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An Investigation of the Identification of One's Own Voice by Speech Defective and Normal Speaking Children

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CHAPTER I

INTRODUCTION

The purpose of this study is to test the vocal self-identification ability of children with functional defects of articulation as compared to children with normal speech. An attempt has been made to determine whether the functional articulatory defective child is able to distinguish his recorded voice from voices of other children who possess no articulatory defects.

A child who is said to be articulatory defective can be described as one who does not form or produce all of the speech sounds in the usual accepted manner. Functional articulation disorders (dyslalias) differ from organic articulation disorders (dysarthrias) in that the former are due to no known organic defect; whereas the latter are due to physical anomalies of the speech organs or defects of the central nervous system. For the purpose of this study no organic articulatory defective children were used as subjects.

This study was undertaken, firstly, to investigate whether or not there is any difference in the auditory self-perceptual ability of children with speech defects and those with normal speech. Since auditory perceptual abilities are factors necessary to the production of adequate speech, the results of this study could prove helpful in the treatment of the functional articulatory defective individual. In that auditory
self-perceptual abilities permit the speaker to monitor and modify his speech, they are necessary components of correct articulation. If the defective speaker does not hear or perceive his voice as others hear or perceive theirs he is said to have faulty self-hearing or auditory perception. In order for retraining to be successful, the person with faulty self-hearing or auditory perception must first have a correct sound standard to match. Therapy, therefore, depends largely on the speaker’s ability to hear and monitor his own speech output.

Secondly, this study was undertaken because of the widespread conflicts of opinion among authorities regarding the role of auditory perceptual factors in relation to speech development. Although a considerable amount of research has been carried out concerning functional articulatory defects, there is still an apparent need for further investigation of auditory perceptual factors.

Related Studies

A large portion of the research dealing with functional articulatory defective children is concerned with their auditory perception and the relation of hearing and its impact upon the development of speech. Travis and Rasmus,¹ in 1931, said:

There is a close relationship between hearing and the development of speech. If auditory acuity is so essential for proper speech development we may rightly expect

a more complex organization in the auditory field to be an important factor as well.

It is in the area of auditory perception that many writers believe speech defects have their beginnings. Van Riper\textsuperscript{1} states that:

In our opinion it is in this area that most of the causes of articulation defects occur, but we have to admit that most of the research does not support that opinion. Studies of auditory memory span and of auditory discrimination have generally failed to show marked differences between groups of normal speakers and articulation cases.

Although research has not found many differences between the normal speaker and the speech defective, there appears to be an auditory inadequacy which enables the speech defective to continue speaking without monitoring his speech as defective and making the needed changes. Along similar lines, Mange\textsuperscript{2} says:

Audition normally serves as the principal controlling unit in the speech servo-system, the motor aspect being subject in large part to the command of audition...one of the principal causative factors in certain functional articulatory defects is the presence of some auditory deficiency or immaturity which permits continued defective articulation beyond the normal development period.

It is interesting to note that often the speech defective who cannot hear his own error in articulation can tell instantly


when someone else makes the same error. In the normal perception system the speaker hears himself when he talks and continually monitors and changes the speech output as different situations present themselves. Fairbanks,\(^1\) discussing the speech mechanism as a servo-system, suggests:

The 'monitoring' interpretation, [of audition] also suggests that the ear is a receiver in a listening system rather than a component of a speaking system. There appears to be a portion missing or a malfunction of the system which prevents accurate feedback or interpretation of the stimulus received. Van Riper and Irwin\(^2\) report that "in the person with defective speech some of these circuits may not be opened". The person who hears other's errors but not his own has, according to Van Riper and Irwin,\(^3\) "a functioning inter-personal auditory circuit but a non-functioning or inefficient intra-personal auditory circuit". For this phenomenon to operate properly other senses may be fed into the servo-system to complete the circuit. Sensory stimulation, other than auditory, often offers additional cues to the attempt at sound production. Milisen\(^4\) supports this position — that in speech

---


\(^3\)Van Riper and Irwin, loc. cit., p. 113.

therapy, **Integral Stimulation**, which emphasizes visual and kinesthetic as well as auditory aspects of a sound, is more effective than the more traditional Stimulus Method, which is primarily an auditory approach.

To introduce or strengthen a sound, the added sensory impact serves as a reinforcing agent to cement the method of producing the sound in the circuit of speaking and perception of speech. Mange\(^1\) supports this by stating that:

Many functional articulatory defectives are completely unaware of their speech deviation until some awareness develops through the reactions of the auditors, that is, the speaker does not recognize articulation deviations which are readily apparent to others.

Because of this lack of attention of the speech defective to self-hearing, Van Riper,\(^2\) Bryngelson,\(^3\) and Ainsworth\(^4\) have emphasized the need of ear training. In summary of other research in this area, Mysak\(^5\) reports that:

Normal efficient oral communication depends upon the simultaneous integration of acoustical-temporal as well as visual-spatial phenomena and not, as sometimes believed, on acoustical-temporal phenomena exclusively.


\(^{2}\)Van Riper, op. cit., p. 235.


This adds support to Milisen's position that integral stimulation provides additional cues which the speech defective can use in selecting proper responses to the auditory circuit. Despite dichotomies and the general negative tone of these research findings, Van Riper adds that:

Most clinicians feel that their articulation cases need a great amount of training in auditory perception, in sensing the location of the focal articulation points, in feeling where the tongue is and what it is doing.

Speech combines the functions of many senses of all modalities operating at an efficient level in addition to motor involvements to carry out the sound production. West, Kennedy and Carr say that:

The factors underlying articulation are both sensory and motor. They are: (1) The acuity to and the discrimination among, sounds of high frequency. Judging from the order in which sounds are learned, one of the most important factors in the development of speech is the ability to hear and to distinguish faint sounds of high pitch. When this function of hearing is late in forming, it would be better for the individual if all the other factors were also late; for although speech would be late in developing it would not be defective when it did develop. (2) Memory span for individual speech sounds. The span for memory for individual speech sounds is also auditory but not so directly sensory as the first. All sounds are at first quite meaningless to the child. (3) A third factor conditioning the development of articulate speech is speed of movement of the articulatory muscles. (4) Specialization of movement. The functions of speech require such

1 Milisen, op. cit., p. 11.
2 Van Riper, op. cit., p. 195.
definite localized movements of the muscles of the
face, tongue, throat, larynx and respiratory apparatus
that development of speech must wait upon the ability
of the child to cause one group of muscles to act and
the others to remain inactive.

The final step in ear training is that of discrimination,
and if the preceding types of ear training have been carried
out it should not be difficult. According to Van Riper,¹

Discrimination consists of comparing and controlling
the correct and incorrect sounds, both in isolation
and in incorporation within regular speech.

Memory span, vocal synthesis ability, auditory discrimi-
nation, and auditory perception are factors of importance,
specifically, in that they contribute much to auditory skills
in general. The auditory perceptive mechanism is thought of
by Davis² as "an acoustic analyser which is superior to all
others as a speech monitoring system". Judson and Weaver³
indicate that the speech sounds which are produced are:

...received and interpreted by the higher centers of
the brain. This fact implies the consideration of
speech sounds as acoustic phenomena and involves: the
physics of sound in general, the anatomy and function-
ing of auditory mechanisms, its limitations and possi-
bilities; problems of auditory range, carrying power,
pitch, volume, resonance, pressure patterns, and the
ability to distinguish between sounds; and lastly the
whole problem of the effect of hearing upon speech as
it concerns sound changes in the language, the learning
of speech by the child and the development of speech
defects.

¹Van Riper, op. cit., p. 232.
²Davis, Hallowell L., "Auditory Communication." Journal
of Speech and Hearing Disorders, XVI (1951), 5.
³Judson, Lyman S. and Weaver, Andrew T., Voice Science.
The ability to discriminate between speech sounds is a factor in normal speech development. Several factor analysis studies have been carried out to isolate basic auditory abilities. Solomon et. al.\(^1\) found that abilities or factors such as "pitch quality discrimination, loudness discrimination, memory span, and synthesis analysis" were contributors to auditory perception. Perceptive skills of normal speaking children differ from those of defective speaking children. Travis and Rasmus\(^2\) say that:

The ability to discriminate speech sounds was found to be a significant factor in differentiating speech defectives from normal children.

Schiefelbusch and Lindsey\(^3\) report that in the children they tested:

The normal speaking group was found to have significantly better sound discrimination than their speech defective peers.

Speech sounds such as consonants, vowels, and words have been experimentally tested for secondary cues and influencing


\(^2\)Travis and Rasmus, op. cit., p. 225.

factors. Wang and Fellman\(^1\) investigated the effects of intrinsic secondary cues on consonant perception. They evaluated these influences which the consonant-vowel inter-effects have on the perception of the consonant. They found that:

Vowel amplitude, vowel nasalization and formant band are significant parameters in the vowels for identifying the consonant which precedes it.

Summers,\(^2\) who also tested perceptive skills in analyzing speech sounds from words, found that:

Sounds are perceived correctly most frequently when they appear in the initial position and vowels are perceived accurately more often than consonants and the voiced cognates more often than voiceless.

Wensley,\(^3\) in a study of the vocal synthesizing ability, found significant differences between groups of speech defective children and children with normal speech. He reports:

While it is apparent that vocal synthesizing ability improves with age, there appears to be a trend for the normal speaking children in grades one through four to demonstrate this ability at an earlier grade level than the articulatory defective subjects.


Roe and Milisen found that age was a factor, in that speech defects decreased in number and severity as age increased.

Mange investigated five auditory factors which he believes have not had a great deal of research devoted to them. These factors include:

...(1) pitch discrimination, (2) loudness discrimination, (3) timbre discrimination, (4) the rate at which a rapidly interrupted continuous auditory stimulus fuses perceptually and (5) the ability to recognize simple words from presentation of single component phonemes. (synthesis ability).

He found that synthesis ability was the only factor found to be significantly related to number of articulation errors and error type.

Metraux, in a study using all types of speech defectives, found auditory memory span for vowels slightly greater for speech defective than for normal speakers. Travis and Rasmus constructed a test of phonetic discrimination which consisted of 366 pairs of syllables. Each phoneme of the English language was paired with itself and each remaining phoneme in the language.

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1Roe, Vivian and Milisen, R., "The Effect of Maturation upon Defective Articulation in Elementary Grades." Journal of Speech and Hearing Disorders, VII (1942), 44.


4Travis and Rasmus, op. cit., pp. 218-20.
They found that:

The discriminative elements were contained in the initial position of each syllable of a pair followed by a vowel in the final position. As each pair was presented, the subjects were asked to judge if the syllables were the same or different. Using this test with 165 functional articulation cases and 383 normal speaking subjects of elementary and adult level... significantly more errors were made by the speech defective than by the normal speakers at every age level.

Templin,¹ using a short form of the Travis-Rasmus test in attempting to determine the ability of children to discriminate between identical and unlike syllables when the position of the discriminating element was changed from initial to final or medial position, found that the least errors of discrimination occurred in the initial position.

It appears that the functional articulatory defective has the ability to discriminate speech sounds, but that this ability is limited. The normal speaking individual, it appears, possesses an auditory perception superior to the speech defective. There may be more implications here than research has brought out. Auditory perception is usually not the only weakness in the speech defective's abilities. Sullivan² found that:


²Sullivan, Margaret E., "Auditory Acuity and Its Relation to Defective Speech." Journal of Speech and Hearing Disorders, IX (1944), 129.
Speech defectives in the public schools of Minneapolis show a hearing loss in one or both ears, 22.2 per cent against 18.8 per cent...and that the hearing loss is probably symptomatic of the general physical condition of these pupils and should be considered in therapeutic treatment.

We learn speech not by listening to isolated sounds, but we learn by listening to words or phrases or sentences. The speech sound has no meaning as a single unit. Only when it is joined to other sounds does it take on meaning. Curtis\(^1\) says that the speech defective child not only has to learn to make auditory discriminations which are new and unfamiliar, but that:

He needs to learn to break down these word patterns, at least to the extent of being able to recognize out of the word pattern, those sounds on which he tends to make errors. And eventually he needs to eliminate that error part of his word habit in order that a correctly formed sound may be substituted in its place.

It is apparent that the speech defective child finds it difficult to decipher adult speech and at times his own speech. Van Riper and Butler\(^2\) say that:

Speech defective children are not equipped with adult minds or ears and yet are expected to absorb much of what is said to them. To listen with understanding and skill is difficult.

Communication for the speech defective individual, according


to most sources, is a task of extreme difficulty. If the speech
defective individual hopes to communicate effectively he must,
therefore, learn the needed skills of auditory perception.
Without these skills he possesses only limited control of his
listener and his environment. Wiener\textsuperscript{1} classifies communication
and control as one. He states:

When I communicate with another person I impart
a message to him and when he communicates back with
me he returns a related message which contains infor-
mation primarily accessible to him and not to me.
When I control the actions of another person, I com-
municate a message to him, and although the message
is in the imperative mood, the technique of communi-
cation does not differ from that of a message of fact.
Furthermore, if any control is to be effective I must
take cognizance of any messages from him which may
indicate that the order is understood and has been
obeyed.

The process of speech has been discussed in detail by a
great number of writers in the field of speech disorders.
The process of speech production is related to many factors.
One of these factors, auditory perception, is considered to
be of great importance, as evidenced by the volume of research
that has been accomplished and is continuing to be accomplish-
ed on this subject. Schiefelbusch and Lindsey\textsuperscript{2} reveal that:

The research of discrimination of speech sounds
has not investigated some of the important variables
of the problem, and we may safely assume that we do
not yet know how and in what way perceptual deficien-
cies affect articulatory development.

\textsuperscript{1}Wiener, Norbert, \textit{The Human Use of Human Beings}. Garden
\textsuperscript{2}Schiefelbusch and Lindsey, op. cit., p. 153.
Powers\(^1\) says that research has found that:

Functional articulation cases have no generalized deficiency in the area of speech and sound discrimination, but there always remains the possibility that any specific articulation case may have such a deficiency.

This study has attempted to test children's abilities to discriminate their voices from others, using different speech situations. It was designed to investigate the possibility that one of the principal mediating factors in functional articulatory defects is the presence of some auditory inefficiency which enables defective articulation to persist when normal speaking children are achieving adequate articulation. It has been observed by Roe and Milisen,\(^2\) Bryngelson,\(^3\) and Wensley\(^4\) that as the defective speaking child grows in age, articulatory defects decrease. It can be noted that speech, normal or functionally defective, is a product of learning. It can be assumed that perceptual abilities can be achieved. Regarding faulty learning, Mange\(^5\) points out:


\(^{2}\)Roe and Milisen, op. cit.

\(^{3}\)Bryngelson, op. cit., p. 17.

\(^{4}\)Wensley, op. cit., p. 39.

\(^{5}\)Mange, "Relationships between Selected Auditory Factors and Articulation Ability," op. cit., p. 4.
If phoneme production has become strongly habitual prior to the time that accurate phonemic discriminations are learned, it may be habitualized defective articulation will occur and continue even after accurate discriminations are learned. In either case, it is possible to see how an articulatory defect may arise and be perpetuated as a result of auditory deficiency.

Therefore, if the speech defective does not monitor or hear his voice as others hear theirs, it is unlikely that he will make the normal adjustments in perfecting his speaking skills.

It is these fundamental perceptual abilities which lead to the importance of self-hearing and self-identification of one's own voice. To test the self-hearing ability, a procedure similar to Metraux's was used, in that the examiner himself pronounced the vowel sounds for the subjects. Although three different types of stimulus material were used, counting, the uttering of a prayer, we also used the isolated vowels as well. The use of vowel sounds is superior to nonsense syllables or numbers, according to Metraux, who said that she used vowels,

...rather than the standardized digit test used by the Stanford-Binet, for instance, because the speech sounds have predominately auditory value for the subject, they are difficult to visualize, the presentation is purely auditory, the reproduction is vocal and immediate, and the sounds have little associational implications.

**Summary of Research**

This chapter has attempted to review the possible relationship between certain kinds of deficiencies in auditory perception...
and functional articulatory defects. The research reviewed suggests the possibility of some type of auditory perceptual deficiency in certain types of functional articulation disorders. A number of possible auditory perceptual abilities which may have effects on phonetic discrimination and speech perception and identification have been discussed. Among the auditory perceptual abilities which show promise of further investigation in functional articulatory defectives and in normal speakers, are those concerned with the identification of the speaker's voice.

In this research study, the ability to recognize one's own voice was tested under a procedure in which the subject attempted to select his own voice from a sampling of three recorded voices. The three conditions used were as follows: (1) identification of voice while listening to isolated vowel sounds, (2) identification of voice while listening to serial counting, and (3) identification of voice while listening to a short memorized prayer.
CHAPTER II

SYNOPSIS OF THE STUDY

The testing of vocal self-identification by children with defective and normal speech was conducted using three conditions of voice presentation. The three conditions were listening to the previously recorded voices saying: (1) a series of ten vowel sounds one second apart, (2) serial counting, and (3) recitation of a short memorized prayer. The ten vowels consisted of the standard vowel sounds: [ae], [i], [e], [o], and [u], and [a], [e], [i], [u], and [ʌ]. The serial counting consisted of counting from one to fifteen. The short prayer was the "Hail Mary", a prayer familiar to all Catholic children. These three conditions were recorded on a magnetic tape recorder. After hearing each condition, the subject was allowed ten seconds to state which voice the subject believed to be his own.

Subjects were matched according to: (1) age, (2) sex, (3) grade level, and (4) academic achievement scores. No subjects were selected who achieved lower than grade level scores on the academic achievement test administered in the school.

The results were based in terms of the number of correct responses and incorrect responses in the recognition of the subject's own voice from a sample of three voices. The performance of the group of normal speaking children was compared with that of the functional articulatory defective group of children.
All of the subjects were drawn from grades one, two, three, four, five, and six of a parochial school.

Phrased in terms of the null hypothesis, the study may be stated as follows:

**Hypothesis One:** There is no significant difference between a group of functional articulatory speech defective children and normal speaking children in their abilities to identify their recorded voices.

**Hypothesis Two:** There is no significant difference between a group of functional articulatory speech defective children and normal speaking children in their abilities to identify their recorded voices when the voiced samples are presented as isolated vowels.

**Hypothesis Three:** There is no significant difference between a group of functional articulatory speech defective children and normal speaking children in their abilities to identify their recorded voices when the voiced samples are presented as serial counting.

**Hypothesis Four:** There is no significant difference between a group of functional articulatory speech defective children and normal speaking children in their abilities to identify their recorded voices when the voiced samples are presented as the recitation of a short memorized prayer.

**Hypothesis Five:** Voices uttering vowels are not more difficult to identify than voices doing serial counting.

**Hypothesis Six:** Voices uttering vowels are not more difficult to identify than voices uttering prayers.

**Hypothesis Seven:** Voices doing serial counting are not more difficult to identify than voices uttering prayers.
CHAPTER III

EXPERIMENTAL PROCEDURES

Subjects

There were forty-four subjects used in this experiment: twenty-two functional articulatory defective speaking children and twenty-two normal speaking children, selected from grades one through six. The speech defective children were matched with normal speaking children of the same sex, age, and grade level. There was no specific plan for selection of these children. If the first grade had ten or twelve speech defective children, and they could fulfill the criteria mentioned below, they were used as subjects. All speech defective subjects were selected if they were deficient in at least three consonant sounds. No subject was accepted if he possessed an organic abnormality which contributed to the defective speech. There were no stutterers used in this experiment.

The following criteria were applied to all subjects: (1) No subject was selected whose performance fell below the grade level achievement test administered in the school. (2) All subjects were free of organic speech disorders and stuttering. (3) All subjects were enrolled in the Saint Augustine Catholic School, Kalamazoo, Michigan.

All subjects were tested individually and each under the same conditions; that is, they were tested in the same room with the same equipment and the same instructions.
Stimulus Material

The stimulus material consisted of the following items: (1) ten standard vowel sounds to be repeated after the examiner, (2) counting from one to fifteen, and (3) recitation of a short memorized prayer.

In selecting the above items for use as the three conditions, it was necessary to determine if all subjects could follow directions, could count to fifteen, and could recite the prayer from memory. This was done through the use of two measures. First, the classroom teachers were requested to check each potential subject relative to the conditions of counting to fifteen and reciting the prayer. All subjects selected could count to fifteen and could recite from memory the prayer.

Secondly, the examiner prepared a set of instructions which he read to the subjects. Following this, he read to them a set of nonsense syllables which they were asked to repeat after him. All subjects selected were able to follow the instructions and repeat the nonsense syllables.

In no instance were any subjects selected who were unable to follow simple instructions, repeat vowel sounds, count to fifteen, or recite the short prayer. Through the two measures mentioned above, it was determined that all of the subjects were familiar with the items requested.

A Wollensak magnetic tape recorder with crystal microphone attachment was used in recording all responses made by the
subjects. The recorder was operated at 7½ cycles per second. The subjects were placed a standard distance from the microphone, which was clamped to the desk in front of the subjects, and each of the subject's responses was recorded in the same manner. No vowel was prolonged for over one second. A two to three second delay was held constant between presentation of the vowels and the subject's response. Ten seconds were allowed between recording of the stimulus conditions. That is, after the subject had repeated the vowels, there was a ten second delay. The subject was then requested to count from one to fifteen. After a ten second delay the subject was requested to recite the short prayer.

Instructions for Subjects

Each subject was given the same directions in regard to the procedure of the experiment. The instructions were read from a card to each subject as follows:

I am going to ask you to do three things for me. I will ask you to say some sounds after me. I will ask you to count from one to fifteen, and I will ask you to say the 'Hail Mary'. Are there any questions?

When I touch your arm with my finger, you will say the same sound that I did. When I touch your arm, you will say the same sound I did. All right? (Examiner demonstrates procedure with three nonsense syllables.) Listen carefully now. [eik]: (Touch.), [ik]: (Touch.), [ark]: (Touch.). That's right. Now listen carefully.

Here we go.

The recording of the vowel responses was begun at the end of the instructions to the subject. After the vowels were recorded, there was a ten second pause, after which the examiner
instructed the subject as follows:

Would you count from one to fifteen please.

When the subject had completed the serial counting there was a ten second pause, after which the examiner instructed the subject as follows:

Would you say the 'Hail Mary', please.

After the subject had recited the prayer, he was told the following:

Thank you. You may leave the room now and send in ______ (next subject) please.

Recognition Testing

Seven days later the subjects were brought to the same room, seated before the tape recorder, and were requested to "listen to some voices". The subjects were instructed as follows:

You are going to hear three voices saying some sounds. One of these voices is yours. You tell me which voice you think is yours; the first, second, or third. Listen to all three voices before you tell me which voice you think is yours. Are there any questions? Ready? Here we go.

The subject then heard the three voices saying the vowels. After the subject made his choice and the examiner recorded his response, he was instructed as follows:

You are going to hear three voices counting. One of these voices is yours. You tell me which voice you think is yours; the first, second, or third. Listen to all three voices before you tell me which voice you think is yours. Are there any questions? Ready? Here we go.

The subject then heard the three voices counting. After the subject made his choice and the examiner recorded his response, he was instructed as follows:
You are going to hear three voices saying the 'Hail Mary'. One of these voices is yours. You tell me which voice you think is yours; the first, second, or third. Listen to all three voices before you tell me which voice you think is yours. Are there any questions? Listen to all three before you tell me. Ready? Here we go.

The subject then heard the voices saying the "Hail Mary". After the subject made his choice and the examiner recorded his response, he was dismissed and asked to send in the next subject. The same procedure was repeated for all subjects in both the normal speaking and the speech defective groups.

The data were then tabulated and subjected to an analysis of variance as described in the next chapter to determine the significance of the differences between groups and conditions of voice presentation.
CHAPTER IV
ANALYSIS OF DATA

This chapter is concerned with the analysis of the results of this study to determine whether or not there were significant differences between a group of normal speaking children and a group of functional articulatory defective children in the ability to identify their own voices. Their voices were recorded and each subject attempted to identify his own voice from a choice of three voices matched with respect to age, sex, and grade level. The null hypothesis was employed in the evaluation of the comparisons made between the speech defective group and the normal speaking group.

**Hypothesis One**: There is no significant difference between a group of functional articulatory speech defective children and normal speaking children in their abilities to identify their recorded voices.

**Hypothesis Two**: There is no significant difference between a group of functional articulatory speech defective children and normal speaking children in their abilities to identify their recorded voices when the voiced samples are presented as isolated vowels.

**Hypothesis Three**: There is no significant difference between a group of functional articulatory speech defective children and normal speaking children in their abilities to identify their recorded voices when the voiced samples are presented as serial counting.

**Hypothesis Four**: There is no significant difference between a group of functional articulatory speech defective children and normal speaking children in their abilities to identify their recorded voices when the voiced samples are presented as the recitation of a short memorized prayer.
To accept or reject the null hypothesis, it is necessary to know the probability that similar research would show similar results. Accordingly, the 5 per cent level of confidence was employed as the measure of significance. Tables of chi square\(^1\) permit us to decide the level of confidence to use in this experiment. In a two by two table\(^2\) such as was used in this experiment there is only one degree of freedom. To determine the degrees of freedom, the following formula\(^3\) was used.

\[
df = (r - 1) \cdot (k - 1)
\]

The formula simply stated means to multiply the rows \((r)\) minus one times the columns \((k)\) minus one. In the two by two table,\(^4\) which has only four cells, this produces 1, which is the degree of freedom.

Three conditions of voice presentation were employed: Condition one, the voices saying ten vowel sounds; Condition two, the voices counting from one to fifteen; Condition three, the voices saying a short prayer from memory.

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\(^2\)Guilford, loc. cit., p. 233.

\(^3\)Guilford, loc. cit., p. 233.

\(^4\)Guilford, loc. cit., p. 233.
Table I shows the number and per cent of correct and incorrect identifications made by the subjects of the speech defective group. Table II shows the number and per cent of correct and incorrect identifications made by the subjects of the normal speaking group. Figures 1 and 2 illustrate graphically the percentages in Tables I and II.

Table I

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<thead>
<tr>
<th></th>
<th>Vowels</th>
<th>Counting</th>
<th>Prayer</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Could Identify</td>
<td>8 (36%)</td>
<td>13 (59%)</td>
<td>17 (77%)</td>
<td>38 (58%)</td>
</tr>
<tr>
<td>Could Not Identify</td>
<td>14 (64%)</td>
<td>9 (41%)</td>
<td>5 (23%)</td>
<td>28 (42%)</td>
</tr>
</tbody>
</table>

Table II

<table>
<thead>
<tr>
<th></th>
<th>Vowels</th>
<th>Counting</th>
<th>Prayer</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Could Identify</td>
<td>13 (59%)</td>
<td>16 (73%)</td>
<td>19 (86%)</td>
<td>48 (73%)</td>
</tr>
<tr>
<td>Could Not Identify</td>
<td>9 (41%)</td>
<td>6 (27%)</td>
<td>3 (14%)</td>
<td>18 (27%)</td>
</tr>
</tbody>
</table>
Table I shows that the speech defective children correctly identified their own voices on the total stimulus material (vowels plus counting plus prayer) a total of 38 times out of a possible 66, or 58 per cent of the time. They correctly identified their own voices when hearing the vowels only 8 times out of a possible 22, or 36 per cent of the time. They correctly identified their own voices 13 times out of a possible 22, or 59 per cent of the time, when listening to the serial counting. They correctly identified their own voices when listening to the prayer 17 times out of a possible 22, or 77 per cent of the time. The above percentages are shown graphically in Figure 1.

Table II shows that the normal speaking children correctly identified their own voices a total of 48 times out of a possible 66 stimulus samples, or 73 per cent of the time. They correctly identified their own voices when hearing only the isolated vowels 13 times out of a possible 22, or 59 per cent of the time. The normal speaking children correctly identified their own voices, from listening to the numbers, 16 times out of a possible 22, or 73 per cent of the time. The normal speaking children correctly identified their own voices, from hearing the prayer, 19 times out of a possible 22, or 86 per cent of the time. The above percentages are shown graphically in Figure 2.

The greatest differences appear to occur in Condition 1, the identification of vowels. Condition 2 and Condition 3 appear to be similar with only slight differences.
Figure 1

Total Correct Identifications of the Speech Defective Group Shown in Percentages

** Per Cent Correctly Identified
* Per Cent Incorrectly Identified
Figure 2

Total Correct Identifications of the Normal Speaking Group Shown in Percentages

** Per Cent Correctly Identified

* Per Cent Incorrectly Identified
Since the data were distribution free, the chi square formula was used to determine if these differences were statistically significant. Since there can be no assumed normal distribution for the data, but merely a "yes" or "no" answer whether or not the voices were identified, it was necessary to use a statistical test which is not concerned with estimates of population distribution. This type of statistical test deals with sums of the yes-no answers and cannot be subjected to tests of central tendency and internal variance.

The following formula\(^1\) was used to compute all chi square values.

\[
\chi^2 = \sum \left( \frac{(f_0 - f_e)^2}{f_e} \right)
\]

To obtain chi square, one must subtract the expected frequencies \((f_e)\) from the obtained frequencies \((f_0)\). The obtained frequencies are the results obtained from the total of the voice identifications. These results, minus the expected score, are divided by the expected frequencies.

To obtain the expected frequencies, the following formula\(^2\) was used.

\[
f_e = \frac{\left( \sum f_r \right) \cdot \left( \sum f_k \right)}{N}
\]

---

\(^1\)Guilford, loc. cit., p. 232.

\(^2\)Guilford, loc. cit., pp. 231-2.
The expected frequencies are obtained by multiplying the sum of the rows \((f_r)\) times the sum of the columns \((f_k)\), divided by the number of subjects \((N)\).

Table III shows the chi square values for the speech defective group versus the normal speaking group for each of the three conditions: saying the vowels, serial counting, and recitation of the prayer. It also shows the chi square value for the combination of the speech defective versus normal speaking groups. For chi square to be significant at the 5 per cent level of confidence with one degree of freedom, chi square must be 3.84 or larger.

Table III

<table>
<thead>
<tr>
<th>Inter-Group Comparisons under Each of the Conditions and Combined Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group vs. Control Group</td>
</tr>
<tr>
<td>Vowel Identification</td>
</tr>
<tr>
<td>Counting Identification</td>
</tr>
<tr>
<td>Prayer Identification</td>
</tr>
<tr>
<td>Combined Samples</td>
</tr>
</tbody>
</table>

A chi square of 2.28 with one degree of freedom was found for the comparison of the speech defective group versus the normal speaking group when listening to vowels. Since a chi square of 3.84 represents the 5 per cent level of confidence...
with one degree of freedom, we are unable to say that the difference revealed in the above comparison was significant.

Chi square for the speech defective group versus the normal speaking group listening to serial counting was .910. It is apparent that this chi square value for voices doing serial counting is not significant. We may conclude that there is no difference in the abilities of these two groups to identify their voices when listening to serial counting.

When the two groups listened to the recorded voices saying the prayer, the comparison revealed a chi square of .153. Once more it is obvious that this value does not approach a chi square of 3.84, which represents significance at the 5 per cent level of confidence. We may assume that there are no differences in these two groups in the ability to identify their voices when listening to this sample of consecutive speech.

However, when the combined samples (prayer plus counting plus vowels) of the speech defective group and the normal speaking group were compared, the chi square value, as shown in Table III, was found to be 3.32. A chi square of 3.84 is needed to be significant at the 5 per cent level of confidence with one degree of freedom. This value (3.32) is very close to significance, representing the 6 per cent level of confidence. While the null hypothesis cannot be rejected, this result indicates that future research with a larger sample of stimulus voices might possibly produce statistically significant differences.
Although no statistically significant differences were found between the experimental and control groups in the ability to identify the speaker's voice, this study also sought to discover which types of voice samples could most easily be identified. We may state this investigation in terms of several other null hypotheses.

**Hypothesis Five:** Voices uttering vowels are not more difficult to identify than voices doing serial counting.

**Hypothesis Six:** Voices uttering vowels are not more difficult to identify than voices uttering prayers.

**Hypothesis Seven:** Voices doing serial counting are not more difficult to identify than voices uttering prayers.

Each of these three null hypotheses was tested for the groups of normal speaking and speech defective children separately. The results are shown in Table IV and Table V.

The results of this portion of the study, as expressed in Table I, show that the children in the speech defective group are able to recognize their own voices less easily from the vowel samples than from the samples of the counting or those of the prayer. From Table I we find that 36 per cent of the children in this group could identify their voices when hearing the vowels alone, 59 per cent when hearing the serial counting, and 77 per cent when hearing the prayers.

Table IV shows the intra-group comparisons of the speech defective group expressed in terms of chi square values. This table shows comparisons of the vowel identifications versus
the serial counting identifications, the vowel identifications versus the prayer identifications, and the serial counting identifications versus the prayer identifications of the speech defective group.

Table IV

Intra-Group Comparisons of the Three Conditions for the Speech Defective Group

<table>
<thead>
<tr>
<th>Conditions</th>
<th></th>
<th></th>
<th>$x^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vowels</td>
<td>vs. Counting</td>
<td></td>
<td>2.27</td>
</tr>
<tr>
<td>Vowels</td>
<td>vs. Prayer</td>
<td></td>
<td>7.50*</td>
</tr>
<tr>
<td>Counting</td>
<td>vs. Prayer</td>
<td></td>
<td>1.67</td>
</tr>
</tbody>
</table>

*Significant beyond 5 per cent level of confidence with one degree of freedom.

The results of this study therefore compel us to accept the null hypothesis which states:

**Hypothesis Five:** Voices uttering vowels are not more difficult to identify than voices doing serial counting.

There appears to be no basic difference in the ability to recognize voices uttering vowels than voices doing serial counting for the speech defective group of children.

However, we must reject our sixth null hypothesis which states:

**Hypothesis Six:** Voices uttering vowels are not more difficult to identify than voices uttering prayers.
It is apparent that voices uttering vowels are harder to identify than voices uttering prayers. Consecutive speech is easier to identify than isolated vowels.

When serial counting and the prayer samples are compared we find no statistically significant difference. Both types of speech would be as easily identified. We therefore must accept our seventh null hypothesis which states:

Hypothesis Seven: Voices doing serial counting are not more difficult to identify than voices uttering prayers.

We may conclude therefore, that for the speech defective group, there is no essential difference in the stimulus value of oral counting or oral prayers so far as identification of voice is concerned.

We now turn to the performance of the normal speaking children in recognizing their voices under the three conditions of stimulus presentation.

Table V shows comparisons of the vowel identifications versus the serial counting identifications, the vowel identifications versus the prayer identifications, and the serial counting identifications versus the prayer identifications for the normal speaking group. To be significant at the 5 per cent level of confidence with one degree of freedom, chi square must be 3.84 or larger.
Table V

Intra-Group Comparisons of the Three Conditions for the Normal Speaking Group

<table>
<thead>
<tr>
<th>Conditions</th>
<th></th>
<th>x²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vowels vs. Counting</td>
<td></td>
<td>.910</td>
</tr>
<tr>
<td>Vowels vs. Prayer</td>
<td></td>
<td>4.12*</td>
</tr>
<tr>
<td>Prayer vs. Counting</td>
<td></td>
<td>1.25</td>
</tr>
</tbody>
</table>

*Significant beyond 5 per cent level of confidence with one degree of freedom.

The results of this portion of the study, as expressed in Table II, show that the children in the normal speaking group are able to recognize their own voices less easily from the vowel samples than from the samples of the counting or those of the prayer. From Table II we find that 59 per cent of the children in this group could identify their voices when hearing the vowels alone, 73 per cent when hearing the serial counting, and 86 per cent when hearing the prayers.

Table V shows the intra-group comparisons of the normal speaking group expressed in terms of chi square values. This table shows comparisons of the vowel identifications versus the serial counting identifications, the vowel identifications versus the prayer identifications, and the serial counting identifications versus the prayer identifications of the normal speaking group.
The results of this study reveal that there is no statistically significant difference between the comparison of the isolated vowels and the serial counting samples for the normal speaking group of children. Both types of speech would be as easily identified or as difficult to identify. We must therefore accept hypothesis five which states:

**Hypothesis Five:** Voices uttering vowels are not more difficult to identify than voices doing serial counting.

We may assume therefore that there is no essential difference in the stimulus value of the uttering of vowels and that of counting so far as identification of voice is concerned.

However, we find a statistically significant difference when comparing the vowel samples with those of the prayer. These results therefore compel us to reject the null hypothesis which states:

**Hypothesis Six:** Voices uttering vowels are not more difficult to identify than voices uttering prayers.

We can conclude that these children can more readily identify their own voices when uttering prayers than when uttering vowels. Consecutive speech is easier to identify than isolated vowels.

When serial counting and prayer samples are compared we find no statistically significant difference. Therefore we must accept the null hypothesis which states:

**Hypothesis Seven:** Voices doing serial counting are not more difficult to identify than voices uttering prayers.

We may conclude, that for the normal speaking group of children,
there is no essential difference in the stimulus value of oral counting or oral prayers as they apply to the identification of voice.
CHAPTER V

INTERPRETATION OF RESULTS

The totals of the combined voice samples of the speech defective group and the total combined voice samples of the normal speaking group were compared and a chi square of 3.32 was found. A chi square of 3.84 is required for significance at the 5 per cent level of confidence with one degree of freedom; thus showing that our difference, represented by a chi square of 3.32, could occur less than 6 per cent of the time as a result of pure chance. This indicates a strong trend which barely fails to achieve statistical significance. This implies that there may be some slight difference in the abilities of these two groups to identify their own recorded voices if enough sampling of the voices could be provided. However, we cannot conclude that the present research has substantiated this implication.

When the two groups of normal speaking and speech defective children were compared on each of the three conditions of voice presentation, no statistically significant differences were found between the two groups on any of the conditions. Evidently, whatever auditory perceptual deficiencies may distinguish articulatory defective from normal speaking children, the ability to recognize one's own voice from recorded transcriptions is not one of them. It was conceivable that the speech defective group might recognize their own voices more readily
by recognizing their characteristic errors. This does not seem to be the case and may possibly be explained in terms of the speech defective's difficulty in discriminating his error sounds. On the other hand, it was also possible that the normal speaking children could more readily identify their own voices since they would have no abnormality to confront or to accept. If this was a factor, it was not strong enough to influence the results of this study. The presence or absence of a speech defect does not seem to be crucial in the identification of one's own recorded voice.

The second part of the study compared the relative ease of voice identification under the three conditions of vowel utterance, serial counting, and the saying of a familiar prayer. We were attempting to discover whether or not we recognize our own voices primarily in terms of phonation or articulation or both. Is it the voice quality, the pitch level, and the intensity levels which serve as the basic cues to voice identification? These cues are present in the utterance of isolated vowels. On the other hand, if the basic cues which help us identify our own voices are articulatory in nature, i.e., if the manner with which we utter our consonants is the essential clue, the sample presenting serial counting should be more easily recognized than the samples using only the vowels. Finally, if the inflectional characteristics and the rhythm of speech were the basic cues for vocal self-identification, the samples using
prayer should be more easily recognized than either those of vowel utterance or serial counting.

The results of this study indicate that for the speech defective group and for the normal speaking group the prayer samples were more easily recognized than the isolated vowel samples. It is evident therefore that children's voices are not identified by them on the basis of pitch intensity or voice quality cues as easily as they are when the rhythmic cues or inflectional cues are added. Modern information theory has long shown that identity is achieved through the cumulative addition of bits of information. Presumably, the articulatory and inflectional and rhythmic cues are not essential in the identification of voice, since many of our subjects were able to recognize their voices on the basis of vowels alone. Nevertheless, the presence of these other cues made the identification easier. We would believe that this research indicates that future research on self-identification of voice should employ samples of consecutive speech rather than isolated vowels. However, we must also recognize that the serial counting and prayer samples were longer utterances than that of the vowel sample, and perhaps this latter conclusion must be accepted with caution.

Other limitations of the present research are those resulting from the small number of subjects employed, the arbitrary set of three voice samples from which the selection of the subject's own voice was made, and the lack of any evaluation of
reliability. All that we can conclude from the present investigation is that speech defective children do not differ from normal speaking children in the ability to recognize their own voices from recorded samples of vowels, counting, or prayers and that articulatory, inflectional and rhythmic cues facilitate this recognition.
CHAPTER VI

SUMMARY

This study attempted to investigate certain auditory abilities in functional articulatory defective children and normal speaking children and relate the presence or absence of these abilities to defects of articulation. A test of vocal self-identification was employed, using three conditions of voice presentation to a group of functional articulatory defective children and a group of normal speaking children. The three conditions were listening to previously recorded samples of voices saying: (1) a series of isolated vowel sounds, (2) serial counting, and (3) the recitation of a short memorized prayer. Subjects were matched according to: (1) age, (2) sex, (3) grade level, and (4) academic achievement scores. There appeared to be a slight difference in the abilities of these two groups to identify their own voices when all voice samples were combined. However, the difference is not significant at the 5 per cent level of confidence. A tabulation of results of the comparisons of the speech defective group versus the normal speaking group demonstrates that we must accept the null hypothesis which states:

**Hypothesis One:** There is no significant difference between a group of functional articulatory speech defective children and normal speaking children in their abilities to identify their recorded voices.

The comparison of the speech defective group versus the normal speaking group identifying their voices saying vowels
revealed a chi square value which was not significant at the 5 per cent level of confidence. We are unable to reject the null hypothesis which states:

**Hypothesis Two:** There is no significant difference between a group of functional articulatory speech defective children and normal speaking children in their abilities to identify their recorded voices when the voiced samples are presented as isolated vowels.

The chi square value for comparing the speech defective group and the normal speaking group listening to serial counting was found to be lower than 3.84. In order to have statistical significance at the 5 per cent level of confidence, chi square must be greater than 3.84. Therefore we are unable to reject the null hypothesis which is stated as follows:

**Hypothesis Three:** There is no significant difference between a group of functional articulatory speech defective children and normal speaking children in their abilities to identify their recorded voices when the voiced samples are presented as serial counting.

The comparison of the speech defective group versus the normal speaking group attempting to identify their voices saying a short prayer was found to be a chi square value below 3.84. Once more it is apparent that when chi square equals a number below 3.84 the differences are non-significant. We are therefore unable to reject the null hypothesis which is stated as follows:

**Hypothesis Four:** There is no significant difference between a group of functional articulatory speech defective children and normal speaking children in their abilities to identify their recorded voices when the voiced samples are presented as the recitation of a short memorized prayer.
Although no statistically significant differences were found between the experimental and control groups in the ability to identify the speaker's voice, this study also sought to discover which types of voice samples could most easily be identified.

Our results show that there is no statistically significant difference in the ability of the children in the speech defective group to recognize their own voices from the vowel samples than from the samples of the counting. We must therefore accept the null hypothesis which states:

**Hypothesis Five:** Voices uttering vowels are not more difficult to identify than voices doing serial counting.

The results of this study show that the speech defective children are able to recognize their own voices less easily from the vowel samples than from the samples of the prayer. Therefore we must reject the null hypothesis which states:

**Hypothesis Six:** Voices uttering vowels are not more difficult to identify than voices uttering prayers.

Our results show that there is no statistically significant difference in the ability of the speech defective children to recognize their own voices from the serial counting samples than from the samples of the prayer. We therefore must accept the null hypothesis which states:

**Hypothesis Seven:** Voices doing serial counting are not more difficult to identify than voices uttering prayers.

The results of this study reveal that there is no statistically significant difference in the ability of the normal
speaking group to recognize their own voices from the vowel samples than from the samples of the counting. We must therefore accept the null hypothesis which states:

**Hypothesis Five:** Voices uttering vowels are not more difficult to identify than voices doing serial counting.

This study shows that the children in the normal speaking group are able to recognize their own voices less easily from the samples of the vowels than from the prayer samples. We therefore must reject the null hypothesis which states:

**Hypothesis Six:** Voices uttering vowels are not more difficult to identify than voices uttering prayers.

Our results show that the children in the normal speaking group are not able to recognize their own voices any more easily from the serial counting samples than from the prayer samples. We must therefore accept the null hypothesis which states:

**Hypothesis Seven:** Voices doing serial counting are not more difficult to identify than voices uttering prayers.


**Sample Data Sheet**

<table>
<thead>
<tr>
<th>Speech Defective Subjects</th>
<th>Normal Speaking Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vowels</td>
</tr>
<tr>
<td>Subjects</td>
<td>*</td>
</tr>
<tr>
<td>R.B.</td>
<td>X</td>
</tr>
<tr>
<td>M.S.</td>
<td>X</td>
</tr>
<tr>
<td>J.F.</td>
<td>X</td>
</tr>
<tr>
<td>M.F.</td>
<td>X</td>
</tr>
<tr>
<td>C.F.</td>
<td>X</td>
</tr>
<tr>
<td>P.B.</td>
<td>X</td>
</tr>
<tr>
<td>L.B.</td>
<td>X</td>
</tr>
<tr>
<td>M.D.</td>
<td>X</td>
</tr>
<tr>
<td>T.C.</td>
<td>X</td>
</tr>
<tr>
<td>J.C.</td>
<td>X</td>
</tr>
<tr>
<td>M.B.</td>
<td>X</td>
</tr>
<tr>
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<td>X</td>
</tr>
<tr>
<td>T.H.</td>
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</tr>
<tr>
<td>L.F.</td>
<td>X</td>
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<tr>
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<td>X</td>
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<td>J.C.</td>
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<td>S.B.</td>
<td>X</td>
</tr>
<tr>
<td>P.B.</td>
<td>X</td>
</tr>
</tbody>
</table>

Totals: 8 14 13 9 17 5 13 9 16 6 19 3

* Correctly Identified
** Incorrectly Identified