER PAGE

LIST OF TABLES

TABLE PAGE

LIST OF FIGURES

CHAPTER I

INTRODUCTION AND STATEMENT OF THE PROBLEM

For many years a population crisis has faced the American educator. He is faced with ever increasing enrollments of students, a condition which exceeds all efforts of the teacher training institutions to supply the professional manpower. This is the dilemma whether the field be educational remediation, therapeutic work with handicapped pupils, or instruction.

Ever increasing numbers of school children are diagnosed as being speech handicapped. This is due in part to better training of classroom teachers and partially to better diagnostic techniques of speech pathologists. The most common speech handicap found in public school therapy is of a functional articulatory nature. At the present time there are only relatively few persons who are trained for public school speech therapy. It is becoming painfully clear to most speech therapists that there are many more speech handicapped children than the therapist can adequately treat. In sparsely populated areas speech

therapy is almost unheard of, except for a possible annual visit by a speech therapist from a distant speech and hearing center.

One of the most promising educational developments in recent years is the teaching machine. The procedure, known as programed learning, has opened many doors in the field of education. Like many of our technological advancements, the teaching machine has been used by the military training institutions for some years. It has only been in recent years that the techniques have filtered down to the more progressive schools. Presently there are a number of different types of teaching machines available and even more numerous programs for each of the various types of machines. Such subject matter as mathematics, science, history, english, and social studies have all been the subjects of programed instruction efforts.

Statement of the problem. The study was initiated to determine whether or not certain skills which are necessary to the development of good speech could be programed. Students utilizing programed instruction techniques would be able to practice skills which were

formerly acquired during regular therapy sessions and, therefore, have the benefit of therapeutic services at their own discretion. The particular phase of speech therapy selected was auditory discrimination ability. This area was chosen because of the logical progression of learning to discriminate between similar and non-similar sounds and also because of the close propinquity of ear-training and articulatory skills. Van Riper and Irwin stress the importance of discrimination in this way:

> We have found that intensive training in the recognition and differential discrimination of the standard sounds greatly facilitates later therapy. In isolated sounds, syllables, words, sentences, and conversational speech, the standard pattern must be made clear. Unless this is done, the whole learning process breaks down. (76:122)

Statement of the objective. The objective of the study was twofold, (1) to develop and (2) to evaluate an automated training program which could significantly aid in the improvement of the sound discrimination skill of school children who misarticulate the /r/ phoneme. To evaluate the program it was necessary to formulate three questions which would be answered by this study. These questions were: (1) How efficiently would this method

teach sound discrimination of the /r/ phoneme? (2) How effective would this method teach the assigned material compared to the traditional methods of the therapist? (3) How practical would this method be in the public school setting?

CHAPTER II

REVIEW OF THE LITERATURE

During the early days of speech and hearing research in America it was evident that a field of study existed somewhere between the medical sciences and psychology, a field of study mainly concerned with adequate human communication. In 1915 the Quarterly Journal of Speech began publishing research studies from a wide variety of fields, i.e., medicine, physiology, linguistics, and psychiatry, in order to bring to light some of the needs of the speech handicapped. This chapter will review the literature, concerning (1) the acquisition of auditory discrimination skills, and (2) the application of the principles of operant conditioning as these relate to programed learning.

A. AUDITORY DISCRIMINATION

This particular phenomenon is sometimes referred to as speech-sound discrimination, (31:96) (69:781-782) (11:89-90) sound discrimination, (3:122-124) auditory

perception, (35) (77) and ear training, (75:257-259). Basically auditory discrimination deals with the ability to perceive, by means of the auditory mechanism, similarities and differences between sounds. This discriminatory technique does not require the subject to maintain or mimic the stimuli, but simply to interpret paired stimuli as being the same or different.

A little over thirty years ago much of the research pointed to a close alliance between auditory discrimination abilities and functional articulatory disorders. Some of these studies concluded that poor auditory discrimination skills were directly responsible for poor articulatory skills, and were in direct correlation to the severity of the speech defect. Travis and Rasmus found that at every age level tested, the speech defective subjects made more auditory discrimination errors than did the comparative group of normal speakers. With the increased severity of articulation came poorer scores on the discrimination tests. (71:217-226) A study by Carrell indicated that articulatory handicapped cases were somewhat inferior to the matched control group tested. However, his results

were considerably less significant than those of the earlier study cited. (8:17-37) Donewald used an auditory discrimination test made up of 100 paired sounds to test a group of speech defectives and a group of normal speakers. He also indicated that there was a significant difference between the two groups tested. (14) In 1954 Kronvall and Diehl studied similar groups of subjects and found that the control group made significantly fewer errors on the Templin Speech Sound Discrimination Test. (36:335-338) Anderson, in an unpublished Master's Thesis, showed a strong correlation between omission-type errors in speech production and errors in auditory discrimination. (2) Mange found that normal speakers and /s/ defective articulatory cases were superior to those subjects who had defective /r/ sounds in auditory discrimination skills. He also found that the position of sounds in words or in sentences was not a factor in determining ease of discrimination. He goes on to state that phonetic discrimination between two defective sounds is less difficult than discriminating between normal and normal, or between normal and defective sounds. (40) Curtis

explains the necessity of teaching auditory discrimination skills when he proposes two minimum goals to be obtained before teaching the subject to produce correct sounds. They are as follows:

> 1. He should learn to break down the word patterns containing his error, in at least a number of commonly used words, so that the error is recognized and isolated as a distinctive sound unit in those words....
> 2. He should learn to recognize and identify the error sound and the correct sound as separate entities, and be able to discriminate between them easily.... (32:122-123)

From the research studies of Brong, it is apparent that sound discrimination is a skill that can be improved through proper training techniques. He also found that discrimination of phrases called for less stringent techniques to train in correct identification of sounds, which was probably due to the increased auditory comprehension. (6) Spriestersbach and Curtis reported in a 1951 study that sound discrimination training may be more important for some subjects than for others. They along with other researchers did feel that diagnostic precautions should be taken to rule out the possible relationship between articulatory disorders and poor auditory discrimination. A wise diagnostic decision can

only be made after all possible etiological avenues have been explored. (64:483-491) (31:96)

Powers has maintained that poorly developed auditory discrimination may be only one of the many possible causes of difficulty. (69:781) Throughout this period of research studies there has been an ever increasing body of literature disputing the close, almost etiological, relationship between functional articulatory disorders and auditory discrimination. Using a very systematic approach for matching groups of normal and non-normal speakers, Hall using the same auditory test that Travis and Rasmus used, found no significant difference between the two groups of subjects they tested. (24:110-132) Mase also found no correlation between auditory discrimination and articulatory disorders and goes on to suggest that further studies be undertaken to determine the exact relationship of articulatory defects and auditory discrimination. (41) Some other researchers who found no significant difference between normal and non-normal speakers are Hansen, (25:347-355) Dickson, (13:263-271) and Ansberry and Carr. (78: 356-357) In 1939 Van Riper wrote:

> Many texts in speech correction agree that the first step in remedial treatment of articulatory cases should be ear training, and most speech correctionists employ it. The exact nature of the ear training is too often vague, unsystematic, and perfunctory, although it is probably the most important tool in the clinicians kit. (73:141-142)

It is interesting to note that throughout the past 25 years Van Riper has continued to emphasize the importance of the systematic approach to ear training. The four steps to the accomplishment of this goal are: (1) isolation, to break up word configurations to allow the subject to hear the correct sound; (2) stimulation, to bombard the subject with the correct sound; (3) identification, to compare correct and incorrect sounds and to identify the different sound elements; (4) discrimination, to differentiate correct and incorrect sounds in isolation and in running speech.

B. PROGRAMED INSTRUCTION

In 1926 Pressey developed a technique for testing students by means of a multiple choice type testing machine. Later he refined this technique to include the teaching of concepts through this testing machine. That is to say, information was being given to the student through the test questions and the student was later tested on that information gained from the previous questions. (49:373-376) These studies were the forerunners to the later research of Skinner, Holland, and many others.

Skinner, a behavioral scientist, studied the techniques of Pressey, along with operant conditioning, and applied them to the shaping of human behavior and the principles of learning. During the past two decades Skinner has been most directly responsible for the teaching machine development, even though the idea was originally Pressey's. (58)

Skinner has concisely described the past fifty years of educational growth in America. He stated:

The techniques of education were once frankly

> aversive. The teacher was usually older and stronger than his pupils and was able to "make them learn...." He [Claude Coleman] tells of a school teacher who published a careful account of his services during 51 years of teaching, during which he administered: ". . . 911,527 blows with a cane; 124,010 with a rod; 20,989 with a ruler; 136,715 with the hand; 10,295 over the mouth; 7,905 boxes on the ear; (and) 1,115,800 slaps on the head. . . ."
>
> Progressive education was a humanitarian effort to substitute positive reinforcement for such aversive measures, but in the search for useful human values in the classroom it has never fully replaced the variables it abandoned. Viewed as a branch of behavioral technology, education remains relatively inefficient. . . . In general we feel that any aid or "crutch"--except those aids to which we are now thoroughly accustomed--reduces the credit due. . . . As long as only a few pupils learn much of what is taught, we do not worry about uniformity or regimentation. We do not fear the feeble technique; but we should view with dismay a system under which every student learned everything listed in a syllabus--although such a condition is far from unthinkable. Similarly we do not fear a system which is so defective that the student must work for an education; but we are loath to give credit for anything learned without effort--although this could well be taken as an ideal result--and we flatly refuse to give credit; if the student already knows what a school teaches. (52:1057-1066)

From a review of the literature it seems that Pressey was either too advanced for the times, or he was simply not influencial enough to have his ideas accepted. (54:481-486) However, in 1950 Pressey's autoinstructional techniques started to kindle new fires under the

psychological researchers. (48:417-447) Skinner experimented with a variety of teaching machines and developed numerous programs for use in these machines. (58, 59, 60) These experiments were spurred on by laboratory studies of the conditioning of animals, therefore, operant conditioning and learning theory were the basis for developing programed instruction. Other important aspects of teaching machine programs include active participation on the part of the student, immediate feedback concerning appropriate responses made, and presentation of material in small steps to assure the correctness of student response. (58, 59) (62)

Silverman lists four common classroom disadvantages that are avoided in the use of "auto-instructional devices:"

> (1) Students are not instructed individually. (2) One student may be entirely passive, another active. (3) Careful organization of material is ineffective when the student is inattentive and passive. (4) Although a student may be responding to the material that is presented, he does not receive immediate information about the correctness of his response, nor is he able to proceed at his own rate. (54:481)

Programed instruction does not seem to have such pitfalls inherent within its structure. However, Silverman expresses some concerns for the future of auto-instructional

devices when he discussed the personal reaction or over-reaction of educators and the general public. The research studies may go on for a considerable length of time, but the educators in this country should be "tooling up" for automated instruction. (54)

Fry, in emphasizing the various ways in which programed material can be used, stated:

> The education of exceptional children, both bright and handicapped, will be considerably aided by having machines which in many ways act like a patient private tutor.
>
> Small schools with limited curriculum offerings can offer a wider variety of subjects in a wide difficulty range by having a machine-laboratory where one teacher can supervise different pupils learning different subjects. (20:143)

In recent years there have been a number of studies conducted in order to assess the value of programed instruction when used with mentally retarded students, (44) with exceptionally bright students, (1) with remedial reading students, (50:35-119) and with speech handicapped students. (27) These studies indicated that a need for further research and program development existed. The mounting school enrollments and the lack of qualified teachers point to the fact that very few elementary

classroom teachers can be equally efficient and effectual with thirty pupils per classroom. This teacher-pupil ratio includes all supportive staff, i.e., art coordinators, music specialists, remedial reading teachers, etc. Therefore, the need for more and better programing is obvious to the progressive educator.

Blyth lists a number of advantages found in the use of programed material. Two of the three major advantages are directly related to teacher-pupil time ratios. They are:

> (1) little or no time was wasted in the classroom on routine drill or on determining whether all the students were equally prepared for classwork, (2) greater classroom efficiency made it possible to devote class time to the development of concepts, and (3) students who might otherwise have failed the course were able to earn better than passing marks. (5:116)

This would seem to indicate that with the advent of teaching machines comes a new role for the classroom teacher and for education in general. As was mentioned earlier, education as we know it today is unsatisfactory in meeting the needs of its students. In a speculative way, Finn believes that the American educational system has not reaped its just share of our economic prosperity

and modern technology. Many of our educational advancements have been brought about through government and military developments. And educators in general have been reluctant to institute innovative ideas because of the financial bounds under which they work. Finn sums up his theory in this way:

> . . . education, as a sector of national life, has, for the most part, been cut off from technological advances enjoyed by industry, business, military establishments, etc. The American educational enterprise exists out of technological balance with great sectors of the society. As such, it can be viewed as a relatively primitive or underdeveloped culture existing between and among highly sophisticated technological cultures. (16:41)

Many of the articles, and much of the research which has been concerned with programed instruction also contain words of advice to those in the teaching profession. Most of them hold an optimistic outlook for teachers, but they have emphasized the importance of "tooling up" for the many advancements which are to come. Advancements which will require a new vocabulary, a new scientific approach to learning, and a better understanding of how and why the human organism learns. Educators have already failed to keep pace with the developments of programed instructional

devices. New innovations for the machines, the technology, and the systems occur almost daily. Since this field is still in its infancy it can be extremely retarded or quickly developed depending upon the professional atmosphere in which it is accepted or rejected. Finn says:

> This is the direction of the future. The machines, the technology, the systems--crude as they are today, improved as they will be tomorrow--will help man become more human <u>if</u> the teachers who will manage them understand instructional technology and make use of it to build teaching into the most human of all professions. (16:44)

Skinner, also speaking about the professional environment in which we hope to get programed instructional devices to grow and flourish, says:

> As a technology, however, education is still immature, as we may see from the fact that it defines its goals in terms of traditional achievements. Teachers are usually concerned with reproducing the characteristics and achievements of already educated men. When the nature of the human organism is better understood, we may begin to consider not only what man has already shown himself to be, but what he may become under carefully designed conditions. The goal of education should be nothing short of the fullest possible development of the human organism. (62:398)

CHAPTER III

METHOD

A. THE SUBJECTS

Thirty-five elementary school children, who distorted the /r/ phoneme, were chosen to participate in this study. All subjects had articulatory defects and were enrolled in the public school speech therapy program. The subjects were randomly divided into a control group and an experimental group. The experimental group consisted of eighteen participants and the control group seventeen. Before the study was completed, nine of the experimental subjects and eight subjects in the control group had moved to schools outside this district. The reason for the large turn-over was the Whidbey Island Naval Air Station which supplied more than seventy-three percent of the total school population. The average tour of duty at the station is two years, therefore, a forty percent turn-over could be expected for any one year.

The Experimental Group. This group was made up of eight boys and one girl who ranged in age from six years,

eleven months to twelve years, eleven months. The average age was eight years, three months, and their average I. Q., as measured by the Peabody Picture Vocabulary Test, (45) was one-hundred and two. This group was given pre-program tests, as earlier described, and then monitored through the automated program designed to teach auditory discrimination of the /r/ phoneme. All of the subjects in this group had articulatory errors, one of which was the /r/ phoneme. Initially, none of these subjects could produce a good /r/ sound in any position tested, even after extensive auditory stimulation, as described by Templin and Darley. (67) All of the subjects scored below the mean scores on the general test of auditory discrimination as reported by Templin. (68:132)

The Control Group. This group consisted of six boys and three girls who ranged in age from six years, eleven months, to nine years, eight months. The average age was eight years, five months, and their average I. Q. on the Peabody Picture Vocabulary Test was one-hundred and five. This group was tested on all previously mentioned pre-program tests, but were not given the

programed material to teach auditory discrimination of the /r/ phoneme. All of these subjects had articulatory errors, one of which was the /r/ phoneme. None of the subjects could produce a good /r/ sound in any position tested, even after extensive auditory stimulation. All of the subjects scored below the mean on the general test of auditory discrimination.

B. THE PROGRAM

The program for teaching /r/ phoneme discrimination was taken from the /r/ phoneme test of auditory discrimination. After the standardization procedures were completed, the test program was placed on an Ampex dubbing tape rack, and only those items judged to be appropriate were used in the program. The individual items were at this time rearranged in a progressive order of difficulty and the tape was recorded at 3 3/4 ips. The /r/ discrimination test and the program contained sixty-four and seventy items, respectively. The auditory discrimination test also supplied the learner with eighteen examples, whereas, the program contained only three. The test took approximately

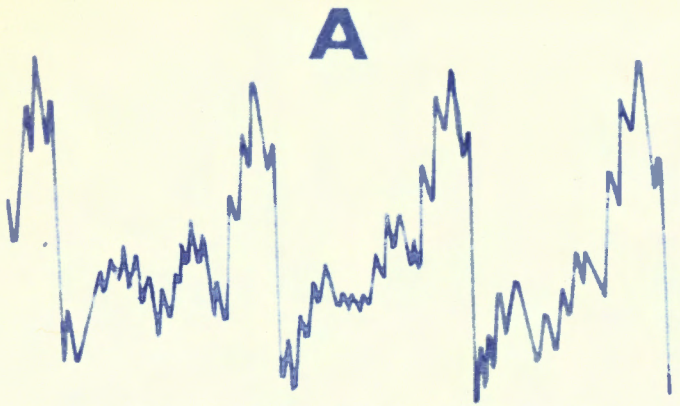
sixty minutes to administer, and the program could be worked through in fifty-two minutes provided no mistakes were made. The program consisted of eight separate phases, recorded on a Magnecorder model 728-44. Each phase of the program presented the learner with problems to which he could respond. The format for recording the program followed that of the Holland-Matthews study. (28)

The entire test program can be found in Appendix A. The test program was standardized by using ten speech therapy majors from the Central Washington State College Speech and Hearing Clinic. The classification of severity for the /r/ phoneme and its variations were based on the Roe-Milisen study (51) which ascribes a numerical value to each one of several possible articulation errors. However, for the purposes of this study only four of these classifications were used. (1) "Sound is made correctly," (2) "Sound is mildly indistinct. . .," (3) "Sound is moderately indistinct. . .," (4) "Sound is. . . severely indistinct. . . ." Any item which did not receive ninety percent agreement was subsequently cut from the program. (Appendix B) A second method of standardization was used

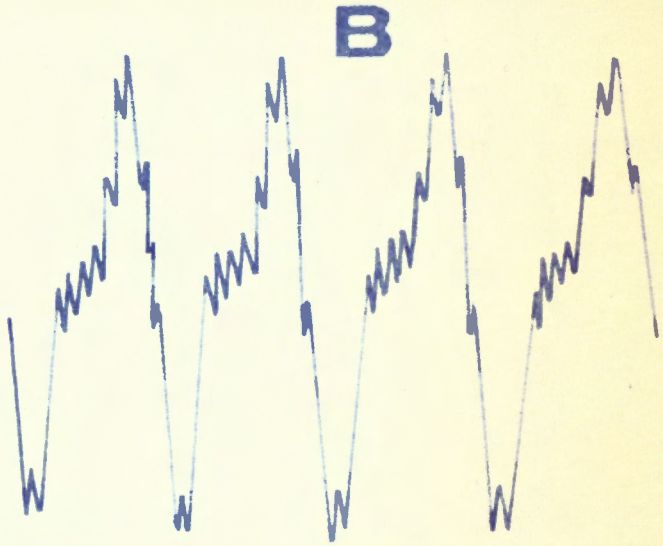
to rank the allophonic variations of the /r/ phoneme in a progressive order of difficulty. This method employed the use of an oscilloscope and a 16MM movie camera. The movie camera was used to record the visual changes in the varying /r/ phonemes as they appeared on the fluorescent screen of the oscilloscope. The film was later analized and the various /r/ allophones were found to have definite distinguishing characteristics. (Figure 1) By using this procedure it was not only possible to determine the most correct /r/ phoneme in each paired item, but also to classify each one as to its relative difficulty. That is a number one /r/ phoneme would be relatively easy to discriminate from a number four /r/ phoneme, but a number two /r/ phoneme would be relatively difficult to discriminate from a number three /r/ phoneme. (43)

The eight phases of the program are: (1) discrimination of the /r/ phoneme in isolation; (2) discrimination of the /r/ phoneme in the initial position of nonesense syllables; (3) discrimination of the /r/ phoneme in the final position of nonsense syllables; (4) discrimination of the /r/ phoneme in the medial position of nonsense

Best pronounced /r/



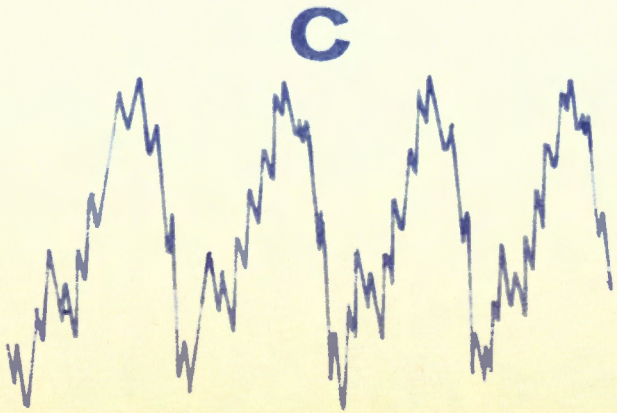
Allophonic Variations of
Number 1 /r/ Phoneme



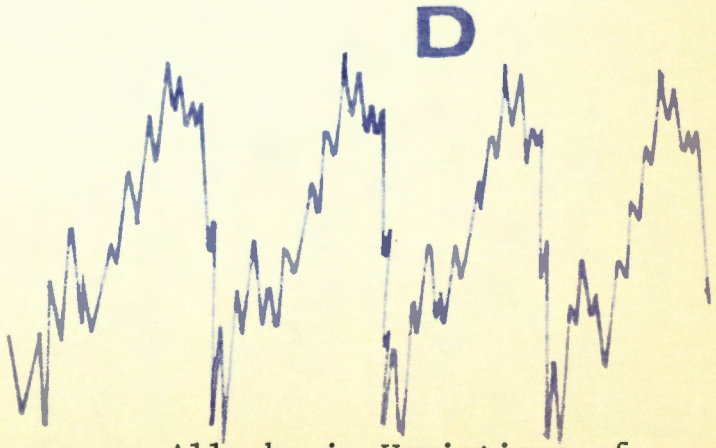
Allophonic Variations of
Number 2 /r/ Phoneme

FIGURE 1.

Poorest /r/



Allophonic Variations of
Number 3 /r/ Phoneme



Allophonic Variations of
Number 4 /r/ Phoneme

syllables; (5) discrimination of the /r/ phoneme in the initial position of simple words; (6) discrimination of the /r/ phoneme in the final position of simple words; (7) discrimination of the /r/ phoneme in the medial position of simple words; (8) discrimination of the /r/ phoneme in all three positions in running speech.

Phase 1. Discrimination of the isolated /r/ phoneme from other /r/ distortions. The problem, which the experimental subjects were asked to solve, dealt with their judgment as to which /r/ phoneme was more correct. After listening to the paired sounds, the subjects were to choose the one which sounded more correct to them. If the first sound was more correct, then they were to place a blue "X" in column 1. If the response was incorrect they repeated the item and used a red "X" to indicate the second trial. By using the information received from the standardization procedures it was possible to arrange the problems in an increasing order of difficulty, i.e., to discriminate between those items presenting gross errors to those items requiring finer discriminatory skills. Including the presentation of directions, this phase took about ten

minutes to complete.

Phases 2, 3, 4. Discrimination of the /r/ phoneme in the initial, final, and medial positions of nonsense syllables. In the use of nonsense syllables a special effort was made to eliminate any combination of sounds which could be identified with a familiar word. After the student completed these phases of the program he was asked to write down some of the things he may have heard on the recording. Several students indicated that they had heard words like "read, ride, road," although what they actually heard were nonsense syllables, /ri/, /raɪ/, /ro/, respectively. Within each phase the progression of difficulty was from least to most difficult. The same principle was true between phases. Phase two was less difficult than phase three, and phase three was less difficult than phase four, because of the differences in phonetic context. It is not as difficult to discriminate between two sounds that initiate syllables as it is to discriminate between two sounds that are found in the middle or at the end of syllables. (68) Each phase was approximately six minutes in length.

Phases 5, 6, 7. Discrimination of the /r/ phoneme in the initial, final, and medial positions of simple words. In constructing these phases it was deemed necessary to use simple and familiar words which would be found in most primary readers in the public schools. At the beginning of each of the three phases being discussed the correct /r/ phoneme was somewhat prolonged and exaggerated. This method of cueing was gradually withdrawn until both paired words were approximately the same length. (9) Each phase took approximately six minutes to administer.

Phase 8. Discrimination of the /r/ phoneme in the initial, final, and medial positions of simple words in sentences. In this phase of the program the subjects were given an opportunity to listen to a sentence with only one /r/ word in it. This was done for each sentence containing an /r/ word, whether the /r/ sound be at the beginning, at the end, or in the middle of a word. Each correctly articulated sentence was paired with a sentence containing a distorted version of the /r/ phoneme. Later in the program, two /r/ words were presented within the same sentence. The second group of items incorporated a word with the /r/

phoneme in the initial position and a word with the /r/ phoneme in the final position within one sentence. The third group of items presented the /r/ phoneme in the initial and medial positions of different words within a sentence. In the fourth group the subjects were given a sentence which contained words having the /r/ phoneme in the medial and final positions. The last few items in this phase dealt with sentences which had initial, medial, and final /r/ words randomly scattered throughout them. This phase took approximately six minutes to administer.

C. THE PROCEDURE

Equipment. A Califone model T75c tape recorder was used because of its versatility and adaptability to general speech training. There were no mechanical changes made in this machine. The taped program of auditory discrimination was placed on the machine by the examiner. The subject was given a test form and two pencils, one was red and one was blue. The first phase of the program was preceded by the necessary instructions for completing the entire program. As each item, of that particular phase, was

presented the subject would indicate his response by making an "X" in the appropriate column with the blue pencil. If the subject's response was correct the tape would proceed to the next item. If, however, the subject gave an incorrect response the examiner rewound the tape to the beginning of that item. The subject then responded with the red pencil. Through this procedure (changing pencils and seeing the red "X") the examiner felt sure the subject was aware of his mistake. This is somewhat similar to the method used by Pressey whereby the size of the hole punched in a card indicated to the student whether his answer was correct or not. (48)

The Tests. Each of the eighteen subjects took a pretest and postprogram test of general articulation, a pretest and postprogram test of /r/ articulation, a pretest and postprogram test of general sound discrimination, and a pretest and postprogram test of the /r/ sound discrimination. Both groups were tested in September and again in May of the same school year. The experimental group worked through the program, for teaching sound discrimination of the /r/ phoneme, in the early stages of therapy. For the

remainder of the year these subjects were given regular speech therapy. The control group, on the other hand, did not work through the program for teaching auditory discrimination of the /r/ phoneme, but continued therapy in a regularly planned program.

The Bryngelson-Glaspey Test of Articulation was used for evaluating the growth, in general articulatory skills, of each subject in this study. The test was administered on an individual basis by the examiner and the subjects responses were recorded on the speech test blank which may be found in Appendix C. The instrument was judged to be a reliable measure for evaluating articulatory handicapped subjects. About this test, Van Riper states, "An especially excellent collection of articulation test pictures is provided by Bryngelson and Glaspey." (74:174) The test consists of sixteen picture cards containing fifty-one stimulus pictures.

The /r/ Phoneme Test of Articulation was adapted from the one-hundred seventy-six items of the Templin-Darley Screening and Diagnostic Tests of Articulation. (Appendix D) There were forty-two items which tested

the /r/ phoneme in vowels, consonants, blends, syllabic and nonsyllabic /ɚ/, /ɝ/, vowels with blends, and other three element blends. The procedures for analyzing the test results were also carried out when applicable. Although normative data could not be used, the particular items dealing with susceptibility to intensive auditory stimulation were carried out. The /r/ phoneme was presented orally five times by the examiner and the subject was asked to imitate the sound as closely as possible. The /r/ phoneme was then presented in a syllable, in a word, and in a consonant blend in a word. This procedure was used to determine the ease with which the subject could correct his errors following auditory stimulation. In discussing the importance of testing for stimulability, Darley says,

> The speaker who is inconsistant must at least be aware of the phoneme which he has misarticulated in some contexts, but not in others, and so he should not require as much ear training as a person who never produces the faulty sounds correctly. (31:93)

The Short Test of Sound Discrimination by Mildred Templin was used to assess the sound discrimination ability of these elementary school children. This test consists of

seventy paired nonsense syllables and three sample problems. (Appendix E) The subjects were tested individually using a Sony 500A tape recorder as the method of presentation. The tape recorder was used to present the nonsense syllables to prevent any variations between pretesting and postprogram testing, and to prevent variations of testing between individual subjects. The subjects were instructed to listen for paired sets of nonsense syllables and to indicate on the record blank whether the two sounds they heard were the same (S) or different (D). The three examples were given and were repeated when necessary before continuing on with the test.

The /r/ Phoneme Test of Discrimination, printed in full in Appendix A, was discussed in the section called "The Program." The test is made up of sixty-four test items and twenty-six sample problems. By using the odd-even method of test analysis of reliability, it was found to have an r of .711. By lengthening the test to 128 items, i.e., using every item twice, the test would have an r of .831. The test scores of the control group were used to compute a test-retest reliability of .826. Although these

correlation coefficients are not exceedingly high they do relate positively with other research in the area of auditory discrimination.

Administration of the Program. Since the subjects had worked through the test before starting the program it was not necessary to repeat the directions before continuing from one phase to the next. The procedures for responding to the test problems were quite similar to those procedures followed in the program. The only exceptions to this were: (1) while working through the program the subjects were instructed to change from a blue pencil to a red pencil whenever an error was made; and (2) when the subject responded erroneously to an item on the program it was rewound and that item was taken over again. The same was true if the subject failed to respond within a given time limit. This procedure differed from the administration of the discrimination test, since during the test only the directions and the sample items could be replayed.

The subjects were seen on a biweekly basis throughout the entire school year. The pretests of articulation,

the /r/ phoneme test of articulation, the general test of auditory discrimination, and the /r/ phoneme test of auditory discrimination, took approximately three weeks to administer and score. The two discrimination tests were recorded to eliminate the variations of presentation and to be preserved for later use as the postprogram tests of discrimination. All postprogram testing was carried out during the first three weeks in May.

The control group was not given any opportunity to develop skills in auditory discrimination, other than what they may have gained from the pretest situation. This group was given regular therapy centered around their particular speech handicap with the exception of ear-training.

The experimental group received therapy plus the program for teaching auditory discrimination. The full range of ear-training was not carried out with this group.

A secondary purpose of this study was to determine whether or not improved discrimination would improve articulation. Only one aspect of ear-training was under study at this time, therefore, no other part of ear-training was taught.

CHAPTER IV

RESULTS

Statistical Comparisons of General Articulation. The *t*-statistic for the experimental group's scores on the pretest and postprogram test of articulation were significant at the .01 level as shown in Table 1. This indicates that a significant amount of growth occurred between the initial administration of the articulation test and the administration of the same test nine months later.

Table 2 indicates that the control group also made significantly different scores between the pretest and the postprogram test at the .025 level of significance. The difference in mean scores indicate that more growth occurred in this group than in the experimental group.

If the experimental group had made significant gains in articulation because of the program they were given, then there should be a significant difference between the two groups tested. Table 3 gives the results of a comparison between the experimental group's test scores and those of the control. The groups were not significantly

Table 1

Comparisons of Pretest and Test Performance
of the Experimental Group on General Articulation

Tests (*df*=8)	Mean Score	Difference	SE Diff.	t
Pretest	41.22			
		6.78	2.11	3.07*
Test	48.00			

*$p \leq .01$ (one-tailed)

Table 2

Comparisons of Pretest and Test Performance of the Control Group on General Articulation

Tests (df=8)	Mean Score	Difference	SE Diff.	t
Pretest	31.22			
		9.78	3.95	2.68*
Test	41.00			

*$p \leq .025$ (one-tailed)

Table 3

Comparisons of Experimental and Control Group Performance on General Articulation

Tests (df=17)	Mean Change	Difference	SE Diff.	t
Experimental	6.78			
		3.00	5.99	.944*
Control	9.78			

*not significant

different in terms of gains in articulatory skills. In order to test the assumption that the two groups were comparable during the initial testing the pretest scores of both groups were computed on the Mann-Whitney U formulation. This statistic yields a score by comparing two sets of data to determine whether or not the results are significantly different. In this statistical analysis U = 26 in order to be significant at the .05 level, therefore, an obtained U score of 32 indicates that the two groups were not significantly different at the time of initial testing. (82:117-127)

Statistical Comparisons of Templin Test of Auditory Discrimination. The growth which was made by the experimental group on a general test of auditory discrimination was significant at the .05 level. Table 4 shows a mean gain of 5.77 between pretest and postprogram tests of sound discrimination. This indicates that the experimental group had learned to discriminate better between nonsense syllables which were the same and those which were different.

The control group made only slight gains (2.78) in

Table 4

Comparisons of Pretest and Test Performance
of the Experimental Group
on the Templin Test of Auditory Discrimination

Tests (df=8)	Mean	Difference	SE Diff.	t
Pretest	52.11			
		5.78	4.79	1.87*
Test	57.89			

*$p \leq .05$ (one-tailed)

terms of correct responses to the test of auditory discrimination. The variety of individual scores was indicative of the test-retest reliability of this instrument. Table 5 shows that the individuals in this group did not significantly improve their listening skills from one administration of this test to the other. Five of these subjects gained less than three points and only one gained six points on the test-retest measurement.

Table 6 gives the comparisons between the experimental group scores and those of the control. The groups were significantly different at the .05 level in terms of gains in auditory discrimination skills. Two of the experimental subjects gained more than twelve points while the largest gain of any member of the control group was six.

Statistical Comparisons of the /r/ Phoneme Articulation Test. The /r/ phoneme articulation test results of the experimental group are shown in Table 7. The pretest and postprogram test comparisons were significant at the .025 level. Five of these subjects made no improvement in producing good /r/ sounds in any position even after working through the program to improve auditory

Table 5

Comparisons of Pretest and Test Performance
of the Control Group
on the Templin Test of Auditory Discrimination

Tests (df=8)	Mean	Difference	SE Diff.	t
Pretest	54.22			
		2.78	6.06	.493*
Test	57.00			

*not significant

Table 6

Comparisons of Experimental and Control Group Performance on the Templin Test of Auditory Discrimination

Tests (df=17)	Mean Change	Difference	SE Diff.	t
Experimental	5.78			
		3.00	1.69	1.78*
Control	2.78			

*$p \leq .05$ (one-tailed)

Table 7

Comparisons of Pretest and Test Performance of the Experimental Group on the /r/ Phoneme Articulation Test

Tests (df=8)	Mean	Difference	SE Diff.	t
Pretest	0.00			
		7.11	2.94	2.45*
Test	7.11			

*$p \leq .025$ (one-tailed)

discrimination. The remaining four subjects could produce good /r/ sounds in some position of a word, but none of them received perfect scores.

The control group also made significant gains in learning to produce good /r/ sounds in some positions of a word. The mean score for this group on the postprogram test was 13.77, as shown in Table 8. Four of these subjects made no improvement in producing good /r/ sounds. None of the remaining five subjects received perfect scores, even though they did produce good /r/ sounds in words occasionally.

Table 9 indicates that there was not a significant difference between the experimental and control groups mean change in scores. If a significant difference were found, it would have shown the control group to have superior ability in producing good /r/ sounds. In a test of this kind, where all pretest scores are zero, caution must be exercised in interpreting changes as a positive indication of results. Considering the length of time between pretests and postprogram tests it should not be surprising that changes in articulation did occur at a

Table 8

Comparisons of Pretest and Test Performance of the Control Group on the /r/ Phoneme Articulation Test

Tests (df=8)	Mean	Difference	SE Diff.	t
Pretest	0.00			
		13.77	5.23	2.63*
Test	13.77			

*$p \leq .025$ (one-tailed)

Table 9

Comparisons of Experimental and Control Group Performance on the /r/ Phoneme Articulation Test

Tests (df=17)	Mean Change	Difference	SE Diff.	t
Experimental	7.11			
		6.66	5.99	1.11*
Control	13.77			

*not significant

significant level ($p \leq .025$).

Statistical Comparisons of /r/ Phoneme Discrimination Test. The experimental group showed significant gains at the .05 level on the /r/ phoneme test of discrimination. The results of the findings are summarized in Table 10. Every subject in the experimental group improved his scores on the postprogram test of /r/ discrimination. Two subjects improved their scores by more than fourteen points.

The results for the test scores of the control group are shown in Table 11. The mean difference between the pretest and the postprogram test was 2.11 and the t-statistic was .679. Two of these subjects made no gains, while six points was the highest score of any subject. The pretest and postprogram test of this group was used to determine the test-retest reliability of the /r/ phoneme discrimination test. A reliability coefficient of .826 was obtained in this manner.

There was a significant difference between the scores made by the experimentals and those made by the controls with a $p \leq .05$ (Table 12). This indicates that the gains made by the experimental group was brought about by a variable

Table 10

Comparisons of Pretest and Test Performance
of the Experimental Group
on the /r/ Phoneme Test of Auditory Discrimination

Tests (df=8)	Mean	Difference	SE Diff.	t
Pretest	47.67			
		6.00	2.46	1.90*
Test	53.67			

*$p \leq .05$ (one-tailed)

Table 11

Comparisons of Pretest and Test Performance
of the Control Group
on the /r/ Phoneme Test of Auditory Discrimination

Tests (df=8)	Mean	Difference	SE Diff.	t
Pretest	49.22			
		2.11	4.06	.679*
Test	51.33			

*not significant

Table 12

Comparisons of Experimental and Control Group Performance on the /r/ Phoneme Test of Auditory Discrimination

Tests (df=17)	Mean Change	Difference	SE Diff.	t
Experimental	6.00			
		3.89	1.80	1.82*
Control	2.11			

*$p \leq .05$ (one-tailed)

which was not present in the control group. It appears reasonable to assume that this variable was the program which was designed to teach auditory discrimination of the /r/ phoneme.

Error Analysis of the Program. By using programed instructional materials it is possible to keep an accurate record of the individual errors and those items which were missed most frequently. This information can then be used to improve the particular program, e.g., by using smaller steps to precede more difficult items. Table 13 shows the items which were programed in phases; 1-10 isolated sounds, 11-20 initial nonsense syllables, 21-30 final nonsense syllables, 31-38 medial nonsense syllables, 39-46 initial words, 47-54 final words, 55-62 medial words, 63-70 words in sentences. It also gives the item, by number, which was missed by more than two subjects. Those items which were missed by more than two subjects (29 - 34 - 54 - 60) needed to be further evaluated in terms of appropriateness of the position in the program. More steps may be needed to lead the student to this level of proficiency in auditory discrimination skills.

Table 13

Error Analysis of the Program

Items	Total errors	Item missed by more than two subjects
1-10	0	0
11-20	2	0
21-30	4	29
31-38	4	34
39-46	0	0
47-54	3	54
55-62	5	60
63-70	3	0
	21	

Percent of errors 3.33

Table 14 shows the results of programing analysis of the individual subjects responses to the seventy items. The phases which gave the subjects the most difficulty were: nonsense syllables, phases 3 and 4; and in words, phases 6 and 7. The average number of items missed per pupil was 2.33.

Table 14

Program Analysis-Individual Subjects

Phase	Subjects 1	2	3	4	5	6	7	8	9
1. Isolated Sounds	0	0	0	0	0	0	0	0	0
Nonsense Syllables									
2. Initial	0	0	1	1	0	0	0	0	0
3. Final	0	1	1	1	0	0	0	1	0
4. Medial	0	1	0	0	1	1	0	0	1
In Words									
5. Initial	0	0	0	0	0	0	0	0	0
6. Final	0	0	0	0	1	0	1	1	0
7. Medial	1	1	1	1	0	0	0	1	0
8. Sentences	0/1	1/4	1/4	1/4	0/2	0/1	0/1	0/3	0/1

Average number missed per pupil 2.33 (out of 70 items)

CHAPTER V

DISCUSSION

The purpose of this study was twofold, (1) to develop an automated auditory discrimination training program, and (2) to evaluate the effectiveness of this program to aid in the improvement of the sound discrimination skills of school children who have articulatory difficulties with the /r/ phoneme. The program developed was used by nine of the eighteen subjects in this study. The design of the program was to gain maximum benefits from both individual instruction and immediate reinforcement of correct responses.

A. THE TESTS OF THE PROGRAM

The pretest revealed that very few subjects had difficulty distinguishing the correct /r/ phoneme in isolation, or in the initial position of words. The error analysis of the program (Table 13) indicates that very little learning was taking place throughout these two phases. The parts of the program which were more difficult,

and the parts of the postprogram test which showed the most improvement were, (1) the /r/ phoneme in nonsense syllables, and (2) the /r/ phoneme in the final and medial positions of words. These phases were even more difficult than distinguishing between sentences which contained distortions of the /r/ phoneme in all three positions of a word.

The results of the experimental group's pretest and postprogram test scores indicate that they did learn to discriminate between the allophonic variations of the /r/ phoneme more accurately than the control group. In addition, the experimental group made significantly higher scores on the general test of auditory discrimination. This would indicate that specific auditory discrimination skills do carry over into the area of general listening abilities.

B. THE PROGRAM

Throughout the administration of the program it was evident that the subjects enjoyed working at a task which was clearly outlined and which would give them immediate

knowledge of the appropriateness of their response. The subjects were given the opportunity to work through the program as rapidly as they could and were free to terminate the lesson whenever the task became tiresome. The average number of sessions necessary to complete the task was two, and only one subject needed more than three sessions to complete the program.

C. OTHER TESTS

The entire program was designed to improve auditory discrimination skills either specifically in relation to the /r/ phoneme or universally in terms of general discrimination. However, other tests were administered in order to assess the program's influence on all aspects of articulation therapy. This data in no way affected the construction of the program or the results obtained from pretest and postprogram testing of auditory discrimination. It did, however, reaffirm the basic hypothesis that extrapersonal auditory discrimination ability alone has little influence on articulation, i.e., without the intervening step of interpersonal auditory discrimination skill little

or no permanent improvement in articulation should be expected.

The general articulation test consisted of 51 items, six of which were tests of /r/ phonemes in the initial, medial, and final positions and in three element blends. The scores were determined by the number of items missed by the individual subjects, and an improved score was not an indication of success on the program. Since both groups performed better on the postprogram test it is evident that something other than the program was responsible for the apparent growth. All of the subjects had articulatory errors which involved more than just the /r/ phoneme, and in many instances the correction of other sounds was responsible for the change in articulation scores.

The specific articulation test of the /r/ phoneme was made up of 43 items which tested this sound in a variety of contexts. Along with those listed above it tested the /r/ phoneme in the initial, medial, and final positions of blends, in three element blends, and in syllabic and nonsyllabic /r/ sounds. On the pretest none of the subjects could produce good /r/ sounds in any

position tested, therefore, their ability to discriminate correct from incorrect /r/ sounds would be most limited. All of the eighteen subjects made some improvement on the second administration of the /r/ phoneme articulation test, but caution should be taken in interpreting this data. The experimental and the control groups' scores on the postprogram tests were higher than those of the pretest, and since only the experimental group was given the program it is most probable that the program itself was not responsible for the improvement.

D. SUGGESTED IMPROVEMENTS IN THE PROGRAM

The analytical review of errors in each phase of the program show how some items could be improved while others are apparently teaching discrimination. Phase one, which dealt with the isolated /r/ phoneme, could conceivably have been shorter without endangering the continuity of the program. Since there were no errors in this phase and the pretest revealed only minor difficulties it could be assumed that less practice was needed in this area. Phase two was very successful in teaching this group to

discriminate between the /r/ phoneme and its distortions in the initial position of nonsense syllables. Phase three and four, which dealt with final and medial nonsense syllables, should have been lengthened to make room for more trials and subsequently to make the steps between each item flow more smoothly. In the final analysis of phase three it was found that items 29 and 30 should have been reversed. Phase five could have been shortened without error increases. This phase was apparently too easy for most of the subjects. Phases six and seven should have been lengthened in order to give the subjects more practice on the more difficult items. This phase dealt with the final and medial /r/ phoneme in words. In phase seven item 60 could have been reversed with item 62 in order to give the subjects more practice before attempting the seemingly more difficult item. Phase eight seemed to relate well with the rest of the program in terms of number of errors per response. The phase presents the subject with sentences containing one, two, and three /r/ words within one sentence.

E. SUGGESTIONS FOR FURTHER RESEARCH

The computer is rapidly becoming standard equipment in many of the larger school districts throughout the country, and with this equipment come many opportunities to develop programs which can do much more than just teach extrapersonal auditory discrimination. By using computers to analyze oscilloscopic prints of the live voice it may be possible to construct a program which would facilitate the learning of the interpersonal auditory discrimination. By setting up a model in the computers memory and then instructing the student to imitate the model, it seems feasible that through successive approximations the student could learn to interpret his own responses in light of the information given to him by the computer. This method of teaching articulation is highly preferred by most professional speech therapists.

CHAPTER VI

CONCLUSIONS

From the results of the study the following conclusions seem warranted:

1. Auditory discrimination of the /r/ phoneme is a skill which can be improved through the use of programed learning techniques. The /r/ phoneme is particularly susceptible because of the common distortion errors of /r/ defective pupils. A wide variety of /r/ phoneme distortions can be programed to fit the majority of the cases found in the public schools.

2. Increasing the efficiency and the effectiveness of teaching auditory discrimination also seems to be an important outcome of this study. In just over fifty minutes students were able to improve their auditory discrimination ability of the /r/ phoneme. With some mechanical adaptations this could be done independently of a therapist.

3. The articulatory skills of the subjects were not improved by the program. However, the lasting effects of

the program were evident in subsequent articulation therapy.

4. The general auditory discrimination ability appeared to improve through specific training of the /r/ phoneme discrimination. It may be that other functions of listening skills should be investigated to determine whether or not specific skills need to be taught.

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APPENDIX A

THE /r/ DISCRIMINATION TEST

(Introduction and Phase I)

I WANT YOU TO LISTEN VERY CAREFULLY TO THE SOUNDS THAT YOU HEAR ON THIS TAPE RECORDING. THE SOUND YOU WILL BE LISTENING FOR IS THE /rrr/. I WANT YOU TO MAKE AN "X" ON THE SHEET OF PAPER IN FRONT OF YOU. IF THE FIRST SOUND YOU HEAR IS A GOOD /rrr/ THEN MAKE AN "X" IN COLUMN ONE. IF THE SECOND SOUND YOU HEAR IS THE GOOD /rrr/ MAKE AN "X" IN COLUMN TWO.

WHEN YOU HEAR THIS BELL.....(ding)..... YOU WILL KNOW (5 sec. / 5 sec.) THAT IT IS TIME TO START LISTENING FOR THE GOOD SOUND.

(1) READY..... EXAMPLE NUMBER ONE.....(ding).....r^1 r^4 (5 sec. / 5 sec. / 5 sec.)

(30 sec. delay)

THAT'S RIGHT, THE FIRST ONE. YOU SHOULD HAVE MARKED AN "X" IN COLUMN NUMBER ONE.

NOW LET'S TRY IT AGAIN.

(2) READY.....EXAMPLE NUMBER TWO.....(ding).....r^1 r^3 (5 sec. / 5 sec. / 5 sec.)

(30 sec. delay)

THAT'S RIGHT, IT WAS THE FIRST ONE AGAIN WASN'T IT.

YOU SHOULD HAVE MADE AN "X" IN COLUMN NUMBER ONE.

5 sec. 5 sec.

(3) ARE YOU READY, ... HERE IS EXAMPLE NUMBER THREE.....

5 sec.

(ding).....r^2 r^1 (30 sec. delay)

THAT'S RIGHT, YOU SHOULD HAVE MADE AN "X" IN COLUMN NUMBER TWO. NOW WE ARE GOING TO TRY IT ONCE AGAIN, JUST TO MAKE SURE YOU KNOW WHAT YOU ARE SUPPOSED TO DO.

REMEMBER, MARK EITHER NUMBER ONE OR NUMBER TWO.

5 sec. 5 sec. 5 sec.

(4) READY.....EXAMPLE NUMBER FOUR.....(ding)..... r^2 r^1

(30 sec. delay) IT WAS THE SECOND ONE. YOU SHOULD HAVE MADE AN "X" IN COLUMN NUMBER TWO. (30 sec. delay)

ALL RIGHT FROM NOW ON YOU WILL BE ON YOUR OWN. BE SURE AND LISTEN CAREFULLY. IF YOU GET TIRED OR FOR ANY OTHER REASON FALL BEHIND, JUST SIGNAL ME BY RAISING YOUR HAND.

THE NEXT SOUND YOU HEAR WILL BE THE SOUND OF THE BELL. WHEN YOU HEAR IT YOU WILL KNOW THAT IT IS TIME TO LISTEN FOR THE /rrr/ THAT SOUNDS THE BEST TO YOU.

(1) .....(ding).....r^1 r^4

(2) .....(ding).....r^3 r^1

(3) .....(ding).....r^1 r^2

(4) .....(ding).....r^2 r^1

(5) .....(ding).....r^2 r^3

(6) .....(ding).....r^4 r^3

(7) .....(ding).....r^2 r^3

(8) .....(ding).....r^3 r^1

(Phase II)

NOW I AM GOING TO PUT ANOTHER SOUND ALONG WITH THE /rrr/. YOU WILL STILL BE LISTENING FOR THE GOOD /rrr/, BUT IT WILL HAVE ANOTHER SOUND FOLLOWING IT. DON'T BE FOOLED BY THE OTHER SOUND. MAKE AN "X" IN COLUMN ONE IF THE FIRST GROUP OF SOUNDS YOU HEAR ARE BEST. MAKE AN "X" IN COLUMN TWO IF THE SECOND GROUP OF SOUNDS ARE BEST. THESE SOUNDS WILL COME IN PAIRS SO BE SURE AND LISTEN FOR TWO GROUPS.

5 sec. 5 sec.
REMEMBER TO LISTEN FOR THE BELL.....(ding).....THEN YOU WILL KNOW THAT IT IS TIME TO LISTEN FOR THE GOOD SOUNDS.

5 sec. 5 sec. 5 sec.
(1) READY.....EXAMPLE NUMBER ONE.....(ding)..... ra^1 ra^4

(30 sec. delay)

THAT'S RIGHT, YOU SHOULD HAVE MADE AN "X" IN COLUMN ONE. NOW WE ARE GOING TO TRY IT ONCE AGAIN.

5 sec. 5 sec. 5 sec.
(2) READY, ...EXAMPLE NUMBER TWO.....(ding)..... ra^2 ra^1 (30 sec. delay)

THAT'S RIGHT, IT WAS THE SECOND ONE. YOU SHOULD HAVE MADE AN "X" IN COLUMN TWO.

NOW YOU HAVE HAD SOME EXAMPLES, SO LET'S SEE HOW WELL YOU CAN LISTEN TO THE NEXT GROUP OF SOUNDS.

(1) .....(ding).....ri^{2} ri^{3}

(2) .....(ding).....ri^{2} ri^{1}

(3) .....(ding).....ri^{2} ri^{1}

(4) .....(ding).....ri^{2} ri^{3}

(5) .....(ding).....ro^{1} ro^{3}

(6) .....(ding).....ro^{1} ro^{4}

(7) .....(ding).....ro^{2} ro^{1}

(8) .....(ding).....ro^{3} ro^{4}

(Phase III)

THIS TIME YOU WILL STILL BE LISTENING FOR A GROUP OF SOUNDS, BUT THE /rrr/ WILL NOT BE AT THE BEGINNING. THE /rrr/ WILL BE ON THE END OF THIS NEXT GROUP OF SOUNDS. DON'T FORGET TO WAIT AND LISTEN FOR THE /rrr/. THEN MAKE AN "X" IN COLUMN ONE OR TWO.

REMEMBER, LISTEN FOR BOTH GROUPS OF SOUNDS.

5 sec. 5 sec. 5 sec.
(1) READY.....EXAMPLE NUMBER ONE.....(ding)..... ur^1 ur^3

(30 sec. delay)

THAT'S RIGHT IT WAS THE FIRST ONE. YOU SHOULD HAVE MADE AN "X" IN COLUMN ONE.

5 sec. 5 sec. 5 sec.
(2) READY.....EXAMPLE NUMBER TWO.....(ding)..... or^3 or^1

(30 sec. delay)

THAT'S RIGHT, YOU SHOULD HAVE MADE AN "X" IN COLUMN TWO.

NOW BE SURE TO LISTEN CAREFULLY FOR THE /rrr/ ON THE END OF THE NEXT GROUP OF SOUNDS.

(1) .....(ding).....ɑr^{1} ɑr^{3}

(2) .....(ding).....ɑr^{3} ɑr^{1}

(3) .....(ding).....ɑr^{2} ɑr^{1}

(4) .....(ding).....ɑr^{4} ɑr^{3}

(5) .....(ding).....ir^{4} ir^{1}

(6) .....(ding).....ir^{1} ir^{2}

(7) .....(ding).....ir^{3} ir^{4}

(8) .....(ding).....ir^{2} ir^{3}

(Phase IV)

YOU ARE STILL LISTENING FOR THE /rrr/, BUT THIS TIME I HAVE HIDDEN IT FROM YOU. IT IS IN THE MIDDLE OF THIS NEXT GROUP OF SOUNDS. BE A GOOD LISTENER AND MARK THE BEST /rrr/ IN EITHER COLUMN ONE OR COLUMN TWO.

5 sec. 5 sec. 5 sec.
(1) READY.....EXAMPLE NUMBER ONE.....(ding)..... ɑrɑ[1]

ɑrɑ[3] (30 sec. delay)

THAT'S RIGHT IT WAS THE FIRST ONE. YOU SHOULD HAVE MADE AN "X" IN COLUMN ONE.

5 sec. 5 sec. 5 sec.
(2) READY.....EXAMPLE NUMBER TWO.....(ding)..... ori[2]

ori[1] (30 sec. delay)

THAT'S RIGHT, YOU SHOULD HAVE MADE AN "X" IN COLUMN TWO.

NOW LISTEN CAREFULLY FOR THE /rrr/ IN THE NEXT GROUP OF SOUNDS.

(1) .....(ding).....oro^{1} oro^{4}

(2) .....(ding).....oro^{2} oro^{1}

(3) .....(ding).....oro^{2} oro^{1}

(4) .....(ding).....oro^{3} oro^{4}

(5) .....(ding).....ira^{2} ira^{1}

(6) .....(ding).....ira^{1} ira^{3}

(7) .....(ding).....ira^{3} ira^{2}

(8) .....(ding).....ira^{3} ira^{2}

(Phase V)

HERE ARE SOME WORDS FOR YOU TO LISTEN TO. IF ONE OF THE WORDS STARTS WITH A GOOD /rrr/ THEN MAKE AN "X" IN EITHER COLUMN ONE OR COLUMN TWO.

BE SURE AND LISTEN TO BOTH OF THE WORDS BEFORE CHOOSING THE GOOD /rrr/ WORD.

5 sec. 5 sec. 5 sec.
(1) READY.....EXAMPLE NUMBER ONE.....(ding)..... rope[1]

rope[4] (30 sec. delay)

THAT'S RIGHT, IT WAS THE FIRST ONE. YOU SHOULD HAVE MADE AN "X" IN COLUMN ONE.

5 sec. 5 sec. 5 sec.
(2) READY.....EXAMPLE NUMBER TWO.....(ding)..... rake[3]

rake[1] (30 sec. delay)

THAT'S RIGHT, YOU SHOULD HAVE MADE AN "X" IN COLUMN TWO.

NOW LISTEN TO BOTH OF THE /rrr/ WORDS BEFORE CHOOSING THE BEST ONE.

(1) .....(ding).....read^{4} read^{1}

(2) .....(ding).....read^{3} read^{1}

(3) .....(ding).....road^{1} road^{2}

(4) .....(ding).....road^{4} road^{2}

(5) .....(ding).....rod^{1} rod^{3}

(6) .....(ding).....rod^{2} rod^{1}

(7) .....(ding).....red^{4} red^{2}

(8) .....(ding).....red^{3} red^{2}

(Phase VI)

NOW I HAVE MORE WORDS FOR YOU TO LISTEN TO. THIS TIME THE /rrr/ WILL BE FOUND AT THE END OF THE WORD...SO LISTEN CAREFULLY. LISTEN TO BOTH WORDS BEFORE MARKING THE GOOD /rrr/ WORD IN COLUMN ONE OR COLUMN TWO.

5 sec. 5 sec. 5 sec.
(1) READY.....EXAMPLE NUMBER ONE.....(ding)..... poor[4]

poor[1] (30 sec. delay)

THAT'S RIGHT, IT WAS THE SECOND ONE. YOU SHOULD HAVE MADE AN "X" IN COLUMN TWO.

5 sec. 5 sec. 5 sec.
(2) READY.....EXAMPLE NUMBER TWO.....(ding)..... hair[1]

hair[3] (30 sec. delay)

THAT'S RIGHT, YOU SHOULD HAVE MADE AN "X" IN COLUMN ONE.

NOW REMEMBER THE /rrr/ SOUND WILL BE ON THE END OF THE WORD, SO LISTEN CAREFULLY.

(1) .....(ding).....car[1] car[3]

(2) .....(ding).....car[3] car[1]

(3) .....(ding).....far[1] far[3]

(4) .....(ding).....far[4] far[2]

(5) .....(ding).....stare[2] stare[1]

(6) .....(ding).....stare[3] stare[4]

(7) .....(ding).....tar[2] tar[3]

(8) .....(ding).....tar[2] tar[3]

(Phase VII)

HERE ARE SOME WORDS THAT HAVE THE /rrr/ IN THE MIDDLE. SEE IF YOU CAN PICK THE GOOD /rrr/ WORD OUT AND MAKE AN "X" IN EITHER COLUMN ONE OR COLUMN TWO. LISTEN TO BOTH OF THE WORDS BEFORE YOU MARK THE RIGHT /rrr/ WORD.

5 sec. 5 sec. 5 sec.
(1) READY.....EXAMPLE NUMBER ONE.....(ding)..... fairy[1]

fairy[3] (30 sec. delay)

THAT'S RIGHT, IT WAS THE FIRST ONE. YOU SHOULD HAVE MADE AN "X" IN COLUMN ONE.

5 sec. 5 sec. 5 sec.
(2) READY.....EXAMPLE NUMBER TWO.....(ding)..... berry[3]

berry[1] (30 sec. delay)

THAT'S RIGHT, YOU SHOULD HAVE MADE AN "X" IN COLUMN TWO.

NOW LET'S SEE IF YOU CAN PICK THE BEST /rrr/ WORD OUT. REMEMBER THE /rrr/ WILL BE IN THE MIDDLE SO LISTEN CAREFULLY.

(1) .....(ding).....orange^{1} orange^{4}

(2) .....(ding).....orange^{3} orange^{1}

(3) .....(ding).....carrot^{2} carrot^{1}

(4) .....(ding).....carrot^{3} carrot^{2}

(5) .....(ding).....cherry^{1} cherry^{3}

(6) .....(ding).....cherry^{2} cherry^{1}

(7) .....(ding).....carry^{3} carry^{1}

(8) .....(ding).....carry^{3} carry^{2}

(Phase VIII)

NOW I WANT YOU TO LISTEN TO THESE SENTENCES. TELL ME, BY MAKING AN "X" IN EITHER COLUMN ONE OR COLUMN TWO, WHICH SENTENCE HAS THE GOOD /rrr/ IN IT. LISTEN TO BOTH SENTENCES BEFORE YOU CHOOSE THE GOOD /rrr/ SENTENCE.

5 sec. 5 sec. 5 sec.
(1) READY.....EXAMPLE NUMBER ONE.....(ding)..... The apple is red[1] The apple is red[3] (30 sec. delay) THAT'S RIGHT, IT WAS THE FIRST ONE. YOU SHOULD HAVE MADE AN "X" IN COLUMN ONE.

5 sec. 5 sec. 5 sec.
(2) READY.....EXAMPLE NUMBER TWO.....(ding)..... Open the door[3] Open the door[2] (30 sec. delay) THAT'S RIGHT, YOU SHOULD HAVE MADE AN "X" IN COLUMN TWO.

NOW LISTEN CAREFULLY TO BOTH OF THE SENTENCES BEFORE CHOOSING THE ONE THAT SOUNDS BEST TO YOU.

(1) .....(ding).....The ball is red[1] The ball is red[3]

(2) .....(ding).....The ball is red[3] The ball is red[1]

(3) .....(ding).....The store is closed[1] The store is closed[4]

(4) .....(ding).....The store is closed[3] The store is closed[2]

(5) .....(ding).....The carrot is orange[3] The carrot is orange[1]

(6) .....(ding).....The carrot is orange[1] The carrot is orange[2]

(7) .....(ding).....The rabbit likes four carrots[2] The rabbit likes four carrots[1]

(8) .....(ding).....The rabbit likes four carrots[3] The rabbit likes four carrots[4]

APPENDIX B

/r/ TEST STANDARDIZATION RESULTS

Phase	Item No.	/r/-rating
Phase 1.	1	1/4
	2	3/1
	3	1/2
	4	2/1
	5	2/3
	6	4/3
	7	2/3
	8	3/1
Phase 2.	1	2/3
	2	2/1
	3	2/1
	*4	2/3
	5	1/3
	6	1/4
	7	2/1
	*8	3/4
Phase 3.	1	1/3
	2	3/1
	3	2/1
	4	4/3
	5	4/1
	*6	1/2
	7	3/4
	8	2/3
Phase 4.	1	1/4
	2	2/1
	3	2/1
	*4	3/4
	5	2/1
	6	1/3
	*7	3/2
	8	3/2
Phase 5.	1	4/1
	*2	3/1
	*3	1/2
	*4	4/2
	5	1/3
	6	2/1
	*7	4/2
	8	3/2
Phase 6.	1	1/3
	*2	3/1
	3	1/3
	4	4/2
	5	2/1
	6	3/4
	*7	2/3
	8	2/3
Phase 7.	1	1/4
	2	3/1
	3	2/1
	*4	3/2
	5	1/3
	6	2/1
	7	3/1
	8	3/2
Phase 8.	*1	1/3
	2	3/1
	3	1/4
	4	3/2
	5	3/1
	6	1/2
	*7	2/1
	8	3/4

*Indicates item not used in the program because of lack of agreement among raters.

APPENDIX C

SPEECH RECORD BLANK

Bryngelson and Glaspey Articulation Test

Name_____ Sex____ Age ____ Grade_____

School_____ Teacher_____ Date_____

Retest Date_____

Key: Mark substitutions with sound substituted; omissions (-); indistinct (ind.)

Card Check Words	1	2	3	Comments	1	2	3
1. sun, bicycle, bus							
2. sled, stairs, squirrel							
3. zipper, scissors, nose							
4. thumb, toothbrush, teeth							
5. thread, feather, swing							
6. red, barn, car							
yellow, house, white							
7. tree, ice cream, drum							
8. lamp, balloon, ball							
9. airplane, clock, blocks							
10. jacks, soldier, orange							
11. chair, pitcher, watch							
12. shoe, washing machine, fish							
13. cat, chicken, milk							
14. gun, wagon, pig							
15. fork, telephone, knife							
16. valentine, davenport, stove							

APPENDIX D

TEST OF THE /r/ PHONEME

No. of Sounds Tested	Item No.	Position and Type
2	7-8	Medial and final Vowel
1	28	Initial and medial Consonants
9	44-52	/r/ Blends
11	53-63	Syllabic /ɚ/
12	64-75	Nonsyllabic /ɚ/
4	102-105	/ɚ/-/ɝ/ Vowels with Blends
3	121-123	/r/ Three Element Blends

WORDS USED IN THE TEST

7. bird	52. shredded	63. washer	74. porch
8. car	53. hammer	64. arm	75. large
28. rabbit-arrow	54. dinner	65. horn	102. sister
44. presents	55. paper	66. sharp	103. whisker
45. bread	56. rubber	67. curb	104. December
46. tree	57. doctor	68. heart	105. first
47. dress	58. ladder	69. card	121. sprinkling can
48. crayons	59. cracker	70. fork	122. string
49. grass	60. tiger	71. iceberg	123. scratch
50. frog	61. gopher	72. scarf	
51. three	62. mother	73. fourth	

APPENDIX E

SHORT TEST OF SOUND DISCRIMINATION

Mildred C. Templin

EXAMPLES:

te-de
ere-ere
os-og

KEY: All D Except:

A. 1,8
B. 1,6,8,10
C. 3,6,8,9
D. 4,9,10
E. 3,9
F. 3,7
G. 3,6

A.	B.	C.	D.
1. te-te	1. ne-ne	1. fo-θo	1. pe-ke
2. hew-we	2. dʒe-tʒe	2. vo-ðo	2. tʃo-ʃo
3. ne-me	3. ʃe-tʃe	3. zo-zo	3. ki-ti
4. ðe-de	4. im-iŋ	4. ʃe-ʒe	4. eb-eb
5. fi-vi	5. hwi-wi	5. fi-θi	5. ehwe-ewe
6. he-pe	6. ge-ge	6. ze-ze	6. en-em
7. se-ze	7. dʒi-tʃi	7. mai-nai	7. eð-ed
8. θe-θe	8. fai-fai	8. θe-θe	8. ehe-epe
9. ʒe-dʒe	9. ðe-ve	9. he-he	9. ov-ov
10. vo-bo	10. pe-pe	10. dʒi-ʒi	10. eθ-eθ

E.	F.	G.
1. eʒ-edʒ	1. eð-ev	1. if-iθ
2. ov-ob	2. et-ep	2. aim-ain
3. ed-ed	3. ep-ep	3. eθ-eθ
4. en-en	4. of-oθ	4. ini-iŋi
5. edʒ-etʃ	5. ov-oð	5. ef-ep
6. eʃ-etʃ	6. ed-eg	6. eð-eð
7. imi-iŋi	7. em-em	7. idʒ-iʒ
8. ihwi-iwi	8. eð-ez	8. ep-ek
9. eg-eg	9. airai-aiwai	9. otʃ-oʃ
10. is-iz	10. eʃ-eʒ	10. ez-eð