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<https://doi.org/10.15760/etd.5720>

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AN ABSTRACT OF THE THESIS OF Janet Gordon Daucsavage for
the Master of Science in Speech Communication: Emphasis
in Speech-Language Pathology presented February 7, 1989.

Title: Naive Listener Judgements of Esophageal Air Intake
Noise Acceptability

APPROVED BY MEMBERS OF THE THESIS COMMITTEE:

Mary E. Gordon, Chair

Robert L. Casteel

Elizabeth Kutza

The purpose of this study was to determine the judgements by naive listeners of the acceptability of esophageal air intake noise and compare those ratings to their judgements of overall esophageal speech proficiency. The primary question this study sought to answer was: Are naive

listener judgements of overall esophageal speech proficiency significantly correlated with naive listener judgements of esophageal air intake noise acceptability? The secondary question asked was: Are naive listener acceptability judgements of air intake noise significantly correlated with sophisticated listener acceptability judgements of air intake noise?

Tape-recorded samples of 18 laryngectomized individuals reading a paragraph using esophageal speech were played for 12 naive listeners. The naive listeners rated overall esophageal speech proficiency on a 5-point scale. After the proficiency rating task, they participated in a short training session to become familiar with esophageal air intake noise. The speech samples were played again and the judges were instructed to rate the acceptability of air intake noise on a 5-point scale. Interjudge and intrajudge reliability scores were determined by Pearson product-moment correlation coefficients. Unclear terminology used on the rating scales places limitations on the interpretation of the results of this study. Intrajudge reliability for ratings of overall esophageal speech proficiency was quite variable ($r=.47-.95$).

Results of the primary question indicate that naive listener judgements of overall esophageal speech proficiency were found to be positively correlated ($r=.81$) with their judgements of esophageal air intake noise

acceptability ratings beyond the .01 level of significance. The Index of Determination ($\underline{r}^2=.65$) indicates a 65% overlap between the variables in terms of shared variance, thus the amount of variance not accounted for by the correlation was 35%. Although this correlation was high, it is unclear as to what the judges meant by their ratings of proficiency and what factors influenced the ratings of the acceptability of air intake noise. The second question posed by this study includes sophisticated judges ratings of air intake noise acceptability obtained from Eccleston's (1982) study. The relationship between naive listener acceptability judgements of air intake noise with sophisticated listener judgements of the same was found to be a high positive correlation ($\underline{r}=.81$) beyond the .01 level of significance. The Index of Determination ($\underline{r}^2=.65$) indicates the amount of variance shared by the variables is 65% while 35% of the variance was not accounted for by the correlation.

Data from this study suggest that as overall esophageal speech proficiency ratings increased, (as judged by naive listeners) so did their judgements of air intake noise acceptability. Both naive and sophisticated listeners' ratings of acceptability judgements of air intake noise appeared to be in agreement indicating they have similar ideas of what they consider acceptable in regards to air intake noise. These results suggest that clinical

and treatment time should focus on the reduction and/or elimination of air intake noise to improve overall esophageal speech proficiency.

NAIVE LISTENER JUDGEMENTS OF
ESOPHAGEAL AIR INTAKE NOISE
ACCEPTABILITY

by

JANET GORDON DAUCSAVAGE

A thesis submitted in partial fulfillment of
the requirements for the degree of

MASTER OF SCIENCE
in
SPEECH COMMUNICATION

with emphasis in
Speech-Language Pathology

Portland State University

1989

TO THE OFFICE OF GRADUATE STUDIES:

The members of the Committee approve the thesis of Janet Gordon Daucsavage presented February 7, 1989.

Mary E. Gordon, Chair

Robert Castéel

Elizabeth Kutza

APPROVED:

Theodore G. Grove, Chair, Department of
Speech Communication

Bernard Ross, Vice Provost for Graduate
Studies

ACKNOWLEDGEMENTS

This research project would not have been completed without the efforts and support of many people who gave their time, energy, and knowledge to complete this project. A special thanks to my husband, Bruce, for his unrelenting patience and encouragement.

A special thanks to Vincent Eccleston for his support, interest, and research data which laid the groundwork for this project and are greatly appreciated.

Many thanks are extended to the "naive listeners" who gave their time and energy and were committed to furthering research in the area of alaryngeal communication. Thanks, also, to my sister, Barbara, who contributed her knowledge of computers and typing skills on a moments notice.

Thanks to my graduate committee: Mary Gordon, Robert Casteel, and Elizabeth Kutza. I am grateful for their insightful observations and suggestions which greatly enhance the quality of this paper. Many thanks to Mary Gordon, my graduate advisor, for her calm, straight-forward manner, her advice, suggestions, and encouragement. To all my professors in the Speech and Hearing Sciences Program at Portland State University, I extend my thanks and gratitude.

Lastly, thanks to my family and friends who provided encouragement and support in many different ways. Thanks to my children, Sara and Peter, for their unconditional love and patience.

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CHAPTER I

INTRODUCTION AND STATEMENT OF PURPOSE

INTRODUCTION

The surgical removal of the larynx is usually performed in a life-threatening situation and excision of malignant tissue is always the primary consideration while conservation of tissue to facilitate voice acquisition is of secondary importance (Snidecor, 1968). Improved surgical techniques and medical management have increased the survival rate of those persons undergoing laryngectomy, and subsequently, loss of voice and its psycho-social implications become of crucial importance. Those involved in total rehabilitation of the laryngectomized individual concentrate on the acquisition of functional alaryngeal voice as a major goal, and after nearly 100 years of laryngectomy, voice restoration is still a challenge. Several methods of voice restoration are available, including the use of an artificial larynx, esophageal speech, and several different surgical-prosthetic voice restoration techniques.

Many factors need to be considered in determining which method of alaryngeal voice is best suited for each laryngectomized individual, including the extent of surgery, radiation, and post-operative healing. Esophageal

speech appears to be the most preferred method of communication. It is estimated between 50% and 70% of laryngectomized individuals will develop esophageal speech as their primary means of communication with various degrees of success (Gardner, 1978; Knox, Eccleston, Maurer, & Gordon, 1987; Snidecor, 1975). Who learns esophageal speech and with what degree of proficiency will be determined by many co-existing factors which interact in a complicated fashion either to facilitate or hinder the development of esophageal speech (Martin, 1979).

Many esophageal speakers produce extraneous noises when taking air into their esophagi for use during speech. This noise varies in intensity and frequency and may range from an infrequent, barely audible "clump" sound to a loud and distracting "klunk" sound that is consistently produced with each new air charge (Gardner, 1978; Snidecor, 1968). "Klunking" appears to be the term most commonly accepted and was used throughout this study.

The klunking noise indicates that air has entered the esophagus and is available for expulsion to create esophageal phonation (Duguay, 1977). Therefore, the klunking noise is most often audible during the intake of air, immediately prior to phonation. It is a generally held belief that the klunking noise results from attempting to take in too much air too quickly, accompanied by too much tension within the pharyngeal and/or esophageal areas

(Diedrich & Youngstrom, 1966; Salmon, 1979). Many authors recommend minimizing or eliminating klunking noise early in treatment (Boone, 1977; Gardner, 1978; Salmon, 1979). Klunking may not have an effect on intelligibility of esophageal speech, but may adversely influence communication by distracting the listener's attention (Hyman, 1979; Shanks, 1979).

The degree to which air intake noise may actually interfere with communication and its effect on the listener is largely unreported in the literature.

STATEMENT OF PURPOSE

The purpose of this study was to determine the judgments by naive listeners of the acceptability of esophageal air intake noise and compare those ratings to their judgments of overall esophageal speech proficiency.

The primary question this study sought to answer was: are naive listener judgments of overall esophageal speech proficiency significantly correlated with naive listener judgments of esophageal air intake noise acceptability? A second question was also posed: are naive listener acceptability judgments of air intake noise significantly correlated with sophisticated listener acceptability judgments of air intake noise?

CHAPTER II

REVIEW OF THE LITERATURE

This chapter provides a brief overview of alaryngeal voice rehabilitation and describes and defines esophageal speech production. The two most common methods of air intake are described and problems commonly associated with each method are defined. Studies relating esophageal speech proficiency and air intake noise acceptability are reviewed and examined to provide background information for the questions posed in this study.

ALARYNGEAL VOICE REHABILITATION

Due to laryngeal carcinoma, approximately 7000 Americans have their larynx and surrounding structure removed annually (Gates & Hearne, 1982). The subsequent effects of laryngeal cancer on speech, deglutition, and respiration permanently change the person's life. Voice preservation has been a major concern and priority inseparable from the evolution of treatment for laryngeal carcinoma. Rehabilitation of the voice may consist of an artificial larynx, acquisition of esophageal voice, or a surgical/prosthetic procedure of vocal restoration (Schaefer & Johns, 1982; Singer, Blom, & Hamaker, 1983).

Traditionally, rehabilitation efforts have centered on the acquisition of esophageal voice. Deidrich and Youngstrom (1966) describe esophageal speech as that in

which the vicarious air chamber is located within the lumen of the esophagus and the neoglottis is located above the air chamber. The site of the neoglottis is the pharyno-esophageal segment (P-E segment) and may contain fibers of the inferior constrictor, cricopharyngeus, and/or the superior esophageal sphincter which are predominantly located at the C₅ and C₆ level. (p. 108)

The acquisition of esophageal speech is the preferred method of alaryngeal communication due to its ready availability and freedom from mechanical or electronic technology (Ryan, Gates, Cantu, & Hearne, 1982). However, not all laryngectomized patients today acquire functional esophageal speech. The literature reports a range of percentages from 43% to 98% of laryngectomees who are able to acquire esophageal speech with various degrees of proficiency (Gardner, 1978; Gates, Ryan, Cooper, Lawlis, Cantu, Hayashi, Lauder, Welch, & Hearne, 1982). King, Fowlks, and Pierson (1968) reported data as to the means of communication of 88 laryngectomized patients who survived their operation by more than one year. They found only 42.6% of their patients from the Veterans Administration Hospital, Portland, Oregon, used esophageal speech exclusively. The effectiveness of esophageal speech was viewed as unsatisfactory for approximately 30% of the patients in some situations, i.e., in a quiet room, restaurant, and on the tele-

phone, and required writing, gestures, or another form to supplement esophageal speech. This study reported the smallest number of patients who achieved esophageal speech as reported in the literature. A probable rationale for the pessimistic figures from the Veteran's Hospital study can be partially explained by the older average age of their patients (median age = 63 years) who would normally present with hearing loss and possible deterioration of speech and language abilities due to the aging process. Other factors that may influence the figures may be increasing difficulty learning new skills with increasing age and less urgent motivation to return to professional or social life.

At the other end of the percentage range, Hunt (1964) reported on 85 private patients of whom 98% achieved esophageal speech. This figure included those considered to have "fair speech" which Hunt defined as "the production of words and syllables but no sentences" up to "superior speech" defined as "sustained sentences without hesitation for injection of air or breath sounds" (p. 389). When the categories of good and superior speech are combined, a total of 86% is reported to have achieved effective esophageal speech. Hunt attributes the high percentages to personal contact with each patient, early evaluation, and persistent encouragement.

Esophageal voice is characterized by a harsh vocal

quality, low pitch, and low volume which is adequate for communication in small groups and those settings where the ambient noise level is low (Gates et al., 1982; Knox et al., 1987; Snidecor, 1975).

Even under ideal conditions, esophageal speech creates problems in listening. Esophageal speech and its lack of perceived loudness is not always a speaker's disorder. Often the spouse or friends of the laryngectomee suffer a hearing loss, complicating the process of communication. In some instances, amplification of speech becomes desirable and necessary to improve communication and quality of life. It becomes of utmost concern to improve the understandability and acceptability of esophageal speech, not only to the laryngectomized individual, but to their family and friends as well (Gates et al., 1982; Ryan et al., 1982; Snidecor, 1975).

ESOPHAGEAL SPEECH PRODUCTION

To produce esophageal speech, air from the oral and pharyngeal cavities must pass down into the esophagus which now serves as the air reservoir. The laryngectomized individual must learn to overcome the tension of the cricopharyngeus muscle which provides closure of the mouth of the esophagus. In its natural or resting state, the segment is closed, opening long enough to allow the entry of food and liquid into the esophagus. Normally, control of

this muscle is reflexive, but because it is composed of striated muscle fibers, voluntary control can be learned making it possible to vary its size, shape, and tension (Duguay, 1979; Salmon, 1979; Torgerson & Martin, 1980). The esophagus must be insufflated to provide the energy source for sound production. Approximately 40-80 cc of air is taken into the esophagus to be used for esophageal speech (Dworkin & Banton, 1982). In turn, this air must be immediately redirected up from the esophagus to set up vibrations of the P-E segment which becomes the sound source.

At that time when consistent, volitional esophageal voice is produced, the laryngectomized individual must learn how to coordinate the production of voice with the articulators to produce intelligible speech. As few as it represents, the good esophageal speaker may generate an average of 10-12 syllables per air charge and as few as 100 words per minute (Dworkin & Banton, 1982). Less skilled esophageal speakers may produce fewer words per minute and have difficulty with consistent insufflation of the esophagus. Therefore, esophageal speech that is efficient and an effective means of communication requires the ability to control voluntarily air intake into the esophagus and the immediate redirection of that air out of the esophagus (Dworkin & Banton, 1982; Salmon, 1979; Torgerson & Martin, 1980).

Insufflation of the esophagus is usually achieved by one of two primary air intake methods, i.e., injection or inhalation. In the former method, pharyngeal air pressure must be increased beyond the level of resistance of the P-E segment so that air will be forced (injected) through the P-E segment into the esophagus; whereas, in the inhalation method, esophageal air pressure must be further reduced so that air that is circulating around in the mouth and pharynx will be sucked or drawn through (inhaled into) the P-E segment by means of a vacuum effect (Damste, 1979; Edels, 1983; Salmon, 1979).

Inhalation Method of Air Intake

The inhalation method is accomplished with little or no tongue movement and a completely patent airway is maintained between the lips and/or nose and the P-E segment. This method is accomplished in coordination with the biomechanics of pulmonary breathing by changing air pressure and creating a vacuum for air to flow into the lungs, as well as the esophagus, providing the P-E segment is sufficiently relaxed. In its natural state, the pressure within the esophagus is -4 to -7 mm Hg. During inspiration, the pressure drops to -10 to -20 mm Hg. This sudden drop in negative pressure within the esophagus forms a partial vacuum allowing the positive air pressure in the oral-pharyngeal area to be drawn into the esophagus to equalize the pressure in both areas (Salmon, 1979). As the

pressure difference is reduced, the P-E segment closes over the inflated esophagus ready for the air to be expelled for voice production (Dworkin & Banton, 1982; Edels, 1983; Salmon, 1979).

Injection Method of Air Intake

The injection method of air intake involves forcing air past the P-E segment by increasing the air pressure within the oral and pharyngeal cavities. This is achieved by closing off the escape routes, lips and velopharyngeal port, for the air and then reducing the size of the air chamber. This technique usually involves pumping or pressing movements of the tongue against the palate and/or pharynx. This action causes a reduction in the size of the oral-pharyngeal cavity thus forcing air molecules backwards and downwards into the pharynx. The increase in air pressure overrides the resistance of the P-E segment and thus drives air into the esophagus. When the pressure above the P-E segment is reduced, the segment closes, trapping air in the esophagus. The tongue movements which are responsible for forcing the air back into the pharynx may occur prior to speech or they may be accomplished during the act of articulating certain specific voiceless consonants (Dworkin & Banton, 1982; Edels, 1983; Salmon, 1979).

Esophageal Voice

Once air has either been inhaled or injected into

the esophagus it must be expelled quickly to provide a vibratory source through the semi-elastic P-E segment (Dworkin & Banton, 1982). When the laryngectomized individual can produce consistent esophageal voice volitionally, the next step is learning how to transform voice into intelligible speech.

Dworkin and Banton (1982) report that 90% of esophageal speakers use the injection method to insufflate the esophagus. Berlin (1963) observed that the more skilled esophageal speaker might use a combination of air intake methods. Each method or combination of methods presents its own set of problems to overcome.

PROBLEMS ASSOCIATED WITH AIR INTAKE AND EXPULSION

Stoma Noise

The inhalation method, requiring skillful coordination of pulmonary breathing and esophageal speech, may be difficult for some individuals. The laryngectomee must maintain a slow and steady expulsion of pulmonary air while at the same time expelling air from the esophagus for use in producing esophageal speech (Salmon, 1979). If the pulmonary breathing is not controlled, the laryngectomee may develop excessively loud wheezing noises through the tracheal stoma which are referred to as "stoma noise". The resulting "stoma noise" can mask esophageal speech and it has been found to be a primary factor in determining

whether judges find esophageal speech acceptable (Eccleston, 1982; Shipp, 1967).

Klunking Noise

A problem commonly associated with the injection method of air intake is referred to as "klunking". Diedrich and Youngstrom (1966) support this theory with cinefluorographic analysis which revealed that the klunk seemed to occur during injection of air, not during inhalation. Shanks (1977) and Perry (1983) describe the "klunk" noise as an audible "pop" from the P-E segment area as the sphincter opens quickly under excessive pressure from above. Martin (1963) associated the cause of klunking with the inability to relax the P-E segment. Most agree that the "klunking" noise is audible during the intake of air and immediately preceeds phonation (Edels, 1983; Martin, 1979; Salmon, 1979). Diedrich and Youngstrom (1966) define klunking as a physiological phenomenon resulting from excessive tension and force associated with the effort to inject too much air too fast. Amster (1979) believes klunking and other habit patterns

appear to arise primarily from excessive force and tension brought about by premature attempts to communicate before the patient has developed voice which is controlled, fused synchronously with articulation and molded into appropriate rhythm and phrasing patterns. (p. 234)

Multiple klunks can occur when the esophageal speaker injects air into the esophagus two or more times in rapid

succession before attempting to speak (Martin, 1979). The esophageal speaker may feel a single injection of air will not be enough to speak with and will continue injecting air hoping to improve length of the utterance. Most experts agree the "klunk" is inappropriate and should be a focus of treatment (Boone, 1977; Gardner, 1978; Salmon, 1979).

Klunking, because it occurs prior to phonation, does not actually interfere with esophageal speech intelligibility, but is considered a distraction, drawing attention and interfering with the acceptability of communication (Hyman, 1979; Shanks, 1979). Shanks predicts that esophageal speech acceptability will improve once the klunking behavior is eliminated to the extent that the speaker is free of distracting and unnecessary mannerisms accompanying air intake and sound output.

EFFECT OF KLUNK ON SPEECH PROFICIENCY

A number of studies have been conducted regarding the acceptability of esophageal speech, but few have directly included the parameter of klunking noise. Ryan et al. (1982) conducted a study to assess aspects of esophageal speech that contribute to effective communication. A series of assessment measures were applied to the esophageal speech of a group of 47 laryngectomees chosen from a data base of 100 laryngectomees. Ryan et al. instructed 24 naive listeners to rate the subjects using speech

intelligibility measures, as well as a 5-point rating scale, to judge overall esophageal speech acceptability. Their results indicate naive listeners had great variability in understanding esophageal speech, but klunking noise was not identified as a factor responsible for interfering with the understanding of esophageal speech. Duration of phonation, consistency of production, and the number of syllables per air injection were shown to be significantly related to the intelligibility and effectiveness of esophageal speech.

Scragg, Martin, and Bliss (1976) investigated the perceptual correlates of proficient esophageal speech. They used a panel of experienced judges who rated speech samples from 50 laryngectomees on ten voice and speech attributes, as well as overall esophageal speech proficiency. Judges used a 7-point equal-appearing interval rating scale. Their investigation revealed that phrasing, vocal quality, overall rate of speech, and articulatory proficiency accounted for 76% of the total variance in mean speech ratings. They also determined that low levels or the absence of audible klunking noise had a positive effect on overall esophageal speech ratings. Scragg and his colleagues recommend placing clinical emphasis on those voice and speech attributes most highly associated with high overall esophageal speech ratings. According to their investigation, emphasis should be on the development

of smooth phrasing, improved vocal quality, acceleration of overall rate, improvement of articulation, and the elimination or reduction of klunking noise.

Salmon, Kushner, and Knox (1979) investigated a concern expressed by many laryngectomy patients as to whether their children would be able to understand and accept their esophageal speech. They had children from a third grade class and a group of adults judge the intelligibility and acceptability of esophageal speech from a videotaped sample of eight esophageal speakers whose speech proficiency ranged from poor to very good. Each esophageal speaker read one page of an eight-page children's story. After each page was read, five multiple choice questions were presented which corresponded to the content of the material read. The responses were used as a measure of speaker intelligibility. An acceptability rating was determined during an informal group discussion regarding the speech or reading of each individual speaker. The judges were asked to state what they liked or disliked about each speaker's reading. Their spontaneous responses were recorded and were classified into either positive or negative categories. Results from this study indicated that children gave higher scores when determining intelligibility, accepted esophageal speech more readily than the adults, and used different values than adults when judging intelligibility and acceptability of esophageal speech.

Eccleston (1982) conducted an investigation to identify physical and perceptual correlates of acceptability of esophageal air intake noise. He selected five objective measures of esophageal speech and determined their relationship with sophisticated listener judgements of air intake noise acceptability. Secondly, this study sought to determine if sophisticated listener judgements of overall esophageal speech proficiency was significantly correlated with sophisticated listener judgements of air intake noise acceptability. Four expert voice clinicians served as judges and were instructed to rate 24 audio-tape recorded esophageal speech samples for air intake noise acceptability. A 5-point equal-appearing interval scale was used for rating air intake noise acceptability. The overall speech proficiency was rated on a 7-point equal-appearing interval scale by the faculty of the laryngectomy institute which included the four judges who participated in this study.

Data revealed four of the objective measures to be positively correlated with air intake noise acceptability ratings: the number of syllables uttered per air intake, the mean intake noise intensity, the rate of speech, and the ratio of mean air intake noise intensity to mean speech intensity. The other objective, mean intensity of speech, was not found to be significantly correlated to air intake acceptability. The number of syllables uttered per air intake was the measurement with the highest correlation to

air intake noise acceptability. It was determined that sophisticated listeners' ratings of overall esophageal speech proficiency was not significantly correlated with their ratings of air intake noise acceptability. Eccleston speculated that because the klunk noise usually precedes speech, it may act as a distraction, but does not actually interfere with overall communication.

The research did not address how naive listener's judgements of esophageal air intake noise relates to judgements of overall esophageal speech proficiency. Eccleston's (1982) study became the basis for the present investigation to determine if naive listener's judgements of air intake noise acceptability is significantly correlated with the sophisticated listener's judgements (from Eccleston's study) of air intake noise acceptability.

SUMMARY

Research has defined klunking noise, attempted to determine its etiology, and developed treatment procedures to eliminate or reduce the klunking noise. Many have speculated that klunking is a distraction having a negative impact on the acceptability of overall communication rather than being a direct interference with speech intelligibility (Hyman, 1979; Shanks, 1979). How much and to what extent klunking affects overall esophageal speech proficiency has had little attention in the research litera-

ture. Little has been published regarding the general population or naive listeners' reaction to esophageal speech. The lack of information in the literature is what prompted the questions of this investigation.

CHAPTER III

METHODS AND PROCEDURES

GENERAL PLAN OF THE STUDY

The general plan of this study consisted of 12 naive listeners rating tape-recorded samples of 18 laryngectomized individuals reading a paragraph using esophageal speech. The tape-recorded sample of esophageal speakers was developed from a previous study conducted by Eccleston (1982). The naive listeners began the study by listening to the recorded samples of esophageal speakers and rating their overall esophageal speech proficiency on a 5-point scale.

A 15-minute break was followed by a short training session which was conducted to familiarize the listeners with esophageal air intake noise. A training tape consisting of audible air intake noise was identified for the listeners. Following the training session, the judges were instructed to listen for air intake noise and rate the acceptability of that noise on a 5-point scale.

A detailed description of methods and procedures appears below.

METHODS

Subjects

The subject sample consisted of 18 laryngectomized individuals who were attending the XIV Annual Institute in Laryngectomy Rehabilitation at Eastern Washington University, Cheney, Washington during the summer of 1981. Speech samples were collected by Eccleston for a study he completed in 1982. Each subject used esophageal speech. The criterion for participation in Eccleston's study was the ability to read the sample paragraph aloud.

Judges

Twelve naive listeners were selected to function as judges in this study. None had previous experience or familiarity with laryngectomized individuals or esophageal speech. Judges consisted of four men and eight women between the ages of 25 and 40 years with diverse educational and occupational backgrounds. It was determined, through audiometric screening testing, that all judges exhibited normal hearing for speech. The definition of normal hearing for speech used in this study was passing an unilateral audiometric screening test administered at 25 dB for the frequencies of 500, 1000, 2000, and 4000 Hz.

Information and data from sophisticated listener's were obtained from Eccleston's (1982) study. These sophisticated listeners were four experienced speech-language

pathologists, chosen from the faculty of the XIVth Annual Institute in Laryngectomy Rehabilitation, Eastern Washington University, 1981. Each judge had a minimum of twenty years experience with laryngectomized individuals. Hearing sensitivities for each judge were within normal limits for speech (Eccleston, 1982).

Instrumentation

Equipment for Recording Subjects. The esophageal speech sample collected by Eccleston (1982) was accomplished in the audiometric suite at Eastern Washington University where the audio-tape recordings were made. Equipment consisted of a Sony model 366 reel-type recorder, an Electrovoice mode 631B dynamic microphone, and Maxell UDXL high-output, low-noise magnetic tape.

Rating Scales. The rating scales used in this study were adopted from Eccleston's (1982) study. The instructions and terminology were identical for both the sophisticated judges from Eccleston's study and the naive judges from the present study. Overall esophageal speech proficiency for each sample was rated by the naive listeners using a scale consisting of 5 equal-appearing intervals with the number 1 representing "no voice" and number 5 representing "very strong" (Appendix A). Esophageal air intake noise acceptability was rated by the naive judges using a 5-point rating scale with equal-appearing intervals. Number 1 on the scale representing the least

acceptable air intake noise and number 5 representing the most acceptable (Appendix B).

PROCEDURES

Recording Subjects

Procedures for audio-tape recording the esophageal speech subject sample were obtained from Eccleston's (1982) study. For each of his esophageal speech subjects, the VU meter was adjusted to peak at zero and the tape speed was set at 7.5 inches per second. The microphone was mounted on a stand and positioned approximately 1 foot in front of and 1 foot to the side of the subject's mouth. This positioning allowed for clear recording of speech and air intake noise while minimizing stoma noise and extraneous body movement. Instructions to each subject were to read aloud the first paragraph of the "Rainbow Passage" (Fairbanks, 1960) twice for practice allowing for adjustment to the soundproof environment and practicing esophageal voice. Subjects indicated when they were ready to begin the recording.

Overall Speech Proficiency Rating Session

The 12 judges were seated in a comfortable table-chair arrangement in a quiet room. A Realistic CTR-68 AC/battery cassette recorder was used to present the recordings of esophageal speech samples in a random order with volume set at 4.5. A 2-minute break followed each

10 minutes of playback of the esophageal speech samples. Each listener unknowingly judged 6 of the recordings twice as a means of determining intrajudge reliability. A total of 24 esophageal speech samples (18 original plus 6 repeated) were rated by each listener. The judges were instructed to listen to the entire reading of the passage and to rate each esophageal speaker according to their impressions of overall speech proficiency using the rating scale appearing in Appendix A. Further verbal explanation was provided to the judges to clarify the instructions. Proficiency was defined as the speaker's skill level and was not to be confused with the intelligibility of the speech. The judges were reminded not to be concerned with intelligibility or understandability of the speech, but to rate the speaker according to their impressions of overall proficiency level. These ratings reflect the subjective judgements of the naive listeners' impressions of overall esophageal speech proficiency.

Esophageal Air Intake Noise Training Session

Following the overall esophageal speech proficiency rating session and a 15-minute break, a training session was conducted to familiarize the listeners with esophageal air intake noise. A training tape consisting of six samples of esophageal speakers who presented with audible air intake noise was played for the listeners. The samples of air intake noise used for the training tape were not ex-

tracted from the subjects used for the rating sessions. After each sample, esophageal air intake noise was pointed out, e.g., "Listen to the sound produced after the word 'strikes'". The term "klunking" was not used to describe air intake noise, in order to avoid prejudicing the listeners. The purpose of the training session was to familiarize the listeners with esophageal air intake noise and allow them to identify the noise for the next rating session.

Esophageal Air Intake Noise Acceptability Rating Session

Following the air intake noise training session and a 5-minute break, the judges were seated in a comfortable table-chair arrangement in a quiet room. The same recorded samples presented during the previous rating session were replayed and presented in a random order. A 2-minute break followed each 10 minutes of play. Intrajudge reliability was determined by each listener unknowingly judging 6 of the recordings twice. A total of 24 esophageal speech samples were rated for air intake noise acceptability. The judges were instructed to listen to the recorded paragraph and to rate each speaker according to their individual impressions of the acceptability of the air intake noise, which they had previously been trained to recognize, using the 5-point scale appearing in Appendix B. The judges were reminded to limit their judgements to the esophageal air intake noise and not to be concerned with overall speech

proficiency or other extraneous noises.

DATA ANALYSIS

The Pearson product-moment correlation coefficient ($\underline{r}$) was used to assess intrajudge and interjudge reliability and to determine the significance of correlation between naive listener judgements of overall esophageal speech proficiency and their judgements of esophageal air intake noise acceptability. The Pearson product-moment correlation coefficient ($\underline{r}$) was used to determine the significance of correlation between naive listener acceptability judgements and sophisticated listener acceptability judgements of esophageal air intake noise. The Pearson product-moment correlation coefficient ($\underline{r}$) provides information related to the strength of the relationships in the two questions posed by this study. A $\underline{t}$ -test for the significance of Pearson product-moment correlation coefficient ($\underline{r}$) was computed for each question to determine the significance of the relationship. The $\underline{t}$ -value for each question was compared with a table of critical values for $\underline{t}$ at the .01 level. The Index of Determination ($\underline{r}^2$) was used to indicate the amount of overlap shared by the variables in terms of percentage of shared variance.

Interjudge Reliability

Each judge's response was compared to the mean

ratings from all judges for each subject. The Pearson product-moment correlation coefficient ($\underline{r}$) ranged from .72 to .95 for overall esophageal speech proficiency (Appendix C) and from .72 to .90 for air intake noise acceptability (Appendix D).

Intrajudge Reliability

The judges unknowingly rejudged 6 of the subjects to test the reliability of each judge. The Pearson product-moment correlation coefficient ($\underline{r}$) for the test-retest scores ranged from .47 to .95 for overall esophageal speech proficiency (Appendix E) and from .76 to 1.00 for air intake noise acceptability (Appendix F).

CHAPTER IV

RESULTS AND DISCUSSION

RESULTS

The results from this study need to be interpreted with caution due to the wide range of interjudge and intra-judge reliability for naive listener's ratings of overall esophageal speech proficiency and their ratings of air intake noise acceptability. This applies especially to the first research question in which intrajudge reliability for the proficiency ratings was quite variable. The limitations of the results is due in part to the terminology used on the rating scale which does not give clear information as to what the judges were actually rating and is reflected by the shifting base of their scores.

The first research question posed was: are naive listener judgements of overall esophageal speech proficiency significantly correlated with naive listener judgements of esophageal air intake noise acceptability? Statistical analysis showed a correlation of .81 between overall esophageal speech proficiency ratings and ratings of air intake noise acceptability (Table I). A two-tailed t-test was calculated and was found to be significant beyond the .01 level of confidence with 16 degrees of

freedom. This resultant ($\underline{r}$) value of .81 indicates a high positive correlation showing that as overall speech proficiency was rated better, the more acceptable were ratings of air intake noise. The Index of Determination was obtained by squaring the correlation coefficient ($\underline{r}^2$). Figure 1 illustrates that 65% of the total variance is shared by the two variables. This leaves 35% of the variance that was not accounted for by the correlation. The high correlation indicated by the results, however, must be interpreted with caution. It is uncertain what the proficiency ratings actually measured because of the unclear terminology used on the rating scale and is reflected by the wide variability of the intrajudge reliability.

TABLE I

RESULTING PEARSON $\underline{r}$'s, STANDARD DEVIATION, AND MEANS
OF THE INDEPENDENT VARIABLES

Variables	Mean	Sd
Esophageal Speech Proficiency (x)	2.73	1.00
		$\underline{r}=.81$
Air Intake Noise Acceptability (y)	2.64	.97

The second research question posed was: are naive listener acceptability judgements of air intake noise sig-

Speech Proficiency

Air Intake Noise

$$\underline{r} = .81$$

$$\underline{r}^2 = .65$$

Variance Remaining = 35%

Figure 1. The Index of Determination represents the shared variance between the variables speech proficiency and air intake noise. Shaded area represents the amount of variance shared and white area with question marks represents the amount of variance not accounted for by the correlation.

nificantly correlated with sophisticated listener acceptability judgements of air intake noise? The sophisticated listener's ratings of air intake noise were obtained from the study conducted by Eccleston (1982) and were compared to naive listener's ratings obtained in this study. The statistical analysis indicated that naive listener acceptability judgements were significantly correlated with sophisticated listener acceptability judgements of air intake noise with an r value of .81 (Table II). With 16 degrees of freedom, a t -test calculation was found to be significant beyond the .01 level of confidence. This r value shows a high correlation between the ratings of naive listeners and "expert" listeners of the speech of esophageal speakers. The Index of Determination (r^2) was used to determine that 65% of the total variance is shared by the two variables leaving 35% of the variance not accounted for by the correlation (Figure 2).

TABLE II

RESULTING PEARSON r 's, STANDARD DEVIATION, AND MEANS OF THE INDEPENDENT VARIABLES

Variables	Mean	Sd
Naive listener acceptability judgement	2.64	.97
		$r = .81$
Sophisticated listener accept. judge.	2.86	.91

Naive listener acceptability
judgements

Sophisticated listener acceptability
judgements

$$\underline{r} = .81$$

$$\underline{r}^2 = .65$$

Variance Remaining = 35%

Figure 2. The Index of Determination represents the variance between the variables naive listener acceptability judgements and sophisticated listener acceptability judgements. Shaded area represents the amount of variance shared and white area with question marks represents the amount of variance not accounted for by the correlation.

DISCUSSION

A discussion and interpretation of the results of this study follows in order of the primary (first) question followed by the secondary (second) question.

Relationship of Esophageal Speech Proficiency and Air Intake Noise

The results of this study indicate that naive listeners' judgements of overall esophageal speech proficiency had a high degree of association with their acceptance ratings of air intake noise. Methodological problems exist due to rating scales that were designed for sophisticated listeners (Eccleston, 1982) and attempting to use them with naive listeners. The terminology and wording of the rating scales seemed to be appropriate for the sophisticated, experienced listener, but lacked clarity, definition, and direction for the inexperienced, naive listener. Therefore, it is not clear as to what the naive judges meant by their proficiency ratings. The air intake noise acceptability rating scale does not give specific information as to why air intake noise is considered acceptable in one situation and not acceptable in another.

Considering the first rating session was also these judges' first exposure to esophageal voice, it is probable they had difficulty determining proficiency level until they had heard a number of different speakers. As the rating session progressed, it is probable they became more

aware of the range of skill and the limits of esophageal speech as they listened to the different speakers. Unsolicted remarks and subjective informal observation of the judges revealed a growing awareness of their understanding and appreciation of esophageal speech production as the rating sessions progressed. It is probable that this new understanding and awareness had an effect on their overall proficiency ratings which is reflected by the wide range of intrajudge reliability (.47-.95).

Intrajudge reliability for air intake noise ranged from .76 to 1.00. A probable rationale for the higher correlation can be explained in part by the training session that helped the judges identify a specific parameter of esophageal speech, air intake noise. It was a more specific, less broad task than rating overall esophageal speech proficiency.

Between-judges ratings ranged from .72 to .95 for overall esophageal speech proficiency and .72 to .90 for acceptability of air intake noise. The higher correlations for interjudge reliability and the high correlations for intrajudge reliability for air intake noise gives the results of this study more credibility.

The results of this study support, in theory, the findings of Scragg et al. (1976) who used experienced judges to rate esophageal speakers on overall esophageal speech proficiency and on ten voice and speech attributes.

Their results showed that a low level of audible noise or absence of klunking had a positive effect on overall esophageal speech ratings. This investigation found acceptability of air intake noise highly correlated with overall esophageal speech ratings. The low level or absence of audible noise (as determined by experience judges) and the subjective evaluation of the acceptability of air intake noise (as determined by naive judges) both had a positive effect on overall esophageal speech ratings.

Eccleston (1982) asked the same question as this study using sophisticated judges. Results of this study do not support Eccleston's investigation. His findings reveal only a slight correlation and determined there was little association between sophisticated listeners' ratings of overall speech proficiency with their ratings of air intake noise acceptability. A probable explanation for the difference between naive listener's ratings and sophisticated listener's ratings may be the lack of "sophistication" or knowledge of naive listeners as to how esophageal speech is produced and all the parameters involved in producing esophageal sound. The voice experts are well aware of the fact that air intake noise occurs before speech and are able to identify other factors that may be more directly related to proficiency level. Naive listeners have little or no background information and are unable to separate the many factors involved in

producing esophageal speech.

Additional analysis was done to provide further information regarding naive and sophisticated listeners' perceptions of esophageal speech proficiency. Sophisticated listeners' esophageal speech proficiency scores were obtained from Eccleston's (1982) study and compared to naive listener judgements of overall speech proficiency. Pearson product-moment correlation coefficient (r) indicates a moderate correlation with an r value of $-.64$. The negative value results from the sophisticated judges using a rating scale with a reversed numerical direction when compared to the rating scale used in the present study. In other words, the sophisticated judges used a rating scale where number one represented "very strong" and the higher numbers were representative of a poorer performance. According to the results, both naive and sophisticated judges tended to agree on the proficiency level of the esophageal speakers.

Shanks's (1979) prediction that esophageal speech acceptability will improve once the klunking behavior is eliminated finds support from the results of this study.

Relationship Between Naive and Sophisticated Listeners Judgements of Air Intake Noise

The results indicate that naive listeners, when trained specifically on air intake noise, and sophisticated listeners have a high degree of association of what they

consider acceptable in regards to air intake noise. Given specific information on a parameter (air intake noise) of esophageal speech, the naive listeners and "expert" listeners tended to agree on what they considered acceptable for air intake noise. Most of the people with whom a laryngectomized individual will communicate on a daily basis will be "naive" listeners. It is of utmost importance to determine acceptability measures of esophageal speech provided by naive listeners. Their input will have a role in shaping the course of rehabilitative treatment the speech-language pathologist will provide.

CHAPTER V

SUMMARY AND IMPLICATIONS

SUMMARY

The purpose of this study was to determine the judgements by naive listeners of the acceptability of esophageal air intake noise and compare those ratings to their judgements of overall esophageal speech proficiency. The primary question this study sought to answer was: Are naive listener judgements of overall esophageal speech proficiency significantly correlated with naive listener judgements of esophageal air intake noise acceptability? The secondary question asked was: Are naive listener acceptability judgements of air intake noise significantly correlated with sophisticated listener acceptability judgements of air intake noise?

Tape-recorded samples of 18 laryngectomized individuals reading a paragraph using esophageal speech were played for 12 naive listeners. The naive listeners rated overall esophageal speech proficiency on a 5-point scale. After the proficiency rating task, they participated in a short training session to become familiar with esophageal air intake noise. The speech samples were played again and the judges were instructed to rate the acceptability

of air intake noise on a 5-point scale. Interjudge and intrajudge reliability scores were determined by Pearson product-moment correlation coefficients. Unclear terminology used on the rating scales places limitations on the interpretation of the results of this study. Intrajudge reliability for ratings of overall esophageal speech proficiency was quite variable ($r=.47-.95$).

Results of the primary question indicate that naive listener judgements of overall esophageal speech proficiency were found to be positively correlated ($r=.81$) with their judgements of esophageal air intake noise acceptability ratings beyond the .01 level of significance. The Index of Determination ($r^2=.65$) indicates a 65% overlap between the variables in terms of shared variance, thus the amount of variance not accounted for by the correlation was 35%. Although this correlation was high, it is unclear as to what the judges meant by their ratings of proficiency.

The second question posed by this study includes sophisticated judges ratings of air intake noise acceptability obtained from Eccleston's (1982) study. A comparison of naive listener acceptability judgements of air intake noise with sophisticated listener judgements of the same was found to be a high positive correlation ($r=.81$) beyond the .01 level of significance. The Index of Determination ($r^2=.65$) indicates the amount of variance

shared by the variables is 65% while 35% of the variance was not accounted for by the correlation.

Data from this study suggest that as overall esophageal speech proficiency ratings increased, (as judged by naive listeners) so did their judgements of air intake noise acceptability. Both naive and sophisticated listeners' ratings of acceptability judgements of air intake noise appeared to be in agreement indicating they have similar ideas of what they consider acceptable in regards to air intake noise. These results suggest that some clinic and treatment time should focus on the reduction or elimination of air intake noise to improve overall esophageal speech proficiency.

IMPLICATIONS

Clinical

The results of this study suggest overall esophageal speech proficiency ratings as judged by naive listeners is related to their judgements of air intake noise acceptability. Clinical implications from these results suggest that klunking should be a focus of clinic and treatment time to increase the overall effectiveness of esophageal speech. The results do not provide more specific information as to what makes the klunk acceptable or unacceptable. Once klunking behavior has been established, it is difficult to eliminate. It is unclear from the results

of this study whether treatment should focus on reducing the intensity or the frequency of the klunk if eliminating it is not possible.

Conversely, Eccleston's (1982) study, which used sophisticated judges, found their overall esophageal speech ratings were not significantly correlated with their ratings of air intake noise acceptability. His data indicated other variables such as the number of syllables uttered per air intake, mean intensity of air intake, and the rate of speech are positively correlated with air intake acceptability ratings. He postulated from the outcome of his study that clinical treatment time might best be spent modifying air intake noise by working on it indirectly.

Combining the implications from both studies, it is suggested that to improve overall esophageal speech, treatment should focus on eliminating or reducing the air intake noise while at the same time focus on improving rate of speech and increasing the number of syllables uttered per air intake. These are just two of the parameters Eccleston (1982) found to be positively correlated with air intake noise acceptability ratings. Focus of treatment would be designed to meet individual needs depending on the esophageal speaker's strengths and weaknesses. Improving overall esophageal speech is the main objective and the reduction of air intake noise could be a part of a total treat-

ment package.

Future Research

The outcome of this study suggests several implications for future research along with the inclusion of other parameters.

Expanding the rating scale to a 7- or 9-point system and using a larger group of judges would provide more differentiation among subjects who were rated at the same proficiency level on a 5-point scale.

A future investigation might include a larger group of naive judges who have been familiarized with esophageal speech before they begin the rating session. If esophageal speech samples were played prior to the rating session the judges would then have an idea as to how esophageal speech sounds, possibly resulting in higher intra-judge and interjudge reliability scores.

It might be of interest to include naive listeners' subjective comments along with their ratings for each subject. Subjective comments would provide further information and insight into how and what each judge listens for and uses to determine overall proficiency ratings. These comments would provide specific information as to what makes the klunk noise unacceptable to the naive listener. Clinical implications would include more specific behaviors to be focused on in treatment that would improve overall esophageal speech proficiency.

Finally, another investigation could instruct naive judges to rate video-taped samples of esophageal speakers on overall esophageal speech proficiency and air intake noise acceptability. These ratings could be compared to judgements of audio-taped samples to determine the possible influence of visual information.

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APPENDIX A

INSTRUCTIONS READ TO JUDGES

You will be listening to recorded speech samples from alaryngeal speakers using esophageal speech. Please rate the overall esophageal speech proficiency for each speaker on a five-point scale, with number one representing "no voice" and number five representing "very strong".

SCALE FOR OVERALL ESOPHAGEAL SPEECH PROFICIENCY

"NO VOICE"

"VERY STRONG"

1

2

3

4

5

APPENDIX B

INSTRUCTIONS READ TO JUDGES

You will be listening to recorded speech samples from alaryngeal speakers using esophageal speech. Please rate the acceptability of esophageal air intake noise for each speaker on a five-point scale, with number one representing the least acceptable air intake noise and number five the most acceptable air intake noise. Please do not judge overall esophageal speaking effectiveness, concentrate only on esophageal air intake noise.

ACCEPTABILITY SCALE FOR ESOPHAGEAL AIR INTAKE NOISE

LEAST ACCEPTABLE

MOST ACCEPTABLE

1

2

3

4

5

APPENDIX C

INTERJUDGE RELIABILITY

Overall Esophageal Speech Proficiency

Judge	<u>r</u>	Significance Level
A	0.91	.01
B	0.80	.01
C	0.93	.01
D	0.81	.01
E	0.85	.01
F	0.90	.01
G	0.82	.01
H	0.72	.01
I	0.83	.01
J	0.87	.01
K	0.95	.01
L	0.88	.01

Range: .72 - .95

APPENDIX D

INTERJUDGE RELIABILITY

Acceptability of Air Intake Noise

Judge	<u>r</u>	Significance Level
A	0.72	.01
B	0.84	.01
C	0.90	.01
D	0.85	.01
E	0.73	.01
F	0.81	.01
G	0.87	.01
H	0.81	.01
I	0.86	.01
J	0.87	.01
K	0.84	.01
L	0.84	.01

Range: .72 - .90

APPENDIX E

INTRAJUDGE RELIABILITY

Overall Esophageal Speech Proficiency

Judge	<u>r</u>	Significance Level
A	0.76	.01
B	0.51	.10
C	0.94	.01
D	0.47	.50
E	0.93	.01
F	0.88	.01
G	0.67	.02
H	0.66	.02
I	0.75	.01
J	0.77	.01
K	0.95	.01
L	0.94	.01

Range: .47 - .95

APPENDIX F

INTRAJUDGE RELIABILITY

Acceptability of Air Intake Noise

Judge	<u>r</u>	Significance Level
A	0.95	.01
B	0.76	.01
C	1.00	.01
D	1.00	.01
E	0.90	.01
F	0.80	.01
G	0.87	.01
H	0.86	.01
I	0.88	.01
J	0.90	.01
K	0.95	.01
L	0.80	.01

Range: .76 - 1.00