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# Stimulus Manipulation in Articulation Therapy With a Hearing Impaired Child

Walter Eugene White
*Utah State University*

STIMULUS MANIPULATION IN ARTICULATION

THERAPY WITH A HEARING

IMPAIRED CHILD

by

Walter E. White

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of the requirements for the degree

of

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Walter E. White

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## ABSTRACT

Stimulus Manipulation in Articulation

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Major Professor: Dr. Frederick S. Berg
Department: Communicative Disorders

Severely hearing impaired individuals typically exhibit speech that is unintelligible and systematic instruction in speech has not effectively alleviated all of the misarticulations found in the speech of these individuals. Behavior modification is a promising development which has meaningful application to the modification of defective articulation by hearing impaired children.

The purpose of this study was to ascertain the feasibility of implementing a specific program of stimulus manipulation to alter the articulation of the /Tʃ/ phoneme as uttered by one severely hearing impaired individual. The training program was structured in a sequence of four operant training conditions. Pre-training tests, training tasks, intra-training probe tests, post-training tests, stimulus generalization tests, and retention tests were administered.

As a result of this investigation, it was concluded that the use of a behavior modification training program appears to be an effective method by which the articulation of a hearing impaired individual may be modified.

(58 pages)

# INTRODUCTION

## The Problem

Severely hearing impaired individuals have numerous handicaps that are typically associated with the inability to detect sound. This group of individuals has speech, language, academic and social problems that are so devastating as the physical handicap imposed upon them. The unintelligible speech of the severely hearing impaired is their most noticeable handicap and is also one of the most serious deficiencies associated with severe hearing impairment.

Adequate speech skills do not develop naturally for severely hearing impaired children. Traditional methods of teaching speech to severely hearing impaired children usually do not enable them to develop the speech skills needed for successful communication. Thus, a need exists in the education of the severely hearing impaired child for the development of special strategies and techniques that will improve speech instruction. The application of behavioral techniques in the teaching of speech to the hearing impaired is one strategy which could be used to meet the need of improved speech instruction for these individuals.

## Purpose

The present study was designed to determine the possibilities of using a specific program of stimulus manipulation to alter the articulation of the /tʃ/ phoneme as uttered by one severely hearing impaired individual. It was hypothesized that through the use of this program, the articulation of a specific phoneme produced by a severely hearing impaired child could be successfully modified. If the results of this study were positive, reason might exist for additional application of behavioral techniques in the teaching of speech to the severely hearing impaired.

Thus, this study was a feasability investigation and because of this the plan encompassed the use of only one subject.

Definitions

1. Articulation: The process of adjusting the shape of the path of the breath stream from the larynx out through the mouth and nose (Leutenegger, 1963).

2. /tʃ/: Phonetic symbol for the "ch" sound as in the word "church".

3. /ʃ/: Phonetic symbol for the "sh" sound as in the word "ship".

4. Echoic behavior: Verbal responses in which the controlling stimuli are usually auditory-visual stimuli (Skinner, 1957).

5. Intraverbal behavior: Verbal responses in which the controlling stimuli are usually a series of words that may be auditory-visual and/or written or printed stimuli (Skinner, 1957).

6. Tact behavior: Verbal responses in which the controlling no stimuli are usually written or printed stimuli (Skinner, 1957).

7. Textual behavior: Verbal responses in which the controlling stimuli are usually written or printed stimuli (Skinner, 1957).

8. Phoneme: A family of sounds none of which is distinctively different from the others (Leutenegger, 1963).

9. Deaf: Individuals who can identify by use of electro-acoustic amplification no more than a few of the distinguishing features of

speech and then not enough to understand any words by hearing alone. An individual typically demonstrating a sensitivity of hearing in the better ear of 91 dB or more (ISO).

10. Severely hearing impaired: Individuals who can identify by use of electro-acoustic amplification more than a few of the distinguishing features of speech but not all of them. An individual demonstrating a sensitivity of hearing in the better ear of between 71 and 90 dB (ISO).

11. Hearing impaired: Individuals with a malfunction of the auditory mechanism of a severity sufficient to affect personal efficiency in the activities of daily living, specifically in respect to communication. This term includes deaf and severely hearing impaired.

12. Stimulus control: A differential form or frequency of a performance in the presence of one stimulus which is not evident in the presence of another. (Ferster and Perrott, 1968).

# REVIEW OF LITERATURE

Oral communication has never been more important to man than it is in today's highly technological society. The hearing impaired child cannot meet the demands and expectations typically placed on children by their homes, schools, and communities without skill in speech communication. Crammatte (1968) and Sanderson (1966) suggested that while intelligible speech was not a prerequisite to the obtaining and holding of many jobs, it was a most desirable attribute for the hearing impaired to possess. The success of many hearing impaired adults, who have high paying jobs, can usually be traced indirectly to their ability to use oral language skills which are developed in childhood.

In the United States, as many as 141,550 children have difficulty hearing even loud speech (Bernero and Bothwell, 1966). These severely hearing impaired youngsters typically have speech, language, academic and social problems that are educationally significant. Table 1 portrays the communication problems and educational needs that are associated with different degrees of hearing loss. Another deficiency associated with hearing impairment, and one of the most serious and noticeable, is that of defective speech articulation.

Table 1. Communicational problems and educational needs associated with different degrees of hearing loss

| DEGREE OF HANDICAP | EFFECT OF HEARING LOSS ON THE UNDERSTANDING OF LANGUAGE AND SPEECH | EDUCATIONAL NEEDS AND PROGRAMS |
|---|---|---|
| SLIGHT<br>16 to 29dB (ASA)<br>or<br>27 to 40dB (ISO) | May have difficulty hearing faint or distant speech.<br>Will not usually experience difficulty in school situations. | May benefit from a hearing aid as loss approaches 30dB (ASA) or 40dB (ISO).<br>Attention to vocabulary development.<br>Needs favorable seating and lighting.<br>May need lip reading instruction.<br>May need speech correction. |
| MILD<br>30 to 44dB (ASA)<br>or<br>41 to 55dB (ISO) | Understands conversational speech at a distance of 3–5 feet (face-to-face).<br>May miss as much as 50% of class discussions if voices are faint or not in line of vision.<br>May exhibit limited vocabulary and speech anomalies. | Child should be referred to special education for educational follow-up if such service is available.<br>Individual hearing aid by evaluation and training in its use.<br>Favorable seating and possible special class placement, especially for primary children.<br>Attention to vocabulary and reading.<br>May need lip reading instruction.<br>Speech conservation and correction, if indicated. |
| MARKED<br>45 to 59dB (ASA)<br>or<br>56 to 70dB (ISO) | Conversation must be loud to be understood.<br>Will have increasing difficulty with school situations requiring participation in group discussions.<br>Is likely to have defective speech.<br>Is likely to be deficient in language usage and comprehension.<br>Will have evidence of limited vocabulary. | Will need resource teacher or special class.<br>Special help in language skills, vocabulary development, usage, reading, writing, grammar, etc.<br>Individual hearing aid by evaluation and auditory training.<br>Lip reading instruction.<br>Speech conservation and speech correction.<br>Attention to auditory and visual situations at all times. |
| SEVERE<br>60 to 79dB (ASA)<br>or<br>71 to 90dB (ISO) | May hear loud voices about one foot from the ear.<br>May be able to identify environmental sounds.<br>May be able to discriminate vowels but not all consonants.<br>Speech and language defective and likely to deteriorate.<br>Speech and language will not develop spontaneously if loss is present before one year of age. | Will need full-time special program for deaf children, with emphasis on all language skills, concept development, lip reading and speech.<br>Program neeos specialized supervision and comprehensive supporting services.<br>Individual hearing aid by evaluation.<br>Auditory training on individual and group aids.<br>Part-time in regular classes only as profitable. |
| EXTREME<br>80dB or more (ASA)<br>or<br>91dB or more (ISO) | May hear some loud sounds but is aware of vibrations more than tonal pattern.<br>Relies on vision rather than hearing as primary avenue for communication.<br>Speech and language defective and likely to deteriorate.<br>Speech and language will not develop spontaneously if loss is present before one year. | Will need full-time in special program for deaf children, with emphasis on all language skills, concept development, lip reading and speech.<br>Program needs specialized supervision and comprehensive supporting services.<br>Continuous appraisal of needs in regard to oral and manual communication.<br>Auditory training on group and individual aid.<br>Part-time in regular classes only for carefully selected children. |

## Articulatory Acquisition

The hearing impaired child learns to speak, as a rule, the way that he hears others speak; and because of this he has communication problems. An understanding of the implications of this statement may be drawn from a brief description of the acquisition of speech by a normal-hearing child.

### Articulatory acquisition by the normal hearing child

Van Riper (1956) noted that normal speech growth was largely based on perception of the speech characteristic of others in the immediate environment of the child. He cited stages of articulation development such as grunting and wailing, babbling, and finally socialized vocalization.

McCarthy (1954) stated that during the first year of life, the normal child characteristically utters many of the consonants and most of the vowels we identify with our linguistic system. An infant is a great imitator, and this tendency is easily observed in the reproduction of vocal sounds. This imitative tendency is an important factor in the acquisition of speech and language by the normal child. Peterson (1968) considered the development of an imitative repertoire as a necessary condition for language and speech acquisition.

Van Riper (1956) reported that some time between the tenth month and the eighteenth month, a normal hearing child learns to say his first true words. During the second and third years of life, the average normal child learns to speak intelligibly. By the time the normal child is three years of age, two-thirds of the articulations of English have been mastered. Templin (1957) found that during the following five years, the normal child typically completed the acquisition of articulatory skills. As the normal hearing child enters school, he has mastered most of the basic elements of his native language, has a workable vocabulary, and is enjoying participation in normal communication cycles (Statts and Statts, 1964).

McDonald (1964) indicated that the process of articulatory acquisition is based upon the maturation of the perceptual and motor neurological processes. The intelligibility and naturalness of speech result from coordination of complex muscle movements. Hedgecock (1955) emphasized that normally a highly refined sense of hearing is required for the achievement of such complexity.

### Articulatory acquisition by the hearing impaired child

Like the normal hearing child, the hearing impaired child utters crying and comfort vocalizations during the first few months of life. Van Riper (1956) asserted that deaf babies begin to babble at a normal time, but because they cannot hear, they probably lost interest and thus have much less true vocal play than normal hearing children. Statts and Statts (1964) reported that because hearing impaired children are not sensitive to auditory stimuli, they are not reinforced by speech sounds. As a result, the hearing impaired child is not reinforced for producing sounds that are similar to others made by persons in his environment.

Peterson (1968, p. 64) said that, "The child who is unable to repeat or echo the sounds made by other persons does not develop adequate speech." His vocalization tends to be limited to grunts and similar noises used to express primary needs such as for food and drink.

The untaught hearing impaired child typically does not learn to articulate certain speech characteristics. The actual articulation of phonemes in words and in syntactical constructions is delayed until special assistance is provided. With provision for skilled training, somewhat articulate but usually defective speech develops (Berg, 1967).

## Characteristics of the Speech of the Severely Hearing Impaired

A description of the speech characteristics of the severely hearing impaired child can be made through a search of the literature on the speech of the deaf child.

Studies on the characteristics of the speech of the deaf date from Hudgins in 1934. By use of kymographic recordings, he compared the speech of the deaf with that of normal hearing subjects. Recordings of speech breathing movements and bucal pressure tracings were made as subjects uttered phrases of four, five, seven, and nine syllables in length. Abnormalities of the speech of the deaf were: (1) slow and labored speech, usually accompanied by high chest pressure with expenditure of excessive amounts of breath; (2) prolonged vowels with consequent distortion; (3) abnormalities of rhythm; (4) excessive nasality of both vowels and consonants; and (5) malfunction of consonants with the consequent addition of superfluous syllables between abutting pairs. Similar findings were reported by Rawlings (1935).

In 1942, Hudgins and Numbers reported a study of errors of the utterances of the deaf and their importance to speech intelligibility. They studied the speech of students at two Eastern schools for the deaf. Analysis of the recorded speech revealed two general types of deficiencies: errors of articulation involving both consonants and vowels, and errors of rhythm.

Consonant errors of the deaf recorded by Hudgins and Numbers included: (1) confusion of voicing, usually voiceless for voiced; (2) substitution of one consonant for another; (3) inappropriate control of velum, nasality or lack of it; (4) dropping one or more members or adding an adventitious syllable in the compound consonants; (5) similar omissions or additions in abutting consonants; (6) non-function of the arresting consonant; and (7) non-function of the releasing consonant.

Vowel errors of the deaf reported by Hudgins and Numbers were: (1) substitution of one vowel for another; (2) excessive duration of diphthongs; (3) diphthongization of vowels; (4) neutralization of vowels; and (5) nasalization of vowels.

Rhythm errors of the deaf found by Hudgins and Numbers included lack of, or irregular use of, phrasing and accent. They substantiated the importance of speech rhythm for speech intelligibility. They found that rhythmically correct sentences had almost a four to one chance of being understood over those spoken with incorrect rhythm. Durational, intensity, and frequency features of the subjects' speech contributed as much to intelligibility as did consonant articulation and more than vowel articulation. Only 30 to 35 percent of selected sentences uttered by the subjects were understood by trained listeners. Hudgins and Numbers concluded that speech intelligibility is determined both by rhythmic and articulatory features.

Haycock (1942) also referred to the speech irregularities of the deaf. He paid particular attention to voice problems, and asserted that the most important defects of voice found in deaf children were nasality, falsetto, breathiness, weakness, strain, hardness, metallic quality, and throatiness.

Hughson, et al, (1941) were also interested in the voice and articulation of the speech of the speech of the deaf. They made speech recordings of children enrolled at a school for the deaf and made comparisons with the speech of school children with normal hearing. The speech of the hearing impaired children was generally more monotonous and their articulation more deviant when compared to speech of normal hearing children.

Peterson (1946) noted that the most characteristic voice and articulation deficiencies of the deaf were breathiness, nasality, monotony, and vowel or semi-vowel distortions.

Hudgins (1953) also reported that the voices of deaf children were abnormal. He described them as breathy, harsh, weak or strong, high or low, but rarely natural.

New (1954) indicated that children whose hearing loss was so great as to preclude normal growth of speech and language had none of the important skills involved in speech. They lacked: (1) good use of the voice; (2) accurate enunciation of the sounds of speech; (3) correct pronunciation of the words of our language; and (4) an acceptable rhythmic pattern in the flow of syllables that go to make up phrases and sentences.

Silverman and Davis (1970) stated that in general the deaf child is likely to develop a breathy, nasalized vocal quality, abnormal temporal patterns, and some errors of articulation.

Additional investigations further clarify the speech characteristics of the deaf child. Voelker (1935) reported that the deaf showed a tendency toward perserverated pitch patterns. He noted that they used pitch intonation, but they did not use it to render meanings to sentences. Similarly, the findings of Haycock (1918), Hudgins (1937 and 1953), Russell (1929), Scripture (1913), and Story (1912), all indicated that the pitch of the deaf was monotonous. Hudgins (1946) noted that the rhythmic and fluency deficiencies in deaf speech were due to defects of speech breathing.

Several investigators have observed the slow rate of utterance characteristic of deaf children. Voelker (1935) observed that the deaf tended to speak almost four times slower on the average than did the normal hearing individuals. Mason and Bright (1937) analyzed recordings of deaf voices and compared their rate of speech to that of normals. They found that the speech of the deaf was abnormally slow; and that in a given sentence the speech rate of the deaf varied greatly, while that of hearing speakers was quite constant. Calvert (1962), through the use of spectrographic recordings, found that older hearing impaired children extended the duration of articulation several times longer than did normal hearing children. Hood and Dixon (1969) reported that the duration of syllables of severely hearing impaired speakers was abnormally long.

Angelloci (1962) made a spectrographic recording of vowel formants of deaf and normal hearing eleven to fourteen year old boys. He found that the deaf boys typically substituted, with little consistency to the substitutions, other vowels for the vowels that they were instructed to produce.

Martony (1968) and Stewart (1968) described the speech problems of the severely hearing impaired. Stewart noted unstable articulatory utterance, irregular gross pitch shifts, and inappropriate melodic patterns. Martony found unpredictable pitch changes. Bel'tyokov and Masyunin (1968) described the speech of deaf individuals in the Soviet Union as being indestinct and inadequately articulated.

Thus, the review of literature revealed considerable information about the speech of the hearing impaired. The defective speech characteristics can be classified into four problem categories: defectiveness in areas of articulation, rhythm, quality, and pitch.

## Speech Correction for the Severely Hearing Impaired

Since the founding of the first school for the deaf in the United States at Cobbs, Virginia, in 1815, attempts were made to develop and correct speech among deaf and severely hearing impaired children. Hudgins (1953) reported that the methodological speech training of the deaf took two general directions: analytic and synthetic.

Analytic approach. Early American educators of the deaf used an analytic approach (Schunhoff, 1957). This involved initially breaking speech down into individual consonants and vowels and teaching these separately. These speech segments were next put together to form words and phrases. Hudgins (1953) felt that the children taught by the analytical method were likely to have slow speech and poor phrasing.

Synthetic approach. Most American educators of the deaf eventually turned to the synthetic rather than the analytic method of speech instruction. This involved starting with larger units of speech, typically words and phrases. The child was taught to utter these meaningful expressions. Hudgins (1953) felt that children taught by the synthetic method had more fluent speech, butter phrasing, and mastered the rhythmic patterns easier than children instructed by the analytic approach. He noted, however, that they still rarely developed accuracy in articulation.

Within the frameworks of either analytic or synthetic approaches, educators of the deaf have placed emphasis on multisensory approaches to better speech. These include utilization of visual, auditory, tactile, and kinesthetic pathways through which the deaf child may learn speech (Schunhoff, 1957).

### Individual contributions to speech correction

Many individuals have made important contributions to the teaching of speech to deaf and severely hearing impaired individuals. Included among these were Avondino (1918) who worked to develop babbling drills. Joiner and Lewis (1926) described an order of acquisition of articulatory and melodic aspects of speech. Alcorn (1938) discussed speech developed through tactile cues. New (1942) used color coding for distinguishing voiced, voiceless and nasal features of speech. Cornett (1967) described a method of speech instruction using a set of cued hand formations. Pronovost, et al (1968) discussed the use of electrovisual indicators as an aid for speech development.

Berg (1968) proposed a combination of promising sensory speech aids for teaching intelligible speech to hearing impaired children. These included a hearing aid, which amplified low audio-frequency energies; electro=visual indicators; a mirror; tactile aids; written notations; and illustrations of articulatory maneuvers.

O'Connor (1945) felt that the teaching of speech was the most difficult educational activity in the curriculum. Systematic instruction in speech typically has not been effective in the alleviation of the misarticulations of the speech of the deaf and severely hearing impaired.

## Behavior Modification

A promising development, which has meaningful application to the modification of defective articulation by hearing impaired children, is behavior modification. Recently, behavioristic methods have gained interest and support as a therapeutic approach to the treatment of speech disorders. Behavior modification refers to that group of learning based theory which can effectively be applied to human behavior, and includes both classical and operant procedures (Gray, 1969).

Operant procedures were formulated through the experimental laboratory work of Skinner (1953), which dealt with the relationship between changes in the environment and changes in an organism's responses. As a result of his experimental work, Skinner viewed behavior in terms of Stimuli, response and consequence. He developed a three-term, contingency paradigm which describes a relationship between a response, the reinforcement which is contingent on that response, and the occasion upon which the response occurs.

The three-term contingency may be represented symbolically as: $S^D \; . \; . \; . \; . \; R \rightarrow S^r$. The first term, $S^D$, represents the discriminative stimuli present; the second term, R, represents the specific response; and the final term, $S^r$, represents the reinforcing stimulus which follows the response (Ferster and Perrott, 1968).

The previous relationship implied that if in the presence of a given stimulus, a given response results in positive reinforcement, the frequency of that response increases. Under these circumstances an organism not only becomes more likely to emit the response which achieves reinforcement, but it also becomes highly probably that it will emit the response in the presence of the prior stimulus. Thus, response probability is a function of both the stimulus occasion on which the response occurs and the consequence the response produces (Ferster and Perrott, 1968). Skinner found that the strength of a response can be controlled just as the strength of stimuli can be controlled. He called his procedure "operant conditioning."

Stimulus control

When a speech clinician desires to modify some aspect of the human speech repertory, an effective procedure also is to make use of stimulus control of verbal behavior (McLean, 1967). Skinner (1957) emphasized the importance of prior stimuli in the control of verbal behavior. He considered prior stimuli important because of their entry into a three term contingency of reinforcement that is a property of the environment. He noted that in the presence of a given stimulus, a given response was characteristically followed by a given reinforcement.

Skinner (1957) classified verbal responses according to various controlling stimuli. He designated some of the more common responses as follows: (1) tact; (2) echoic; (3) textual; and (4) intraverbal. In tact behavior the stimulus which controls the response is usually nonverbal, and is some object or event which increases the probability that a desired vocal response will be emitted. For example, the presence of a piece of cheese will increase the probability that an individual will emit the word "cheese." In echoic behavior the prior stimulus is an auditory-visual stimulus presented for an individual to imitate. Textual behavior is preceded by written word or picture stimuli. An intraverbal response is prompted by a series of words designed to evoke a desired verbal behavior. For example, "Mice like to eat (cheese) ."

McLean (1967) has listed some items that the speech clinician can attain through use of stimulus control. First, he can obtain any specific vocal behavior he desires to modify. For example, the probability that the phoneme / t / will be produced is increased by presenting an individual with the picture of a top. Secondly, the clinician can choose evoking stimuli that increase the relative probability that a response emitted by an individual will be correctly articulated. Third, emission of the response is extended to situations in which the probability of occurrence is low.

McLean (1967) observed that the stimulus condition controlled the general nature of a response that an individual emits. He stated that different stimuli increase or decrease the probability of the occurrence of correct or incorrect responses. McLean emphasized that shifts in stimulus control were the basic procedures by which a new response was generalized toward correct usage in the general environment.

McLean (1967) designed a study to investigate the use of a behavioristic approach to modify one aspect of the articulation of five high-level mentally retarded individuals. His subjects consistently substituted one phoneme for another. For example, one subject substituted the phoneme / w / for the phoneme / l /. The program was designed to transfer a correctly articulated response from the control of auditory-visual stimuli to the control of picture, printed word, and intraverbal stimuli. For each subject, ten words were selected which required production of the misarticulated phoneme in the initial position. For the subject mentioned above, McLean selected ten words which required production of the phoneme / l / in the initial position. Skinner's three-term reinforcement contingency was then utilized to establish correct responding in the presence of the auditory visual stimuli.

Four of the five subjects completed McLean's program, and were able to articulate their experimental phonemes correctly under all stimulus conditions. Three of the four subjects that finished the program no longer substituted untrained phonemes for their trained phonemes. This fact was true, however; only whenever the trained phoneme was required in the same word position in which it was trained. For example, the above mentioned subject no longer substituted the untrained phoneme / w / for the trained phoneme / l / whenever the phoneme / l / was required in the initial position of a word. If a subject was required to produce the phoneme / l / in the medial position of a word, he would then substitute the phoneme / w / for the phoneme / l / as he had done before the training program.

McLean found that the three subjects, who no longer substituted untrained phonemes for trained phonemes, now tended to overgeneralize. That is, they now substituted trained phonemes for untrained phonemes in words that required the untrained phoneme to be produced in the initial position of a word. For example, the above mentioned subject now incorrectly substituted the phoneme / l / for the phoneme / w / in words which correctly required production of the phoneme / w /.

White (1968) patterned a study after McLean's program, and was able to modify one aspect of the articulation of a severly hearing impaired child. Before participation in the training program, White's subject consistently substituted the phoneme /ʃ/ for the phoneme /tʃ/. Upon completion of the study, the subject no longer made the original substitution error; but did overgeneralize as had the subjects in McLean's study.

The present study was designed to modify McLean's technique, and to utilize it in an attempt to modify the articulation of a severely hearing impaired child. Unlike the McLean (1967) and White (1968) studies, the present training program required differential responding between the trained and untrained phonemes. This was provided in an attempt to prevent the subject from overgeneralizing upon completion of the training program.

Other than experimental educational work with hearing impaired individuals who were mentally retarded or emotionally disturbed, little reference is made in the literature in regard to the use of behavior modification techniques to modify the speech of the hearing impaired. However, a study by Holbrook (1968) is significant. He devised a system designed to modify vocal frequency and intensity through the application of reinforcement principles. He successfully modified, toward normal levels, the vocal pitch of five deaf or severely hearing impaired individuals. He demonstrated that behavior modification techniques can modify an undesirable aspect of hearing impaired speech.

# PROCEDURES

The teaching of speech skills to the deaf and severely hearing impaired has been approached by various remedial methods. These methods have been successful in varying degrees, but they typically have not enabled the deaf and severely hearing impaired to obtain highly intelligible speech. The behavior modification model may provide the basis for a break through in this difficult area of education. A series of studies in the application of the model to the teaching of speech skills to the deaf and severely hearing impaired may have far reaching beneficial effects.

The purpose of this study was to evaluate the use of an operant conditioning training program in the modification of the /TS/ articulation of one severely hearing impaired individual. The procedures described in this chapter include selection and description of subject, preparation of speech stimuli, and presentation of the remedial tasks.

## Selection of Subject

### Descriptive information

The subject used in this study was a male residential student enrolled in the entermediate department of the Idaho school for the Deaf. Descriptive information concerning the subject is provided in table 2.

The subject's general IQ as measured by use of the Chicago Non-Verbal Examination, was 114. His reading and academic achievement composite was fourth grade.

The subject demonstrated extensive leadership ability in the classroom, and had a good relationship with his peers. Teachers and dormitory supervisors found him to be cooperative at all times.

Table 2. Descriptive information about the subject

| Age | IQ | Hearing loss in dB (BBA) | Metropolitan Achievement Scores[b] | | Templin-Darley Articulation age[c] |
|---|---|---|---|---|---|
| | | | Reading | Academic composite | |
| 11-7 | 114 | 88 | 4.4 | 4.41 | 4.0 years |

[a]IQ measured by Chicago Non-Verbal Examination one year prior to study.
[b]Test administered one week prior to study.
[c]Test administered one week prior to study.

Audiological information

The subject's parents were realistic and had accepted their child's auditory handicap. They had provided little, if any, direct academic assistance, but did express considerable interest in their child's academic achievements. The subject had attended the Idaho State School for the Deaf since he was six years old.

The experimenter administered several standard audiometric tests to the subject. The data may be seen in figure 1. His pure tone thresholds indicated a bilaterally symmetrical loss of 88 to 90 dB, depressed precipitously in the higher frequencies. Pure tone air conduction thresholds were slightly better in the right ear than in the left ear. Bilateral air-bone gaps from 25 to 30 dB were shown when sensitivity for pure tones was measured by bone conduction. Thus, the information indicated that the subject had a mixed loss in both ears.

Speech reception thresholds were measured using spondaic stimuli. The speech reception thresholds were 85 dB for the left ear and 90 dB for the right ear. Thus, the pure tone averages and the speech reception thresholds were in good agreement. The results indicated that the subject had a severe hearing impairment. School records indicate the subject had a congenital hearing loss. He had worn a bilateral body aid since he entered the Idaho School for the Deaf.

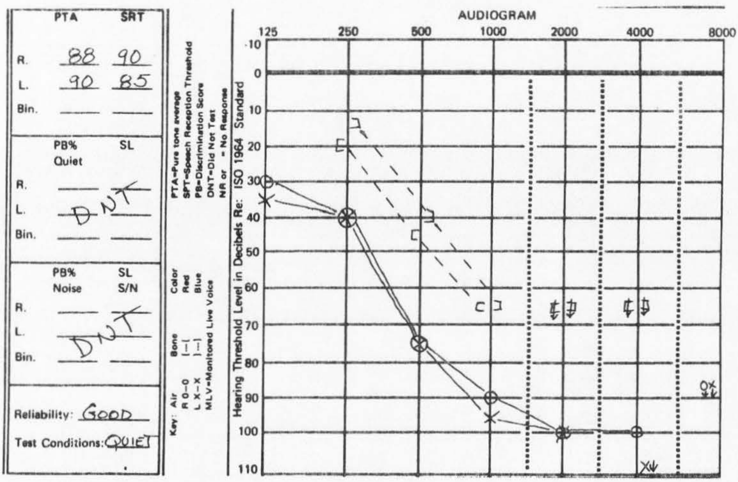


Figure 1. Results of audiometric testing

The experimenter was unable to accurately test the subject's ability to discriminate comfortably loud speech. The PB words used to test discrimination of comfortably loud speech are relatively difficult to understand, and persons with limited auditory systems have difficulties no matter how high the intensity (Hirsh, 1952).

Articulation testing

To determine detailed information about the subject's articulation skills, the 1960 Templin-Darley Diagnostic Test was administered. The test consisted of 176 items, and included the English phonemes in a variety of phonetic contexts. Articulation skills seem to mature in the normal child at eight years of age, and it seemed likely that any sounds the subject was misarticulating were those which he could not hear and/or perceive.

The test results are summarized in Table 3. (See appendix for detailed information.) They reveal that the subject could produce 120 of the 176 items correctly, and that he had considerable potential for speech improvement. According to test norms, the subject's articulation was typically that of a four year old normal hearing male. His speech was noticeably nasal, and he had numerous errors of prosody.

Communicational abilities

Dependent upon communicational need, the subject used speech, the language of signs, and fingerspelling in conversing with others. His written language, although defective, was understandable. The errors noted in his written work were typical of the deaf population. He used short choppy sentences, and his speech was often unintelligible, and his oral reading was always difficult to understand. Articles and plural endings were often omitted during oral reading sessions.

Criteria for selection

Specifically, the subject met the following criteria for selection: (1) at least one phoneme defective in the initial, medial, and final positions on presentation of the Templin-Darley Articulation Test; (2)

correct imitation of the isolated form of a phoneme that was defective in spontaneous speech. This imitation occurred after the presentation of an auditory-visual stimulus no more than five times by the experimenter; (3) at least an educable level of intelligence as determined by use of the Chicago Non-Verbal Examination, and (4) a willingness to cooperate in the experiment.

Table 3. Articulation skills of the subject as measured by the Templin-Darley Test of Articulation

| Speech Sound Types | Test Production |
|---|---|
| Vowels and Diphthongs | 16/18 correct; distortion of /ɔ/ and /ɔɪ/ |
| Semivowels (v, l, y, w) | 9/9 correct |
| Nasals (m, n, ng) | 5/8 correct; distortion of n and ng |
| Plosives (p, b, t, d, k, g) | 13/16; d/t(I,M), distortion of t(F) |
| Fricatives (f, v, th, TH) | 10/12 correct; distortion of ð (M) and θ (M) |
| Affricatives (Tʃ , j) | 1/5 correct; ʃ/Tʃ (I,M,F) |
| Sibilants (s, z, ʃ, ʒ) | 5/11 correct; distortions s(F); z (I,F); ʃ (M,F); and ʒ (M,F) |
| Blends (e.g.: pl, pr, str) | 56/94 correct; omission of t; some distortions and many omissions |

The response selected for modification was a substitution of / ʃ / for / Tʃ /. The subject was able to correctly imitate the isolated form of the / Tʃ / phoneme. The experimental training program was designed to shift the correct production of the / tʃ / phoneme from the isolated form to contextual speech.

## Tests and Tasks

### Training conditions

Ten different words, initiated with the / tʃ / phoneme, were chosen which evoked the misarticulated / tʃ / phoneme. Two additional words, initiated with the / ʃ / phoneme, were chosen which evoked the substituted / ʃ / phoneme. These two / ʃ / words were included to require differential responding between the / tʃ / and / ʃ / phonemes. The materials included twelve stimulus pictures and twelve cards with the stimulus words written on them in manuscript print. Table 4 lists words used to evoke responses in the entire study. The stimulus pictures were taken from magazines and mounted on cardboard. Twelve short phrases were written in manuscript on small cards to evoke these same twelve words as responses to intraverbal stimuli.

Throughout the training program, each articulation response was followed by immediate positive reinforcement. In this study, the positive reinforcer was a poker chip delivered in a shallow box by the experimenter. At the close of each training session, the subject was allowed to redeem his chips for money at the rate of five chips for one penny.

Table 4. Words used to evoke responses

| Pre-Post Tests | Training Conditions | New Item Test | Across-position Test | Generalization Test |
|---|---|---|---|---|
| Chair | Chair | Chain | Catch | Shark |
| Check | Check | Chalk | Hatch | Sharp |
| Cheek | Cheek | Chart | Latch | Ship |
| Cheese | Cheese | Chest | Patch | Shoot |
| Cherry | Cherry | Chick | Watch | Shower |
| Child | Child | | | |
| Chimney | Chimney | | | |
| Chin | Chin | | | |
| Chip | Chip | | | |
| Chocolate | Chocolate | | | |
| | *Shirt | | | |
| | *Shoe | | | |

*Differential response words

Tests of generalization after training

New item generalization. Five cards with new words written on them in manuscript print were developed. In the new words the trained phoneme appeared in the initial position of each new word.

Across-position generalization. Five cards with new words written on them in manuscript print were developed. In the new words the trained phoneme appeared in the final position of each word.

Overgeneralization. Five cards with new words written on them in manuscript print were developed. The new words evoked the substituted phoneme in the initial position.

## Presentation

The operant conditioning training program was structured in a sequence of four training conditions. Each condition had a specified terminal level of performance that had to be met before the subject moved to the next condition. The training program was designed to generate a correct articulation response in words under the echoic stimulus-type and then to shift his response to the control of the other three stimulus-types in succession. When the subject reached final criterion on the fourth condition, the training aspect of the study was completed.

Pretest

The subject's responses to ten training words, each of which evoked the misarticulated /tʃ/ phoneme, were recorded twenty-four hours before the training sequence started. The responses were evoked under all four stimulus conditions. There was no reinforcement contingent on any of the responses in this test. The responses on this test represented baseline responses to these stimuli before the onset of training.

Training program

The four training conditions and their criteria are presented in general terms.

Condition one. Twelve words were presented one by one as auditory-visual models ($S^1$). The examiner was seated across a table from the subject. Ten of the words evoked the misarticulated /tʃ/ phoneme, and two of the words evoked the substituted /ʃ/ phoneme. The two /ʃ/ words were included to provide differential responding between /tʃ/ and /ʃ/. The subject was instructed to watch the examiner, to listen to the word spoken by the examiner, and then to say the word which had been presented to him. Correct articulation responses to all stimuli were followed immediately by positive reinforcement. Incorrect responses did not receive reinforcement of any kind. The stimuli were presented in repeating blocks of twelve words until the subject made correct articulation responses to /tʃ/ stimuli in at least 50 percent of the words in each of four successive blocks within the condition. When the subject had met the criterion, i.e. correctly articulated at least five words which evoked the /tʃ/ phoneme in each of four successive blocks, condition one was terminated. Condition one was designed to generate the correct response under one stimulus-type, echoic, and to bring the response into contact with the positive reinforcement contingency. Figure 2 shows a paradigm of condition one. $S^1$ represents the auditory-visual stimulus, R the correct response, and $S^r$ the positive reinforcer.

$$\begin{tikzcd} S^1 \arrow[r, dash] & R \arrow[r, dash] & S^r \arrow[ll, bend right] \end{tikzcd}$$

Criterion = 50 percent correct on
four successive blocks

Figure 2. Paradigm of condition one

<u>Condition two</u>. The twelve auditory-visual models ($S^1$) were presented to the subject as in condition one. The subject was again instructed to watch the examiner, listen to the word spoken by the examiner, and to say the word presented to him. However, in condition two the experimenter presented a picture stimulus ($S^2$) simultaneously with the auditory-visual stimulus. The picture stimulus for each word was held just to the right of the experimenter's mouth as he uttered the $S^1$ model.

Correct articulation responses to all stimuli were followed immediately by positive reinforcement. The paired stimuli were presented in blocks of twelve words until the subject reached a criterion of 20 correct /tʃ/ responses in 20 attempts. After the subject had correctly articulated 20 consecutive words in the paired-stimulus conditions, the auditory-visual stimulus ($S^1$) was dropped and only the picture stimulus ($S^2$) was presented. Correct articulation responses were reinforced and these conditions continued until the subject had reached a criterion of at least 38 correct responses to /tʃ/ stimuli in 40 attempts.

Condition two was designed to shift the correct response from echoic control (auditory-visual) to textual control (picture). Figure 3 is a paradigm of condition two.

$$\begin{matrix} S^1 \\ S^2 \end{matrix} \longrightarrow R \longrightarrow S^r \longrightarrow S^2 \longrightarrow R \longrightarrow S^r$$

Cr= 20/20, i.e. 2 blocks    Cr= 38/40, i.e. 4 blocks

Figure 3. Paradigm of condition two

<u>Condition three</u>. Condition three duplicated condition two in procedure and criteria, but the stimulus-types differed. In condition three, the picture stimuli ($S^2$) and the printed word stimuli ($S^3$) were paired until the subject had emitted 20 correct responses in 20 attempts. When this criterion was achieved, the picture stimuli were no longer presented. Only the printed word stimuli ($S^3$) were presented, and correct responses were reinforced until the subject emitted 38 correct responses to /tʃ/ stimuli in 40 attempts.

In condition three, the experimenter presented the paired picture and printed word stimulus cards by placing the two stacks of cards face down, side by side on the table in front of the subject. Simultaneous presentation of each picture and printed word pair was achieved by exposing the face of each card of a given pair at the same time.

Condition three was designed to shift the control of the correct response from one type of textual control (picture) to another type of textual control (printed word). Figure 4 is the paradigm of condition three.

$$\begin{matrix} S^2 \\ S^3 \end{matrix} \longrightarrow R \longrightarrow S^r \longrightarrow S^3 \longrightarrow R \longrightarrow S^r$$

Cr= 20/20, i.e. 2 blocks    Cr= 38/40, i.e. 4 blocks

Figure 4. Paradigm of condition three

<u>Condition four</u>. Except for stimulus-types, condition four was identical to conditions two and three in procedures and criterion. The initial stimulus conditions in condition four paired the printed word ($S^3$) with the intraverbal stimuli ($S^4$). The subject was instructed to read a sentence in which a word was omitted. For example, one sentence was, "Mother paid the man with a <u>(check)</u> ." He read the sentence aloud, and inserted the omitted word. Just as the response word was needed by the subject to complete the verbal chain, the experimenter exposed the printed word card. The stimuli remained paired until the subject had emitted 20 consecutive correct responses to the paired stimuli. The printed word stimulus was then removed and the responses were evoked by the intraverbal stimuli only. When the subject had emitted 38 correct responses to /TS / stimuli in 40 trials, condition four was terminated.

Condition four was designed to shift the correct response from the printed word stimulus (textual) to an intraverbal stimulus-type. Figure 5 is the paradigm of condition four.

$$\genfrac{}{}{0pt}{}{S^3}{S^4} \longrightarrow R \longrightarrow S^r \longrightarrow S^4 \longrightarrow R \longrightarrow S^r$$

Cr= 20/20, i.e. 2 blocks          Cr= 38/40, i.e. 4 blocks

Figure 5. Paradigm of condition four

Intra - training probes

When the subject's correct responses were emitted at the criterion level associated with acquisition of a given stimulus type, his unreinforced responses to the stimulus type which was to be introduced in the succeeding condition were recorded. For example, a picture of a piece of cheese was presented to the subject to evoke the word "cheese" before any training by use of the stimulus type. Thus, a probe test on $S^2$ was made after the subject had reached criterion on $S^1$, and other probes were made on $S^3$ and $S^4$ after the subject had attained criterion on $S^2$ and $S^3$ respectively. The intra-training probe tests indicated the number of correct responses to untrained stimulus types, which occurred after training to criterion on a preceding stimulus type.

Post-test

The subject's responses to the ten training words, which evoked the misarticulated /*TS*/ phoneme, were recorded twenty-four hours after the conclusion of training. The responses were evoked under all four stimulus conditions. There was no reinforcement contingent on any of the responses in this test. The responses on this test represented the operant-level responses to these stimuli after training had been completed.

A comparison of the data on the pretest and the post-test reflected change in articulation response which occurred during the training program.

Tests of generalization after training

Immediately after administration of the post-training test, three brief tests of stimulus generalization were given to the subject.

New item generalization. Five cards developed for new item generalization were presented to the subject. On each card, a new ~~card~~ word was written in manuscript print. In each new word the /Tʃ/ phoneme appeared in the initial position. Responses to these new words were recorded and analyzed. If the subject articulated the initial phoneme in the new items correctly, new item generalization was considered to have occurred. No reinforcement was given during this test.

Across-position generalization. Five cards developed for across-position generalization were presented to the subject. On each card, a new word was written in manuscript print. In each word, the /Tʃ/ phoneme appeared in the final position. His responses were recorded and analyzed. Across-position generalization was considered to have occurred if the subject produced /Tʃ/ correctly in the new words. No reinforcement was given during this test.

Overgeneralization. Five cards developed for over-generalization were presented to the subject. Again a new word was written on each card in manuscript print. The new words evoked the /ʃ/ phoneme in the initial position. Responses were recorded and analyzed. Overgeneralization occurred if the subject produced /tʃ/ rather than /ʃ/. No reinforcement was given during this test.

Responses in all three of these tests were evoked under only one of the stimulus types which controlled responses after training. Printed word stimuli were chosen to elicit responses for these tests. These tests sampled the subject's ability to generalize responses to words other than those used in the training conditions.

Retention tests

One week following termination of the post-test and generalization tests, the subject was given the retention tests. The tests were designed to determine if changes had occurred in his responses after one week. Changes were identified by comparing the data from these retention tests with the data of the post-training tests and generalization tests presented twenty-four hours after training had been completed. The retention tests were identical to the post-training tests and generalization tests given earlier.

Duration of program

The pretest was administered on a Monday. On the following day condition one was presented, and an additional condition was presented each day thereafter through Friday. The post-test and generalization tests were presented on Saturday. One week later, the retention tests were given. Thus the entire study, including retention tests, covered a thirteen day period. All tests and training sessions were conducted between 12:45 and 1:15 each day.

# RESULTS AND DISCUSSION

The speech of the severely hearing impaired is defective if not unintelligible. Educators of the severely hearing impaired continue to express interest in all methods that might prove beneficial in the modification of the speech of these individuals. An operant conditioning program was designed in an attempt to modify the articulation of a severely hearing impaired child. The training program was structured in a sequence of four training conditions. Pre-training tests, training tasks, intra-training probe tests, post-training tests, stimulus generalization tests, and retention tests were administered. Each test and training program will be reported and discussed in this section of the thesis.

## Pre-training tests

The subject's responses on each test given under each stimulus condition prior to the training program are shown in Table 5.

Table 5. Correct /tʃ/ articulations evoked by four types of stimuli prior to training

| Stimulus-types | | | |
|---|---|---|---|
| $S^1$ Echoic | $S^2$ Picture | $S^3$ Printed Word | $S^4$ Intraverbal |
| 0 | 0 | 0 | 0 |

The data in Table 5 show that the subject did not articulate his training phoneme correctly in any of the stimulus conditions prior to the training program.

Training program

Figure 6 shows the number of correct responses for each training block in each of the four training conditions. The graph begins with the correct responses made in condition one, and proceeds to report the number of correct / TS / articulations for each block of words until the subject reach~~ing~~es criterion in the second stage of condition four. This was the final condition of the training program. When a final criterion was attained within any condition, the change in conditions is indicated with a solid vertical line.

Figure 6 indicates that the subject attained the final criterion of the entire program after a total of 30 training blocks. A condition-by-condition analysis shows that the subject began block one with four correct / TS / responses. He remained at this inadequate level for the following five blocks. In the seventh block of condition one, the subject gave nine correct responses and was able to attain the 50 percent criterion of four successive blocks by the end of the tenth block.

During condition two the subject maintained a high level of correct responses when $S^1$ and $S^2$ were paired, and was able to meet criterion after only three blocks of training words. After 20 consecutive correct responses in blocks twelve and thirteen, the support of the $S^1$ stimuli was removed and the responses were evoked by $S^2$ alone. The initial responses on $S^2$ fell to seven correct and rose to eight correct responses on the next block. The following three blocks showed ten correct

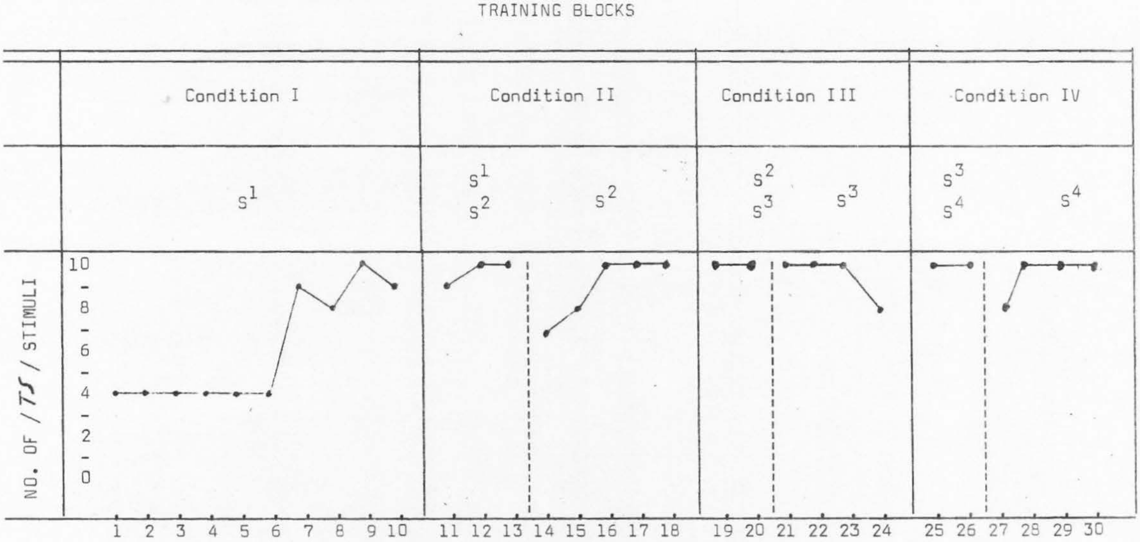


Figure 6. Number of correct / TS / articulations in 10 presentations for each of 30 training blocks; occurring among the 4 stimulus conditions

responses, and the subject thus met the criterion of 38 correct responses in 40 attempts.

During condition three the subject again maintained a high level of correct responses to the pairing of stimuli. $S^2$ and $S^3$ were paired and he gave 20 consecutive correct responses in blocks nineteen and twenty. The support of the $S^2$ stimuli was removed and the responses were evoked by $S^3$ alone. The subject also met criterion in the minimum number of blocks in the second part of condition three.

The subject quickly achieved criterion in both stimulus conditions in condition four. The criteria for this condition were again attained in the minimum possible number of blocks. The training aspect of the study was thus completed after a total of 30 training blocks.

The general trend in the training curve of the subject indicated that once an articulation response was brought under control of the echoic stimulus, its shift to other stimulus types was comparatively easy. The training program brought correct articulation under control of four different stimulus-types.

Differential response. The subject's response to the two words initiated with /ʃ/, in each of the thirty training blocks that required differential responding, are shown in Table 6.

Table 6. Correct / ʃ / articulations evoked by various stimuli during the four training conditions

| Evoking Stimulus | | | | | | |
|---|---|---|---|---|---|---|
| | $S^1$ | | $S^2$ | | $S^3$ | |
| $S^1$ | $S^2$ | $S^2$ | $S^3$ | $S^3$ | $S^4$ | $S^4$ |
| 20/20 | 6/6 | 10/10 | 4/4 | 8/8 | 4/4 | 8/8 |

The data in Table 6 show that the subject was able to correctly articulate the / ʃ / phoneme in all words which required that phoneme in the initial position. Thus, during the entire training program, he responded differently to the stimuli which evoked either the trained / tʃ / phoneme or the substituted / ʃ / phoneme.

Post-training tests

Twenty-four hours after the training program had been completed, post-training tests on each of the four stimulus-types were obtained. Table 7 shows the number of correct responses on the ten words in each of the stimulus conditions utilized in these tests.

Table 7. Correct /TS/ articulations evoked by four types of stimuli after training

| Stimulus-types | | | |
|---|---|---|---|
| $S^1$ | $S^2$ | $S^3$ | $S^4$ |
| Echoic | Picture | Printed Word | Intraverbal |
| 10 | 10 | 10 | 10 |

The data in Table 7 show that the subject was able to correctly articulate his training phoneme 100 percent of the time under control of each of the four training stimuli twenty-four hours after training had been completed. A comparison with the pretraining data, as noted in Table 5, reflects a 100 percent increase in correct articulation of the /TS/ phoneme as a result of the training program.

Intra-training probe tests

Table 8 shows the subject's ability to articulate the /TS/ phoneme correctly in stimulus conditions which had not been trained. These were presented after he had responded to criterion on the preceding stimulus-type.

The data in Table 8 indicate that the subject established an extremely high percentage of correct responses to untrained stimuli by the end of condition one. He maintained this percentage throughout the two following training conditions. Responses trained under one stimulus condition generalized to a high degree to new stimulus-types.

Table 8. Number of correct responses to stimuli before training

| Stimulus type | | |
|---|---|---|
| Pictures | Printed Word | Intraverbals |
| 9 | 10 | 10 |

Stimulus Generalization Tests

Table 9 shows the results of the three tests of stimulus generalization.

Table 9. Percentage of correct articulations of the trained response in new items which tested various types of stimulus generalization

| Types of Generalization | | |
|---|---|---|
| New Item | Across-position | Overgeneralization |
| 100 | 100 | 0 |

The subject showed: (1) complete generalization of the trained phoneme to new-word items which were initiated by the trained phoneme; (2) complete generalization of the trained response to new-word items in which the trained phoneme was required in the final position; and (3) no generalization of the trained response to new-word items which, if correctly produced, required the phoneme which the subject had substituted for the trained phoneme prior to training. The extremely high level of new-item generalization and across-position generalization by the subject appeared to indicate that articulation responses which were conditioned by the procedures of this study had a high level of operant emission. Introduction of differential response requirement at the initiation of training program appeared to have suppressed any inappropriate generalizations by the subject. It would appear that if McLean (1967) and White (1968) had included a differential response requirement in their studies, their subjects may not have overgeneralized on responses at the end of the training programs.

Tests of retention

Table 10 shows the percentage of correct responses of the trained phoneme in the various retention test conditions.

Table 10. Percentage of correct articulations on the trained response in printed word conditions on various tests one week after training

| Trained words | New item generalization | Across-position generalization | Over generalization |
|---|---|---|---|
| 100 | 100 | 100 | 0 |

The subject maintained the exact responses he emitted on the initial generalization tests, and maintained 100 percent articulation on the ten words on which he had been trained.

Summary

This study was designed to use behavior techniques to modify the articulation of a single phoneme produced by a severely hearing impaired individual. This was the phoneme $/T\int/$ which prior to the training experiment was typically substituted with the $/\int/$ phoneme in contextual speech. Analysis of the various tests revealed that the subject was trained by behavior techniques to articulate correctly the $/T\int/$ phoneme, which he had previously misarticulated. The training program brought the correct articulation response under the control of four different stimulus-types. Once the phoneme came under control of one stimulus-type, it tended to be readily shifted to other stimuli which had not evoked the response previously.

After the phoneme had been trained and was successfully emitted under all four stimulus-types, the subject tended to generalize the response to new items. The subject did not appear to over-generalize his trained phoneme to his old substitution phoneme.

The subject was able to articulate correctly the ten words on which he had been trained, one week after training. He also maintained his original generalization patterns. It cannot be assumed that the acquisition of the correct articulation of the $/T\int/$ phoneme will carry over into spontaneous speech or have any lasting effect unless a strategy for stabilization and habituation is successfully carried out.

# SUMMARY AND CONCLUSIONS

## Summary

A literature review has revealed that speech skills are important attributes for hearing impaired persons to possess. The speech of this handicapped group is seldom adequate and often contains defects of articulation, rhythm, quality, and pitch. Past speech instruction has not been completely effective in the alleviation of defects, and unintelligible speech often remains. Behavior modification is a promising development which may make a major impact upon the teaching of speech skills to hearing impaired children.

In the present study an operant conditioning training program was designed to modify one aspect of the articulation of one severely hearing impaired child enrolled at a residential school for the deaf. Specifically, the /tʃ/ typically substituted with the /ʃ/ was selected for modification. The training program was structured in a sequence of four training conditions. These conditions were designed to generate a correct articulation response to words under a specific stimulus-type and then to shift the response to the control of three other stimulus-types. Instructional materials were developed to generate responses under the desired stimulus types. Pre-post tests were administered prior to and following the training program. Generalization and retention tests were also administered after completion of the post-tests.

## Conclusions

Conclusions that may be drawn from the results of this investigation are as follows:

1. The use of an operant conditioning training program was an effective method by which the articulation of a severely hearing impaired subject could be modified. After the training program, the subject properly articulated a phoneme that previously he did not articulate correctly.

2. After the subject was trained and could articulate the /Tʃ/ phoneme under the four stimulus-types used in the training program, he was able to generalize correct responses to new words that were not part of the training program.

3. Articulation responses which were trained by the procedures used in this study tended not to overgeneralize to other words which did not require the trained phoneme. For example, the subject did not overgeneralize his trained phoneme /Tʃ/ to his old substituted phoneme /ʃ/.

4. Articulation responses trained by the procedures used in this study did generalize to words requiring the trained phoneme in a position different from that in which it was trained. Although the subject was trained on words initiated with /Tʃ/, he was later able to correctly articulate words ending with /Tʃ/.

5. The responses and generalization patterns acquired in the training program were maintained for at least one week.

## Practical Application

If used along with conventional therapies, procedures utilized in this study may prove to be a practical tool with which the speech of the hearing impaired may be modified. As noted earlier, conventional therapies utilized by speech clinicians and educators of the deaf have not proved to be totally effective in the modification of the speech of the hearing impaired. At the Idaho School for the Deaf, the school speech clinician is presently using some behavioristic methods in her therapy that are quite similar in nature to the procedures followed in this study. Additional experimental work with ideas utilized in this study may provide therapeutic techniques that may prove to be of a beneficial nature.

## Suggestions for Further Studies

This study seems to suggest the need to conduct additional investigations into the use of stimulus manipulation to modify the articulation of hearing impaired individuals.

1. One study might be an extension of the present procedure to include the use of additional defective speech sounds.

2. Another might include the use of a large enough group of subjects to allow statistical analysis of data.

3. A third study might incorporate follow-up by teachers and houseparents to require proper production of phonemes stabilized in therapy. The experimenter noted that the subject in the present study often inconsistently produced the trained /tʃ/ phoneme in any environmental situation that excluded the experimenter. Communication between the experimenter, teachers, and houseparents of the subject might have pre-

cluded this lack of transfer and in turn the inconsistencies in the production of trained speech sounds might have been effectively eliminated.

4. A fourth study might be a comparison of the use of this modified McLean procedure and other more conventional therapies for the modification of speech behavior in clinical and educational curricula.

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APPENDIX

Results of the Templin-Darley Diagnostic Test of Articulation

Key: Mark correct sound (✓); substitutions with sound substituted; omitted sounds (-); distorted sounds (x); no response (nr).

| | | I | M | F | | Syllabic | Non-Syllabic ɚ | Other 2-element Blends |
|---|---|---|---|---|---|---|---|---|
| 1. i ✓ | 19. m | ✓ | ✓ | ✓ | r-blends | | | |
| 2. ɪ ✓ | 20. n | ✓ | ✓ | X | 44. pr- ✓ | 53. -mɚ ✓ | 64. -ɚm Xm | 109. tw- ✓ |
| 3. ɛ ✓ | 21. ŋ | | X | X | 45. br- ✓ | 54. -nɚ ✓ | 65. -ɚn Xn | 110. kw- ✓ |
| 4. æ ✓ | 22. p | ✓ | ✓ | ✓ | 46. tr- ✓ | 55. -pɚ ✓ | 66. -ɚp ✓ | 111. -zm ✓ |
| 5. ʌ ✓ | 23. b | ✓ | ✓ | ✓ | 47. dr- ✓ | 56. -bɚ ✓ | 67. -ɚb ✓ | 112. -ŋk ✓ |
| 6. ə ✓ | 24. t | d | d | X | 48. kr- – | 57. -tɚ -ɣ | 68. -ɚt ✓ | 113. -dʒd dʒx |
| 7. ɜ ✓ | 25. d | ✓ | ✓ | ✓ | 49. gr- ✓ | 58. -dɚ ✓ | 69. -ɚd ✓ | 114. -mp ✓ |
| 8. e ✓ | 26. k | ✓ | ✓ | ✓ | 50. fr- ✓ | 59. -kɚ ✓ | 70. -ɚk ✓ | 115. -nt n- |
| 9. a ✓ | 27. g | ✓ | ✓ | ✓ | 51. θr- ✓ | 60. -gɚ ✓ | 71. -ɚg ✓ | 116. -nd ✓ |
| 10. ɔ X | 28. r | ✓ | ✓ | | 52. ʃr- ✓ | 61. -fɚ pɣ | 72. -ɚf ✓ | 117. -kt kx |
| 11. ʊ ✓ | 29. l | ✓ | ✓ | ✓ | | 62. -ðɚ ✓ | 73. -ɚθ ✓ | 118. -pt px |
| 12. u ✓ | 30. f | ✓ | ✓ | ✓ | | 63. -ʃɚ ✓ | 74. -ɚtʃ ʒʃ | 119. -ft f- |
| 13. ju ✓ | 31. v | ✓ | ✓ | ✓ | | | 75. -ɚdʒ ʒX | 3-element blends |
| 14. oʊ ✓ | 32. θ | ✓ | X | ✓ | l-blends | 81. -pl̩ ✓ | Vowel l 88. -lp ✓ | 120. spl- -pl |
| 15. aʊ ✓ | 33. ð | ✓ | X | ✓ | 76. pl- ✓ | 82. -bl̩ ✓ | 89. -lb xb | 121. spr- ✓ |
| 16. eɪ ✓ | 34. s | ✓ | ✓ | X | 77. bl- ✓ | 83. -tl̩ dl̩ | 90. -lt xt | 122. str- s-r |
| 17. aɪ ✓ | 35. z | X | ✓ | X | 78. kl- ✓ | 84. -kl̩ ✓ | 91. -lk ✓ | 123. skr- s-r |
| 18. ɔɪ X | 36. ʃ | ✓ | X | X | 79. gl- ✓ | 85. -gl̩ ✓ | 92. -lf ✓ | 124. skw- s-w |
| | 37. ʒ | | X | X | 80. fl- ✓ | 86. -fl̩ ✓ | 93. -lθ ✓ | 125. -kst ksx |
| | 38. h | ✓ | ✓ | | | 87. -sl̩ ✓ | 94. -lz lX | 126. -mpt mpx |
| | 39. m | ✓ | ✓ | | s-blends 95. sm- ✓ -sm xm | | | 127. -mps mp- |
| | 40. w | ✓ | ✓ | | 96. sn- xn | | ɚ, ɝ, and vowel l with blends | 128. -ntθ ntx |
| | 41. j | ✓ | X | | 97. sp- ✓ -sp ✓ | | | |
| | 42. tʃ | ʃ | ʃ | ʃ | 98. st- s- -st s- | | 102. -stɚ sxr | |
| | 43. dʒ | ✓ | ✓ | x | 99. sk- ✓ -sk sx -ks xs | | 103. -skɚ sxr | 106. -ŋkl̩ ✓ |
| | | | | | 100. sl- ✓ | | 104. -mbɚ ✓ | 107. -ŋgl̩ ✓ |
| | | | | | 101. sw- ✓ | | 105. -ɝst ɝx | 108. -lfθ lfx |

VITA

Walter E. White

Candidate for the Degree of

Master of Science

Thesis: Stimulus Manipulation in Articulation Therapy With a Hearing Impaired Child.

Major Field: Communicative Disorders (Educational Audiology)

Biographical Information:

Personal Data: Born at East Springfield, Ohio, September 11, 1939. son of Samuel D. and Amanda E. White; served in the United States Air Force 1958-1962; married Julianne Steed June 10, 1966; two children, Sharlyn and Matthew.

Education: Attended elementary school in Wintersville, Ohio, graduated from Wintersville High School in 1957; received the Bachelor of Science degree from Utah State University with a major in Elementary Education with a minor in Science, in 1966; completed requirements for the Master of Science degree, specializing in Educational Audiology at Utah State University in 1972.

Professional Experience: Worked as member of diagnostic teams in Out-Patient Clinic and Indian Clinic at Utah State University, 1968, Educational Audiologist for the Idaho State School for the Deaf and Blind, 1968 to present.