An Investigation of the Relationships between Judgements of Esophageal and Artificial Larynx Speech Made by Sophisticated and Naïve Judges

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AN INVESTIGATION OF THE RELATIONSHIPS
BETWEEN JUDGEMENTS OF ESOPHAGEAL
AND ARTIFICIAL LARYNX SPEECH MADE BY
SOPHISTICATED AND NAIVE JUDGES

by

Gerald Robert Moses

A thesis presented to the
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of the
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An Analysis of the Categories and the Frequency of Their Use in Describing Artificial Larynx Speech
CHAPTER I
THE BACKGROUND AND PURPOSE OF THE STUDY

Introduction

Laryngectomy, the surgical removal of the larynx, is performed to save life threatened by a carcinomatous condition of the larynx. This surgical procedure is also performed when necessitated by accident, injury or other pathologies of the larynx. (35).

There are living, in the United States, an estimated 15,000 to 20,000 individuals who have undergone surgical removal of the larynx due to a carcinomatous condition of that organ (33). It is probable that the total population of laryngectomized persons would exceed this number if statistical information were available concerning the number of laryngectomies necessitated by other pathologies (24,25,35).

Many problems beset the laryngectomy patient both before and after his operation (1,21,29,31,33). Nahum (29) feels that four of the most common preoperative fears are those of death, mutilation, loss of communication and recurrent cancer. Further fears arise when the patient considers the influence of his
surgery on his return to work and social standing in his community. Economic problems arise as a function of the great cost of the operation, hospital care and return visits to the physician.

Martin (26) suggests that the physician can be of great assistance to the psychological well being of his patient by contacting his employer and making arrangements for the return to the patient's previous job and by contacting a teacher of post-laryngectomy speech. Brief talks with the family of the patient have proved valuable for better family understanding of the patient's temporary loss of speech and new hygiene habits.

Arnold (1), Equen (12) and Martin (26) have discussed the present day suggestions of speech pathologists and physicians for pre-operative as well as post-operative counseling for laryngectomy patients.

Post-operatively, the patient must adjust to a new way of breathing and learn new life preserving habits of everyday hygiene (33). Furthermore, he must now face the great financial strain necessitated by the expense of the operation and loss of work time.

One of the more profound problems facing the laryngectomee post-operatively is the loss of voice. His larynx or voice box has been removed making it
impossible, at least for now, for him to speak. He is faced with the task of learning a new way to communicate.

Three modes of communication are readily available to the patient. He can communicate his wants and needs by writing messages on paper. Although this is the most common mode of communication immediately after the operation, it is the least desirable in terms of a permanent alternative to normal verbal communication.

The other alternative modes of communication consist of the acquisition of pseudovoice; either by means of an artificial larynx or by esophageal voice (26).

VanRiper and Irwin (25, page 76) describe esophageal voice as

...like normal speech, is based on a modulated air stream. The air supply has been swallowed into the stomach or, more usually, trapped in the upper portion of the esophagus. The modulation or vibration seems in most cases to be due to the action of the cricopharyngeal sphincter.

Martin (26) describes esophageal speech as "a deliberate and controlled belch, the sound of which is vocalized and articulated into speech by normal anatomical structures (tongue, teeth, lips, etc.)." It is apparent then, that the principle characteristic of esophageal speech is the use of the anatomical structures of the speaker in both voice production and
articulation.

Artificial larynx speech has been described by Arnold (1) as "speech produced through the use of a mechanical or electrical sound source." For example, in the reed type artificial larynx, a vibrating reed generates a sound which is introduced through a tube directly into the oral cavity. This sound in turn is articulated by the oral structures, thus producing speech.

At least 5 types of artificial larynges have been employed experimentally. These are: 1.) the externally applied reed larynx activated by pulmonary air or by special bellows; 2.) an internally applied mechanical device which replaces the larynx and simulates all laryngeal functions; 3.) an electrically activated larynx applied cervically; 4.) an external electric larynx which directly activates the oral resonator; and 5.) an intra-oral sound source.

The most common artificial larynx in use in the United States is the electrically activated artificial larynx applied cervically. The first workable electrolarynx was introduced in 1942 by Greene (14). Since that time, vast improvements in the size and effectiveness of this type of artificial larynx have occurred.

Snidecor (33) has traced the developments and im-
provements in the construction and use of the artificial larynx. An excellent summary of refinements in the construction and use of artificial larynges also appears in an article by Heaver and Arnold (16).

The Aurex Corporation and the Bell Telephone System have been most active in the improvements of the artificial larynx and presently are the primary distributors of the electrolarynx.

Barney (3) designed a modern, miniature, electronic artificial larynx with the help of the Bell Telephone Laboratories. In 1960, Barney (4) introduced a new artificial larynx with a smaller vibrator and pitch control system to further enhance the intelligibility of the modern artificial larynx.

Lafon (10) studied the acoustical aspects of artificial larynx speech and compared sonagrams of artificial larynx, esophageal and normal speech. He noted that although esophageal speech resembled normal speech very closely, the improved, cervically applied artificial larynges were closer to normal speech than were their predecessors.

The principle behind the modern, cervically applied larynx is that a vibrator introduces sound into the pharynx when the vibrator portion of a cylindrical instrument is placed against the neck. The sound passes
through the pharynx upward, into and through the oral cavity where it is modified by movements and positions of the articulatory structures.

Levin (21) while investigating the medical aspects of rehabilitation of laryngectomized patients, found that most laryngectomees have the physiological potential for acquiring esophageal voice. When one appreciates the comparative ease with which one can learn to use the artificial larynx, it is obvious that the laryngectomized patient has a choice of type of post-laryngectomy speech. Hyman (18) has noted that, traditionally, the choice of type of post-laryngectomy speech taught to the patient was determined by the personal preference of the patient's physician or speech therapist.

The attitude toward therapy for laryngectomized persons which prevails in Europe and elsewhere was expressed by Damste when he states: "Unfortunately, in some clinics it is still customary to use the artificial larynx." His objections are shared by others who are concerned with the esthetic and theoretical aspects of post-laryngectomy speech.

Studies have shown that over the years speech pathologists and physicians have preferred the acquisition of esophageal voice rather than artificial larynx
voice (26,27,28). It was felt that among other disadvantages of the artificial larynx the visible use of a prosthetic device seriously detracts from the intelligibility of the artificial larynx user. It was felt that a major benefit of esophageal phonation was the absence of a visible prosthetic device.

O'Neal (30) found that esophageal speakers were very negative in their attitudes toward the use of the artificial larynx.

Other writers (12,22,26) have suggested that the use of the artificial larynx is conspicuous, cumbersome, embarrassing to the speaker, and distracting to the listener.

Damste, van den Berg and Moolenaar-Bijl (10) have remarked:

We also object to the use of the artificial larynx; intelligibility can be very good, but the sound lacks volume and naturalness and always betrays its mechanical source. Moreover, as a mechanical, foreign body it can never become part of the user.

Damste asserts that "most patients can learn esophageal speech following daily lessons over a few weeks. This form of speech is very intelligible at short range and although not exactly pleasing to the ear, the personal attributes of speech are better and the voice more human than with an artificial larynx."
Levin (21) has established criteria for the use of the artificial larynx. He says that a patient should use an artificial larynx when he: 1.) suffers stenosis of the esophagus after removal of a widespread lesion; 2.) has undergone resection of the cervical portion of the esophagus; 3.) has multiple handicaps, for example, laryngectomy plus deafness; 4.) has suspected recurrence, metastasis or multiple lesions, such as bronchial carcinoma, in addition to the laryngeal lesions; and 5.) is senile or has some other feebleness.

Bauman (5) recommends the use of the artificial larynx only immediately after surgery.

Miller (27) also cited certain reasons to "justify" the use of the artificial larynx: 1.) to provide increased volume for patients in specific situations in which esophageal speech is unsatisfactory; 2.) to permit the patient to communicate with his therapist and with other patients in the early stages of esophageal speech instruction; and 3.) to assist laryngectomized patients who have difficulty on the telephone.

The philosophy of therapy advocated by many qualified speech therapists and physicians, as well as by laryngectomized patients who instruct in the technique, fails to recognize or acknowledge that realistic assess-
ment of the patient's psychological, domestic, social and pressing economic needs may indicate that time is of the essence.

In such cases, the intelligent rehabilitation effort employs the temporary or permanent use of a mechanical aid to restore the patient's lost ability to speak intelligibly. Whether or not this measure is prescribed and made available can mean the difference between successful restoration of the patient's post-operative social and economic status and generation of his chronic despair over living in progressive personal oblivion and economic dependence (1).

Hejna (17) has stated that successful acquisition of esophageal speech is correlated with 1.) more intelligence; 2.) more intrinsic motivation; 3.) the lack of excessively high social standards; and 4.) better over-all personality adjustment. Were these standards not too ideal and were most laryngectomy patients possessors of them, the fact would remain that pressures of time and the usual multiple fears demand more urgent measures than eventual acquisition of esophageal voice.

The laryngectomized patient's fundamental psychological status following operation must be considered in voice and speech rehabilitation. A pathologic reactive depression is the usual sequel to the doctor's
dictum that the larynx is cancerous, that it must be removed at once, and that natural speech no longer will be possible. "Fright, anxiety, insomnia, confusion, self-pity, fear of death, and suicidal impulses pervade and devitalize the patient's psychic energy. The depression occasionally can be seen as euphoria" (15).

It is the view of Arnold (1) and others that the rehabilitative process begins when the physician informs the patient of his carcinomatous condition and of its consequences. The physician's awareness of resources for prompt restoration of communication, including both esophageal voice instruction and the availability of artificial larynges, can determine the patient's eventual success as a communicator. Arnold further recommends the use of an artificial larynx as soon as the surgeon deems it possible as, at least, a temporary post-operative measure.

Such great controversy over recommendation of type of post-laryngectomy speech has pervaded the fields of speech pathology and medicine for years. A further and excellent review of contrasting studies can be found in a Masters thesis by Carder (7). Laryngectomized persons, however, deal with people other than speech pathologists and physicians. How well they and their speech type are received by others plays an important
role in their daily adjustment.

The Purpose of the Study

It was the purpose of this study to investigate the relationships between judgments of esophageal and artificial larynx speech made by sophisticated and naive judges.

Specifically, the investigation was directed toward answering the question: Is there a difference between preferences for the same samples of esophageal and artificial larynx speech when these preferences are expressed by sophisticated and naive listeners?

Review of Related Research

Research concerning post-laryngectomy speech has focused, primarily, on acoustical or physical aspects of speech and voice production (2,20,34) or judgments by listeners of their preferences for various voice types (7,6,16,28).

Various authors have discussed the relative merits of speech resulting from the use of the artificial larynx and esophageal speech (1,22,32).

Barney (4) reviewed the scientific development of the artificial larynx and summarized the experimental findings concerning acoustical characteristics of voice.
produced by means of a mechanical device. On the basis of his findings, two major characteristics of the artificial larynx were reported: 1.) most laryngectomized persons can acquire through practice a normal conversational level of loudness; and 2.) the frequency spectra of the artificial larynx essentially resemble those of normal speech.

Barney (2) in another study noted one major deficiency of speech produced by the artificial larynx. This deficiency was described as inadequate sound production which resulted in shortening of continuants and was related to the insufficiency of the volume of trapped air used by the speaker. Specifically, the /s/ and /sh/ were reportedly insufficient in volume. The glottal consonant /h/ sound was understandably completely omitted.

Snidecor (34) discovered that the time and rate performance of superior esophageal speakers was above that necessary for satisfactory speech. In this study, six superior esophageal speakers who served as subjects were asked to perform at the highest possible level of esophageal speech proficiency. Each subject was rated in terms of the number of words and syllables spoken per charge of swallowed air, and the number of words spoken per minute relative to normal speech. This
study emphasized the superior esophageal speaker and its purpose was to define the maximum expected performance level for esophageal speakers in order to establish goals for the therapy process.

Curry and Snidecor (2) experimentally assessed esophageal speech with regard to fundamental frequency and pitch perception. The results of this study, which used six superior esophageal speakers and six superior normal speakers, showed that the mean fundamental frequency level for most esophageal speakers to be about one full octave below that of normal adult male speakers.

Another study of the acoustical properties of post-laryngectomy speech was done by Lafon (20) who compared the speech of normal, esophageal and artificial larynx speakers. Sonagrams of certain vowel and short sentence productions were analyzed and compared. Lafon found that esophageal speech closely resembled that of normal speech.

Research pertaining to listener reactions to type of post-laryngectomy speech has been undertaken to gather further information pertinent to recommendations of type of speech available to laryngectomized persons.

Hyman (18) conducted an extensive experiment in which the specific physical measurements of artificial larynx speech, esophageal speech, and normal speech
were investigated and a comparative evaluation of the intelligibility of artificial larynx speech and esophageal speech was made, and note taken concerning which method of post-laryngectomy speech was "preferred" by naive listeners.

Tape recorded samples of both types of post-laryngectomy speech were utilized in the study. Speakers using artificial larynges were found to be superior to esophageal speakers in reference to loudness; but no differences in intelligibility were found to exist between "good speakers of each group." Hyman reports that the voices of the artificial larynx speakers appeared to be preferred by listeners in that their voices were more "pleasant" than the esophageal speakers. Hyman concluded that, acoustically, speech produced by means of an artificial larynx was preferred to speech produced by the esophageal method.

In another study of listener reaction to the relative merits of esophageal and artificial larynx speech, McCroskey and Mulligan (28) investigated the relative intelligibility of the two methods of speech as judged by naive and sophisticated listeners. Three panels of ten listeners each were comprised of experienced speech therapists, graduate students in speech pathology, and of naive listeners. Each panel judged tape
recorded samples of ten laryngectomized speakers reading different multiple-choice intelligibility word lists. These lists were derived from an earlier study by Black (6). Speech therapists and graduate students judged esophageal speech to be superior in intelligibility to artificial larynx speech, while, artificial larynx speech was judged to be more intelligible than esophageal speech by the panel of naive listeners. It was suggested by the authors that professional preferences or training may have had an influence upon the judgements made by the sophisticated listeners. It was concluded that the results of the study indicated that artificial larynx speech was judged more intelligible than esophageal speech when these judgements are made by persons not previously exposed to either method of post-laryngectomy speech. The authors suggested that the effect of visual as well as auditory cues should be further investigated to better determine listener reaction to both types of post-laryngectomy speech.

In an unpublished study, Crouse (8) demonstrated a "preference" for esophageal speech over artificial larynx speech when judged by both naive and sophisticated listeners. Crouse, however, used both auditory and combined auditory-visual presentations of laryngectomized speakers. Crouse reports that esophageal
speech was preferred in each condition tested with a stronger preference for esophageal speech being expressed when judgements were based on the combined auditory-visual presentation of the speakers.

Carder (7) undertook an investigation of the differential effects of auditory and combined auditory-visual cues upon the judged intelligibility of esophageal and artificial larynx speech. Simultaneously filmed and tape recorded samples of esophageal and artificial larynx speech were presented to 38 naive judges. Each judge was asked to rate the intelligibility of each sample of speech on a seven point equal appearing interval scale. She concluded that there is a lack of convincing evidence that visual cues importantly affect the judgments of intelligibility of post-laryngectomy speech.

Summary and Limitations of Related Studies

The research which has been reviewed concerning post-laryngectomy speech has indicated the individual acoustic strengths and weaknesses of each of the types of speech to be considered in this study, and has provided an overview of the relative merits of each of the two methods. Attempts to compare the two methods in terms of listener reaction have resulted in contradic-
tory findings as to which method, if either, is superior to the other.

With the exception of Hyman's study, all previous research indicates the superiority of esophageal speech over artificial larynx speech when "preference" was the criterion measured used by naive and sophisticated judges.

Although Gardner and Harris (13) show that approximately 40 per cent of successfully laryngectomized patients never acquire intelligible esophageal speech, it seems that those concerned with the rehabilitation of laryngectomized persons introduce psychological bias against the use of the artificial larynx, a bias apparently based in part upon the opinion that esophageal speech is preferred unequivocally by listeners.

**Statement of the Problem**

The primary purpose of this study was to investigate the relationships of judgments of esophageal and artificial larynx speech when these judgments are made by naive and sophisticated listeners. Specifically, the following questions were asked:

1. Is there a difference between the judgments of the same samples of esophageal speech and artificial larynx speech when these judgments are made
by naive and sophisticated judges?

2. Do the preferences of naive and sophisticated judges for one type of speech over the other become evident when the factor of intelligibility is minimized by pairing esophageal speakers with equally intelligible artificial larynx speakers on the basis of scores derived from a multiple choice intelligibility test?

It was assumed that by comparing the preferences of both groups of judges for one type of speech over the other when samples had been prejudged by the same judges to be of near equal intelligibility, the specific influence of personal preference for type of speech could be more adequately investigated.

Naive and sophisticated judges were used to determine if a degree of sophistication in the field of speech pathology has a bearing on preference for one type of speech over the other. Since the majority of studies have shown that speech pathologists tend to prefer esophageal speech to the extent of rejection of the uses of the artificial larynx, it was felt that by comparing the personal preferences for speech type from both naive and sophisticated judges information may be derived as to the nature and source of the characteristic preference for esophageal speech among
speech pathologists.

It was further proposed that these relationships could best be investigated by having both groups of judges pre-judge many samples of esophageal and artificial larynx speech on a multiple choice intelligibility word list test. Samples of esophageal and artificial larynx speech which received near equal intelligibility scores would be paired and a series of paired comparisons would be presented to both groups of judges. Speakers were matched on the basis of their scores being separated by no more than two correctly identified words. If no preference for type of speech existed, a 50-50 percentage for preference for type of speech would be found within each group. If a preference existed, the preferred type of speech would have a significantly higher incidence of selection by the judges.
CHAPTER II

THE SUBJECTS AND PROCEDURES OF THE STUDY

The Subjects

The subjects who participated in this study were 19 male esophageal speakers and 11 male artificial larynx speakers. All of the speakers were members of the Anamilo Club of Detroit, a chapter of the International Association of Laryngectomees, and volunteered their participation in the study through that organization. In each case the speech used by the participant was being used as the mode of his everyday speech.

The age range for the esophageal speakers was 41 years to 79 years with a mean age of 58.6 years. For the artificial larynx group, the ages ranged from 34 years to 74 years with a mean age of 57.6 years.

The esophageal speakers had been using esophageal speech for from 18 months to 17 years with a mean of 6.1 years. The artificial larynx speakers had utilized the artificial larynx for from one year to eight years with a mean of 3.9 years.

Of the 11 artificial larynx speakers, four used the Aurex Electrolarynx, six employed the Western Elec-
electric Electrolarynx and one used the Aurex portable artificial larynx.

The Stimulus Material

The stimulus material in the study consisted of tape recorded speech samples of 19 esophageal and 11 artificial larynx speakers. Each speaker was required to perform two speaking tasks.

Task one consisted of the reading of eight three word phrases. The words spoken by each speaker were preselected for use in a multiple choice intelligibility test. A different series of eight three word phrases was used by each speaker. A sample copy of speaker task one appears in Appendix A. Further discussion and information relating to multiple choice intelligibility tests can be derived by reading Black (6).

In task two, each speaker read a fifty-five word passage of continuous discourse. With the exception of the semi-vowel /hw/ each of the vowel sounds and each of the consonant sounds utilized in General American speech appeared at least once in the passage which read as follows:

Many people are taking a trip to the New York World's Fair this year. Everybody should go up to the fair if they have the chance. Right now, my plans are to go for just a few days. My family and I are looking
forward to the trip with pleasure; we talk about it often.

In task one, speaking time for the individual esophageal speakers varied from 31 seconds to 56 seconds with a mean for the group of 44 seconds. The time range for the artificial larynx speakers was 29 seconds to 45 seconds with a mean for the group of 38 seconds.

In task two, the speaking time for the esophageal speakers ranged from 19 seconds to 45 seconds with a mean for the group of 28 seconds. The time range for the artificial larynx speakers was 17 seconds to 39 seconds with a group mean of 27 seconds.

Recording Procedures and Equipment

All but two of the subjects participating in the study were tape recorded in a conference room at the headquarters of the Michigan Cancer Foundation, Inc., in a room judged to be appropriately low in noise level and free of ambient noise. Two subjects were recorded in quiet rooms in their homes. If sudden, ambient noise occurred, the speech sample was re-recorded.

Each speech sample was recorded on a Voice of Music portable tape recorder (Model 730, Tape-O-Matic), using a crystal microphone which was placed on a table of standard height directly in front of each speaker. All of the speakers were standing during the recordings.
This placed the microphone approximately twelve inches in front of the speaker at lower than waist level. Each speaker was recorded at a tape speed of 3.75 inches per second at a loudness level that was judged to be adequate to provide clear and undistorted recordings.

Prior to being recorded, each speaker was given the following directions by the investigator:

You are asked to speak aloud two brief reading tasks. Task one will include a list of words in series of three. You will begin by saying "I am speaker number ___." You will then read the word list line by line, adding the appropriate number before each line. For example, you might say, "Number one heat wire fence." You may pause after each complete line. Read each line in a comfortable and relaxed manner as though you were talking to a friend. However, do not drop your voice at the end of a line. Are there any questions? If you are ready, we will begin task one now. Here is a copy of what you are to read.

When task one had been completed, the following instructions were given for task two:

You are now asked to read aloud a brief paragraph. Read again in a comfortable and natural manner as though you were talking to a friend. Are there any questions? If you are ready, we will begin task two now. Here is a copy of what you are to read.

In the case of gross misreadings or errors that made the speaker feel dissatisfied with his performance or in the case of sudden, ambient noise, the tape recording was repeated.
Two groups of judges were utilized in this investigation. A group of 40 students at Western Michigan University who were majoring in speech correction and who had completed the course in Introduction to Speech Correction and Phonetics was designated as the sophisticated group. This group ranged in age from 18 years to 45 years, and was comprised of 20 males and 20 females, none of whom had a hearing loss.

Another group of 40 students at Western Michigan University who were not majors in speech correction was designated as the naive group. This group ranged in age from 20 years to 35 years and was comprised of 20 males and 20 females, none of whom reported a hearing loss; nor had had any previous contact with postlaryngectomy speech.

There were two judging sessions for each group of judges. In the first session, both groups of judges heard randomly all speakers performing task one, that of reading the word lists. Each judge was asked to select, from a group of four foils for each word, those 24 words that he heard spoken. Answer sheets for the judges for task one can be found in Appendix B.

For eight blocks, each containing three stimulus words, a total of 24 words were circled by the judges.
for each speaker. The mean number of correct identifications by the judges became the intelligibility score for each speaker.

When scores were derived for each speaker, intelligibility scores for individual esophageal and artificial larynx speakers were compared and matched. Separate matching was done on the basis of intelligibility scores derived from the sophisticated and then the naive judges.

When the matching was completed, i.e., when each esophageal speaker was matched to an artificial larynx speaker with an equal or near equal intelligibility score, nine pairs of speakers were derived for both groups of judges. A near equal score represented mean scores for two speakers that were within two correct identifications of each other.

There appeared to be a wide range of speech proficiency among the esophageal speakers. However, only those esophageal speakers who were matched in speech proficiency to artificial larynx speakers were used in the study.

In the second judging session, both groups of judges were presented with matched esophageal and artificial larynx speakers who were reading task two, the continuous discourse passage. Both groups of judges then made a series of choices indicating which speaker
in each pair they preferred. Both groups of judges were then asked to indicate why they had made their particular choice. The order of speakers within each pair was randomly determined.

The judging sessions were held in small classrooms. Auditory stimuli were presented to the judges using the tape deck of a Voice of Music (Model 720, Tape-O-Matic) tape recorder, the signal from which was directed into an Ampex (Model 620) amplifier-speaker unit. The stimulus material was presented free field at a loudness level which was comfortable and clear for all judges.

Detailed instructions concerning the methods of judging were given by the investigator at the beginning of both judging sessions. A copy of these instructions can be found in Appendix C. Judges answer sheets for task two can be found in Appendix D.

Approximately ten seconds of blank tape followed both speakers in the second judging task to allow the judges time to record their preferences. The time required for the first judging session was approximately 50 minutes, and the second judging session required 20 minutes.

Treatment of the Data

The number of preferences expressed for each
speaker within each pair was tabulated for both the sophisticated and naive judge groups.

A Chi square was computed for each pair of speakers to determine whether any differences existed in the preferences of the sophisticated and naive judges for the two types of postlaryngectomy speech.

When there was a preference for one type of speech over the other, the reasons given by the judges for their preference were investigated.
CHAPTER III

THE RESULTS AND DISCUSSION OF THE STUDY

Results of Judging Task One

In task one, the number of words spoken by esophageal speakers that were correctly identified by naive judges ranged from a score of one given to one speaker by nine judges to a score of 23 given to one speaker by one naive judge. Sixteen naive judges scored zero for one artificial larynx speaker while two naive judges gave one artificial larynx speaker a score of 20.

The number of words spoken by esophageal speakers that were correctly identified by sophisticated judges ranged from a score of one given to two speakers by 23 judges to a score of 22 given to one speaker by one sophisticated judge. Twenty-nine sophisticated judges scored zero for one artificial larynx user while two sophisticated judges gave one artificial larynx speaker a score of 15. The overall range of individual scores for esophageal and artificial larynx speakers as judged by both groups of judges is depicted graphically in Figure 1.
Figure 1. Overall range of individual scores for esophageal and artificial larynx speakers as judged by naive and sophisticated judges.
Individual mean scores of intelligibility were computed for each speaker for the first judging task, that of identification of words spoken in eight three word phrases. These mean scores for individual esophageal and artificial larynx speakers are presented in Appendix E.

Mean intelligibility scores for esophageal speakers ranged from 4.58 to 18.22 for judgements by naive judges and from 3.83 to 15.78 for judgements made by sophisticated judges. Mean intelligibility scores for artificial larynx speakers ranged from 1.45 to 10.43 for judgements by naive judges; and from .38 to 11.28 for judgements made by sophisticated judges. Figure 2 indicates in graphic form the range and median of the mean scores for esophageal and artificial larynx speakers as judged by both the naive and sophisticated judges.

The wide range of individual mean scores is indicative of the individual differences of speech proficiency that existed among the subjects of the study. Although high intelligibility scores were given to some individual speakers regardless of the method of speech employed, it is apparent from the group means and ranges (see Figures 1 and 2) that, as a group the esophageal speakers were scored higher in intelligibility than the artificial larynx users by both the naive and sophis-
Figure 2. Range of mean scores for esophageal speech and artificial larynx speakers as judged by naive and sophisticated judges. Median score for each speaker group by judge group is written within each graph bar.
icated judges. The individual and group differences were not detrimental to the purpose of the study, however, as only those esophageal and artificial larynx speakers were matched whose mean scores were separated by no more than 2.0 correct identifications.

Although the same speakers were paired by both groups of judges, the naive judges tended to judge all speakers higher in intelligibility than did the sophisticated judges. A possible explanation for the higher scoring of all speakers by the naive judges is that naive judges tend to be more accepting of obviously deviant speech than sophisticated judges.

Results of Judging Task Two

Individual mean intelligibility scores were computed and compared for each esophageal and artificial larynx speaker. Esophageal and artificial larynx speakers whose mean intelligibility scores lay within 2.0 correct identifications of each other were matched and considered to be of equal intelligibility. Nine pairs of speakers (one esophageal and one artificial larynx speaker to a pair) were derived when all individual speaker means were compared. Mean scores and identifying information for the paired speakers appear in Appendix F.
For nine pairs of speakers, 40 naive judges made a total of 360 preferential judgements. Of 360 total preferences, the naive judges preferred esophageal speech 323 times and artificial larynx speech 37 times.

In order to test the significance of the preferences for esophageal and artificial larynx speech by naive judges, a frequency Chi-square was computed.

The obtained Chi-square of 261.22 with one degree of freedom was significant beyond the .005 level of confidence.

Out of the 323 times the naive judges preferred esophageal speech to artificial larynx speech, one naive judge preferred esophageal speech in six of nine trials; six preferred esophageal speech in seven of nine trials; 22 preferred esophageal speech in eight of nine trials; and 11 preferred esophageal speech in all nine trials.

Of 360 total preferences, the sophisticated judges preferred esophageal speech 333 times and artificial larynx speech 27 times.

A frequency Chi-square was computed to test the significance of the preferences for esophageal and artificial larynx speech made by sophisticated judges.

The obtained Chi-square of 260.1 with one degree of freedom was significant beyond the .005 level of
confidence.

Out of 333 times the sophisticated judges preferred esophageal speech to artificial larynx speech, three sophisticated judges preferred esophageal speech in six of nine trials; six preferred esophageal speech in seven of nine trials; six preferred esophageal speech in eight of nine trials; and 25 preferred esophageal speech in all nine trials.

An overall frequency Chi-square was computed to determine the significance of the difference between the preferences for esophageal and artificial larynx speech made by both the naive and sophisticated judges. A Chi-square of 1.714 for one degree of freedom was computed indicating that the judgements made by the naive judge group did not differ significantly from the judgements made by the sophisticated judge group.

Comparison of the combined data from the two judging groups indicates a preference in both groups for esophageal speech. The significant preferences by both groups for esophageal speech indicated that information about the nature of their preferences might be derived from analysis of the reasons given for preferring one speaker over the other by both groups of judges.

Historically, research in the field of speech
pathology has described the negative aspects of the artificial larynx as "distracting." The term "distracting," however, has remained undefined especially as it may apply to auditory cues.

In this study, preference for esophageal speech was reflected in words describing the negative aspects of artificial larynx speech.

The judges responses indicating why they preferred esophageal speech serve to define the term "distractibility" and present further specific information about negative aspects of artificial larynx speech.

Six general categories describing the negative aspects of artificial larynx speech were derived from the responses of both groups of judges. An analysis of the categories and the frequency of their use in describing artificial larynx speech appears in Table 1.

Both groups of judges felt that the artificial larynx voice lacked inflection and expression. The monotone which pervaded the entire sample of artificial larynx speech served to cause the judges to react negatively to this type of speech. Other criticisms of artificial larynx speech consisted of negative reactions to the speed, loudness, jerkiness and lack of phrasing in the heard samples of artificial larynx speech.

Both naive and sophisticated judges noted the
absence of surds or unvoiced speech sounds. The most commonly noted absence of a surd was the substitution of a /b/ sound for a /p/ sound by most of the artificial larynx users.

TABLE I. AN ANALYSIS OF THE CATEGORIES AND THE FREQUENCY OF THEIR USE IN DESCRIBING ARTIFICIAL LARYNX SPEECH

| I. Lack of expression and inflection. Presence of a monotone. (74) |
| II. Too great loudness which interferes with hearing of speech. (53) |
| III. The lack of phrasing and unsmooth turning on and off of the sound source. (59) |
| V. Too rapid rate of speech. Words were slurred together. (47) |
| VI. The absence of surds or unvoiced sounds. Most common substitution was /b/ for the /p/ sound. (17) |

The most common criticism of artificial larynx speech by both groups of judges concerned the mechanical sound of the artificial larynx. Most judges described the mechanical sound as being unnatural, twanging, buzzing and less human sounding than esophageal speech.

In the case of the most commonly preferred arti-
ficial larynx speaker, both groups of judges again reacted to the mechanical sound of the artificial larynx; but considered the apparent struggle in the paired esophageal more unpleasant than the sound of the artificial larynx.

In general both groups of judges found elements of distractibility in various aspects of the artificial larynx; but defined the greatest distraction factor as being concerned with the mechanical sound and unnaturalness of the artificial larynx.

Discussion

An analysis of the data compiled from the first judging task revealed that both groups of judges gave higher intelligibility scores to esophageal speakers. Although nine pairs were derived on the basis of equal or near equal scores for individual esophageal and artificial larynx speakers, four esophageal speakers received scores so high as to not be matchable with artificial larynx speakers; and three artificial larynx speakers received scores so low as to not be matchable with esophageal speakers. It can therefore be stated that both groups of judges generally found esophageal speech to be more intelligible than artificial larynx speech.
Intelligibility scores from the first judging task also indicated that the naive judges tended to score most of the speakers higher than did the sophisticated judges. This was true for judgements of both esophageal and artificial larynx speakers. A tentative explanation was offered in that naive judges tend to be more accepting of obviously deviant speech than are sophisticated judges. An alternative explanation would suggest that sophisticated judges tend to be more critical of spoken speech than are naive judges.

Either possible explanation for the higher scoring of both types of speakers by the naive judges suggests that either type of postlaryngectomy speech is more readily received and understood by unsophisticated persons. Since the laryngectomized person deals with unsophisticated persons in everyday life much more than with speech pathologists and physicians, his chances for acceptance and communication are increased.
CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

It must be concluded on the basis of the present study that naive and sophisticated judges tended to judge samples of esophageal and artificial larynx speech in the same ways. Within both groups of judges esophageal speech was preferred with significantly greater frequency than was artificial larynx speech. It must also be concluded that both groups of judges found esophageal speech to be more intelligible than artificial larynx speech.

The presence of a differential bias for esophageal speech on the part of the sophisticated judges was not demonstrated in this study. Rather, the sophisticated judges tended to judge postlaryngectomy speech in much the same manner as did naive judges. Preference for esophageal speech by both groups appeared to be based on a mutual dislike for the quality of the artificial larynx voice. Both groups of judges tended to employ six basic categories in describing the distracting aspects of the artificial larynx voice. The most common negative reaction was to the mechanical and unnatural
sound of the artificial device.

The results of the first judging task indicated that the naive judges tended to find both types of postlaryngectomized speakers more intelligible than did the sophisticated group. Explanations for the higher scoring by naive judges were suggested. The higher scores of intelligibility given by the naive judges suggested that the naive judges were more accepting of obviously deviant speech than were the sophisticated judges or that the sophisticated judges were more critical of the spoken word than were the naive judges. As it is with the unsophisticated listener that the laryngectomized person must deal in his everyday life, the greater acceptance of obviously deviant speech on the part of naive judges is in favor of the laryngectomized person's adjustment to post-surgical verbal communication.

Both groups of judges felt that the performances by the artificial larynx speakers could have been improved with further speaker skill in the use of the artificial larynx. Many of the negative aspects of the sound of the artificial larynx as seen by both groups of judges are subject to improvement with further skill in the use of the artificial larynx.

It is obvious, therefore, that further instruction
in the use of the artificial larynx typically is needed by artificial larynx users. It seems to be the obligation of distributors of artificial larynges and those speech pathologists and physicians who attempt to instruct in this type of postlaryngectomy speech to see to it that adequate instruction is given to the artificial larynx user.

Throughout this investigation, the investigator was aware of the limitations of the study. Certainly, with a greater number of subjects the results of the study could be made more meaningful.

More accurate judgements of intelligibility could have been made had standard pauses been inserted at the end of each speaker phrase in task one. Some artificial larynx speakers did not pause between phrases. The first judging task, therefore, became for some judges a reading task as they hurriedly searched through the foils. It is suggested that further studies present the tape recorded speech samples with a pause of standard length at the end of each phrase for each speaker.

Although both groups of judges preferred the esophageal speakers to the artificial larynx speakers, there appeared overlap between speaker groups and occasional preferences for artificial larynx speakers.
These events signify that the artificial larynx may under certain conditions provide an adequate means of postlaryngectomy speech.
CHAPTER V

SUMMARY

It was the purpose of this study to investigate the relationships between judgements of esophageal and artificial larynx speech when these judgements are made by naive and sophisticated judges, and to determine if and in what ways judgements of postlaryngectomy speech differed between naive and sophisticated judges. The major objective of the formulation of this purpose was to provide a means of investigating whether or not a bias for one type of speech over the other would appear among students of speech pathology.

Tape recorded samples of postlaryngectomy speech consisting of 30 samples of eight three word phrases and 18 readings of a 55 word passage of continuous discourse constituted the stimulus material that was presented to 40 naive and 40 sophisticated judges.

In the first of two tasks, the judges were asked to score each speaker reading the eight three word phrases. The mean number of words correctly identified by the judges constituted each speaker's intelligibility score.
After the mean intelligibility score for each speaker was computed, nine pairs of speakers (one esophageal and one artificial larynx speaker to a pair) were matched on the basis of equal or near equal intelligibility scores.

The 55 word connected speech samples of the nine pairs of speakers were presented in a second judging task. The judges were asked to indicate a preference for one speaker or the other in each pair and to indicate briefly the reasons for each preference.

Although the naive judges tended to score most speakers somewhat higher than did the sophisticated judges, nevertheless the scores derived from each group of judges paired the same speakers. Two possible explanations were offered for the higher intelligibility scoring by the naive judges; naive judges may tend to be more accepting of obviously deviant speech; and/or sophisticated judges, as a function of their training, may be more critical of spoken speech than are the naive judges.

In task two, both groups of judges preferred esophageal speech over artificial larynx speech to a significant degree.

The reasons for judge preference were investigated; and it was discovered that both groups of judges re-
garded the artificial larynx as distracting due to factors of loudness, rate of speech, lack of phrasing, lack of inflection and expression, and the mechanical and unnatural sound of the artificial device.

The results of this study suggest that no differential bias for one type of postlaryngectomy speech over the other existed among the sophisticated judges. Both groups of judges appeared to define their preferences for esophageal speech in terms of relatively discrete and mutually perceived negative aspects of artificial larynx speech.


8. Crouse, Gertrude P., "An Experimental Study of Listener Preference for Artificial Larynx or Esophageal Speech by Comparison of Audio with Audio-visual Presentation." M. A. Project, Emory University, 1962.


EXAMPLE OF SPEAKER TASK ONE

I am Speaker Number One

<table>
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<th>Number</th>
<th>Word</th>
<th>Word</th>
<th>Word</th>
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<td>piston</td>
<td>firm</td>
<td>banner</td>
</tr>
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<td>2</td>
<td>eve</td>
<td>attain</td>
<td>scream</td>
</tr>
<tr>
<td>3</td>
<td>rupture</td>
<td>tour</td>
<td>medal</td>
</tr>
<tr>
<td>4</td>
<td>ark</td>
<td>spotter</td>
<td>gain</td>
</tr>
<tr>
<td>5</td>
<td>cannon</td>
<td>detract</td>
<td>made</td>
</tr>
<tr>
<td>6</td>
<td>lumber</td>
<td>case</td>
<td>pierce</td>
</tr>
<tr>
<td>7</td>
<td>jail</td>
<td>glimmer</td>
<td>ward</td>
</tr>
<tr>
<td>8</td>
<td>nature</td>
<td>enact</td>
<td>old</td>
</tr>
</tbody>
</table>
JUDGES ANSWER SHEET FOR TASK ONE (FIRST DAY)

SAMPLE SAMPLE SAMPLE

I am speaker number oneteen
Number one heat cold foot

SAMPLE SCORING SHEET

meat old foot
heat sold soot
feat cold fort
hat mold put

**************************

CIRCLE THE WORDS THAT YOU HEAR SPOKEN

I am speaker number one

form campus court
warm canvas fort
swarm pamphlet port
storm panther quart
air force spark tassel
airport park tackle
air corps dark cattle
airborne bark pastel
group quicker beef
3 troop flicker beast
coupe slicker beat
fruit licquor beam
reason wonder corn
region blunder torn
legion thunder horn
legend sponsor born
stretch hear guard
5 threat steer hearten
dread near garden
bread deer bargain
certain export file
pertain extort panel
person expert funnel
curtain escort final
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<td>rage</td>
<td>sitting</td>
<td>all</td>
</tr>
<tr>
<td>8</td>
<td>uncle</td>
<td>dread</td>
<td>screech</td>
</tr>
<tr>
<td></td>
<td>buckle</td>
<td>dress</td>
<td>preach</td>
</tr>
<tr>
<td></td>
<td>knuckle</td>
<td>rest</td>
<td>reach</td>
</tr>
<tr>
<td></td>
<td>stucco</td>
<td>red</td>
<td>street</td>
</tr>
</tbody>
</table>
APPENDIX C
INSTRUCTIONS TO THE JUDGES (FIRST DAY)

This is a research project in which you are asked to judge the intelligibility of speech used by persons who have undergone surgical removal of the larynx. They will be using two types of what is sometimes called a "substitute voice." You can, therefore, expect that the speech will sound somewhat different from what might be called "normal" speech.

You will now hear four examples of "substitute voice;" two each of each type of speech. These are examples so you need not indicate anything on your answer sheet. (play samples)

You will now be listening to 30 tape recorded speech samples. The speakers will be reading a list of phrases which are found one word to a column on your answer sheets.

You are to circle the words that you hear. Be sure your circle is neat and that it does not encompass more than one word. If you wish to change an answer, cross out your undesired answer with a large X; then circle your desired word. You will have sufficient time between phrases to circle your answers. However, if you fall behind, do not stop. Circle as many answers as accurately as you can.
Now look at the sample found at the top of your scoring sheet.

Assume that a speaker has just said "number one heat cold foot." You will notice that the words "heat, cold" and "foot" have been underlined in the sample.

Mark your answers by circling the words that you hear.

Are there any questions?

We are now ready to begin. Here is speaker number one.
INSTRUCTIONS TO THE JUDGES (SECOND DAY)

During this second judging session, you are asked to listen to a series of pairs of speech samples. When you have heard two speech samples you are to indicate your preference for one speech sample by underlining the letter of the speech sample preferred. Be sure that you make a choice for every pair of speech samples. Some may seem equally preferable; but choose one sample anyway.

Now look at your sample at the top of your answer sheet.

Assume that you have just heard speaker X and speaker Y. Assume also that you prefer speaker Y. The sample indicates how you should mark your answers when the judging session begins.

Every speaker that you hear will be reading the same passage. A copy of this passage is found at the top of your answer sheet.

Please indicate in the space provided your reasons for preferring one speaker over the other.

Are there any questions?

If you are ready, we will begin the second judging session now.

Here is your first pair of speech samples.
JUDGES ANSWER SHEET (TASK TWO)

NAME: ___________________________  MAJOR: _______________________

1.) I prefer speaker A  B  Why________________________

2.) I prefer speaker C  D  Why________________________

3.) I prefer speaker E  F  Why________________________

4.) I prefer speaker G  H  Why________________________

5.) I prefer speaker I  J  Why________________________

6.) I prefer speaker K  L  Why________________________

7.) I prefer speaker M  N  Why________________________

8.) I prefer speaker O  P  Why________________________

9.) I prefer speaker Q  R  Why________________________

10.) I prefer speaker S  T  Why________________________
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<thead>
<tr>
<th>Speaker Number</th>
<th>Naive Mean</th>
<th>Sophisticated Mean</th>
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<td>15.78</td>
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<td>12.13</td>
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<td>10.88</td>
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<td>6</td>
<td>18.22</td>
<td>15.43</td>
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<tr>
<td>7</td>
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<td>10.75</td>
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<td>5.87</td>
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<td>25</td>
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<td>12.32</td>
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<td>29</td>
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<td>14.53</td>
</tr>
<tr>
<td>30</td>
<td>13.38</td>
<td>12.63</td>
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</table>
### Mean Scores for Artificial Larynx Speakers as Judged by Naive and Sophisticated Judges

<table>
<thead>
<tr>
<th>Speaker Number</th>
<th>Naive Mean</th>
<th>Sophisticated Mean</th>
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<tr>
<td>22</td>
<td>1.45</td>
<td>.38</td>
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<td>24</td>
<td>3.1</td>
<td>2.08</td>
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<td>31</td>
<td>8.15</td>
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<td>33</td>
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<td>34</td>
<td>10.37</td>
<td>10.18</td>
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</tr>
<tr>
<td>40</td>
<td>5.85</td>
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</tbody>
</table>
APPENDIX F
### Mean Intelligibility Scores for Paired Esophageal (E) and Artificial Larynx (AL) Speakers Derived from Judgements Made by Naive and Sophisticated Judges.

<table>
<thead>
<tr>
<th>Speaker Number and Type</th>
<th>Naive</th>
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<tbody>
<tr>
<td>A 12.1 (E)</td>
<td>25</td>
<td>12.32</td>
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<tr>
<td>B 10.43 (AL)</td>
<td>32</td>
<td>11.28</td>
</tr>
<tr>
<td>C 4.56 (AL)</td>
<td>36</td>
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</tr>
<tr>
<td>D 4.58 (E)</td>
<td>3</td>
<td>3.83</td>
</tr>
<tr>
<td>E 4.58 (E)</td>
<td>3</td>
<td>3.83</td>
</tr>
<tr>
<td>F 4.56 (AL)</td>
<td>38</td>
<td>2.68</td>
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<tr>
<td>G 5.85 (AL)</td>
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<td>H 5.87 (E)</td>
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<td>J 10.37 (AL)</td>
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<td>10.18</td>
</tr>
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<td>L 12.13 (E)</td>
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<td>10.6</td>
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<td>M 8.38 (E)</td>
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<td>31</td>
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<td>O 10.43 (AL)</td>
<td>32</td>
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<tr>
<td>P 11.65 (E)</td>
<td>27</td>
<td>10.33</td>
</tr>
<tr>
<td>Q 10.05 (E)</td>
<td>21</td>
<td>8.48</td>
</tr>
<tr>
<td>R 10.37 (AL)</td>
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