NORMAL VOICE CHARACTERISTICS OF THE AGED

A Thesis

by

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ABSTRACT

NORMAL VOICE CHARACTERISTICS

OF THE AGED

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This study was undertaken to examine the voice characteristics of older adults. While normative data exists for voice characteristics of children and adults, little has been researched in the area of normal voice characteristics of the normal older adult.

Using a series of voice assessing instruments, fifty males and fifty females between the ages of 65-80 were examined in the study. Persons having had any history of stroke or a cerebral vascular accident (CVA), Parkinson's disease, having a hearing aid or any neurologic/psychologic involvement that might contribute to a voice disorder were omitted. Only "normal" subjects were included in this study. The assessment measurements included 1) fundamental frequency indicator, 2) sound pressure level meter and 3) an electronic stop watch.

The results of this study indicate the normal voice characteristics of normal older adults. Data are reported relative to the range, mean, median, mode and standard deviation of each of the areas tested.

Conclusions and recommendations are made relative to 1) typical voice characteristics, 2) implications of the study and 3) recommendations for further research.

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In loving memory
of my father
William E. Hockaday

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CHAPTER 1

INTRODUCTION

Statement of the Problem

In order for speech-language pathologists to determine if the voice characteristics of average aged adults are abnormal, it is essential that normative data be established determining the voice characteristics of the average aged population. Normative data exists for voice characteristics of children and adults below the age of 65 (Boone, 1983; Eisenson & Ogilvie, 1977; Michel & Wendahl, 1971). However, little research has been done in the area of normal voice characteristics of the average older adult population (Honjo & Isshiki, 1980; McGlone & Hollien, 1963; Hollien & Shipp, 1972; Mysak, 1959; Ptacek, Sander, Maloney & Jackson, 1966). More specific data are needed in order that speech-language pathologists may provide 1) more accurate diagnoses of normal versus pathologic and psychogenic voice disorders and 2) more appropriate treatment to the disordered group with more realistic goals for treatment.

Speech-language pathologists provide a wide range of services to many age groups including the older population. Judgments must be made by speech-language

pathologists as to what is abnormal in any specific disorder. It is important to remember that abnormality cannot be determined until normality has been established (Wilson, 1979; Darley & Spriestersbach, 1978). For example, a three year old child who is experiencing an articulation disorder of substituting [w] for [r] in the word rabbit would likely not be considered abnormal, since the child has not reached the age where the [r] phoneme develops (Eisenson & Ogilvie, 1977). The error is obvious; however, the error is not considered a disorder but rather a problem that will likely be self-corrected with maturation. Without normative data, however, such judgments cannot be made. The same general concept holds true with older adults who are experiencing high frequency hearing losses. Such hearing losses would be evident, but not necessarily considered outside the range of normal limits for it has been shown that high frequency hearing losses are common and are a part of the normal aging process (Oyer & Oyer, 1976; Davis, 1970). Such a hearing loss in a thirty year old would be considered a disorder. Again, however, without normative data on older adults such judgments as to what constitutes a disorder cannot be made. Until norms are established for average older adult voice characteristics, it is impossible to accurately determine when a disorder exists. Subsequently it is difficult to accurately diagnose their voice

characteristics as disordered or to establish an appropriate program of treatment.

Significance of the Study

Without knowledge of normative data concerning voice characteristics of the normal older adult it is difficult for speech-language pathologists to diagnose abnormal voice characteristics for an older adult and determine prognosis of treatment (Darley & Spriestersbach, 1978). Determination of normal voice characteristics of older adults would give the speech-language pathologist a basis on which to determine 1) whether there is a voice disorder, 2) the degree of severity of the disorder, 3) realistic goals and objectives for treatment and 4) more appropriate methods of treatment.

Hypothesis

This study will establish normative data on voice characteristics of a select group of average older adults, aged 65-80. Mean, median, mode, range, and standard deviation of ratings for the areas of 1) fundamental frequency, 2) average volume, 3) maximum volume, and 4) duration of phonation will be the basis of reporting the results.

Methodology

An oral questionnaire will be administered to a group of adults aged 65-80, selected from Watauga, Cove Creek, Wilkes, Newland, and Alamance Senior Centers, Hi Lands Rest

Home and Watauga Village Apartments. The questionnaire will determine if the subjects are in the category of normal older adults, i.e., if they do not have or have not had any of the following: CVA or stroke, Parkinson's disease, wear a hearing aid, or have any neurological/ psychological involvements. When it has been determined that they are indeed "normal", then fifty (50) males and fifty (50) females will be selected. This groups' fundamental frequency will be determined using a fundamental frequency indicator, their average and maximum volume will be determined using a sound pressure level meter, and their duration of phonation will be determined using an electronic stop watch.

Assumptions

1. The sample is assumed to be a valid representative of normal voice characteristics of average older adults.

2. Persons in the study are assumed to be giving true and accurate responses to the questionnaire.

3. The instruments used are assumed to be calibrated and the proper instruments for such testing.

4. The examiner is assumed to be competent.

Limitations

1. The study will be limited to 50 normal aged males and 50 normal aged females.

2. The study will be limited to older adults in the state of North Carolina.

3. The study will be limited to the following instruments: 1) fundamental frequency indicator, 2) sound pressure level meter, and 3) a stop watch.

Delimitation

1. This study will be confined to persons aged 65-80.

Definitions

1. Voice -- Sound produced by the vibration of the vocal folds (Wood, 1971).

2. Older Adult -- For the purpose of this study older adult will refer to those persons aged 65-80 years of age. It should be noted that the term older adult and aged will be used synonymously.

3. Normal older adults -- Having no medical disorders that would affect the voice.

4. Voice disorder -- Any problem which deviates from the norm.

5. Neurologic disorder -- Any problem with the nervous system.

6. CVA -- Cerebral vascular accident; a stroke (Wood, 1971).

7. Psychologic disorders -- Any mental disorder.

8. Fundamental Frequency Indicator -- An instrument used to determine a person's lowest speaking frequency (Hanley & Peters, 1971).

9. Sound Pressure Level Meter -- An instrument used to determine average and maximum volume (O'Neill & Oyer, 1966).

Remainder of the Study

In the remaining chapters, the present literature will be reviewed. The data will be examined and conclusions will be drawn and recommendations for further study will be made.

CHAPTER 2

REVIEW OF RELATED LITERATURE

Introduction

In order to gain perspective in the examination of normative data on voice characteristics of older adults, this chapter summarizes and reviews the major literature related to this subject. This chapter includes 1) normal voice characteristics for children and adults under the age of 65, 2) normal voice characteristics for older adults, and 3) abnormal voice characteristics for older adults.

It is essential for speech-language pathologists to first know what are normal voice characteristics of the average aged population before the clinicians can determine what, if anything, is abnormal about an older person's voice. Speech-language pathologists need normative data on voice characteristics of the average aged population in order that they may provide 1) more accurate diagnoses of normal versus pathologic and psychogenic voice disorders and 2) more appropriate treatment to the disordered group (Wilson, 1979).

By determining normal voice characteristics of the aged population, speech-language pathologists may provide a more accurate diagnoses of normal versus pathologic and

psychogenic voice disorders. This normative data will enable the speech-language pathologist to determine if average older adults have the voice characteristics that are suitable for their age or if their voice characteristics are deviant. For example, it has been shown that as adults reach the older years, they begin to develop a high frequency hearing loss (Oyer & Oyer, 1976; Davis, 1970). While this is indeed a major change, it is considered a part of the normal aging process and not necessarily a clinical disorder because normative data has been established for the hearing ability of the older adult (Oyer & Oyer, 1976). Similarly, it is generally accepted that voice characteristics of adults change as they grow older; however, it is essential that more specific knowledge/data be obtained regarding this change. Once the voice changes can be characterized as being "different" but within normal limits for their age, then speech-language pathologists can better diagnose and treat true pathologic and/or psychogenic voice disorders. If a true deviancy is found in the voice characteristics, then the speech-language pathologist may place the person into therapy with more substantial justification. Without the ability to reference normal voice characteristics, however, the speech-language pathologist must make clinical judgments on

placement based primarily on subjective opinions which may lack professional veracity (Wilson, 1972).

Once placement has occurred, speech-language pathologists also need normative data so that more appropriate treatment may be offered to the disordered group. If speech-language pathologists have no normative data on which to base their treatment, then appropriate prognoses are difficult (Wilson, 1972). If prognoses are determined without normative data, then speech-language pathologists may have as their goal something that is not feasible because the voice characteristics have changed with the aging process and are not truly abnormal. Incorrect diagnosis may result in treatment that is not truly needed or treatment that is longer than needed. An incorrect diagnosis could also require alterations in treatment by going through many trial and error sessions with dubious results in treatment and reduced credibility of the speech-language pathologist (Darley & Spriestersbach, 1978).

Normative Voice Data for Children and Adults

While there has been little research and few attempts have been made to determine the voice characteristics of older adults, normative voice characteristics have been established for children and adults under the age of 65. The areas of voice that have been examined are 1) vital

capacity of the lungs, which indicates the amount of air that a person can exhale after an inhalation; 2) maximum duration of blowing, which is how long a flow of air can be sustained; 3) modal fundamental frequency, which is the frequency most often used by an individual; 4) maximum frequency range, which gives the lowest and highest frequency an individual can phonate; 5) duration of sustained phonation, which is the amount of time an individuual can sustain a sound; 6) volume/velocity air flow, which is the amount of air flow during phonation; 7) glottal waveform, which is the time it takes for the opening and closing of the vocal folds; 8) sound pressure level range, which is the sound pressure levels an individual can produce; 9) jitter, which is when an individual is sustaining phonation at a constant frequency, the difference in each period; 10) shimmer, which is when an individual is sustaining phonation at a constant frequency the difference in amplitude; 11) effort level, which is the amount of effort used in phonation; and 12) transfer function of the vocal tract, which is a modification of a laryngeal signal (Michel & Wendahl, 1971).

Fundamental frequency is the lowest frequency at which an adult phonates. A child's fundamental frequency is 235-265 Hz, for a women 18 years of age it is 205 Hz and for a man 18 years of age it is 125 Hz. An individual's

fundamental frequency can be determined by a Fundamental Frequency Indicator (FFI). The FFI isolates the fundamental frequency of an individual voice from other components by using electronic components, circuits and principles including filters and logic circuits. An adult male has a maximum fundamental frequency for the pulse register between 7 Hz and 78 Hz. The modal register for a male ranges from 71 Hz to 561 Hz and the loft from 156 Hz to 795 Hz. The measures for an adult female for the same measurements are 2 Hz to 78 Hz, 122 Hz to 798 Hz and 210 Hz to 1729 Hz respectively (Wilson, 1972; Hanley & Peters, 1971).

Average speaking volume and maximum speaking volume are loudness levels at which a person phonates, the average being the one at which a person phonates most often and the maximum being the loudest the person can phonate. The average volume of an adult when engaged in face to face speech is 46-86 dB. The average for a man is 67 dB and the average for a woman is 64 dB. The average volume can be determined with a sound pressure level meter. Maximum volume would be approximately 86 dB for an adult. This also would be determined with a sound pressure level meter. The sound pressure level meter is used to provide a estimation of the sound pressure of noise. A sound is presented to the sound pressure level meter and is

converted to an electrical signal which is amplified and is shown on the meter (Wilson, 1972; Hanley & Peters, 1971; O'Neill & Oyer, 1966).

Duration of phonation is the maximum amount of time a person phonates. The duration of phonation time as determined by Ptacek and Sander (1963) was found to be 25 seconds for men and 17 seconds for women. Finnegan (1984) also found a significantly longer duration of phonation for males than females, and as the age increased, so did phonation time. Van Riper (1954) stated that a person should be capable of sustaining phonation for at least 15 seconds. To measure duration of phonation the person is timed from the initiation of phonation until the voice drops to a whisper (Wilson, 1972).

Normative Voice Data for Older Adults

While little research has been conducted regarding normal voice characteristics for the older adult, the few studies that have been done are concerned with 1) the pitch of older males as compared to younger male adults (Mysak, 1959), 2) the comparisons of vocal fold in younger adults and older males and females (Honjo & Isshiki, 1980), 3) the pitch and duration of phonation for younger adults as compared to older males and females (Mysak, 1959; McGlone & Hollien, 1963), 4) fundamental frequency perterbation and maximum inflection (Benjamin, 1982), and 5) phonational capability of older females (Walker, 1984).

Adults go through many changes as their age increases and one of them is a change in their voice (Mysak, 1959; McGlone & Hollien, 1963; Hollien & Shipp, 1972; Ptacek & Sander, Maloney & Jackson, 1966). As a person ages the cartilages of the larynx change. There have been a number of reports that are concerned with the aging voice but there has been no agreement as to what vocal abilities older adults are capable of (Luchsinger & Arnold, 1965; Meyerson, 1975; Schow et al., 1978).

Ptacek, Sander, Maloney and Jackson (1966) found that older males and females showed a statistically significant reduction in their total pitch ranges as compared to young adults. These findings were in agreement with the findings by Kaplan (1960) who found there to be a decrease in the range of the voice. This decrease in range was especially true for the high frequencies.

Honjo and Isshiki (1980) studied 20 men and 20 women whose ages ranged from 69 to 85 years and found that men showed vocal fold atrophy and a higher fundamental frequency than younger men. The women showed vocal fold edema with a lower fundamental frequency than younger women. The men's fundamental frquency was 162 Hz as compared to 120-130 Hz for younger men and women's fundamental frequency was 165 Hz as compared to 260 Hz for younger women. Mueller (1982) also found that the mean fundamental frequency of the older male in his study was

higher than that of the average male fundamental frequency. These studies also agreed with Hollien and Shipp (1972) and Mysak (1959). Walker (1984) found that the older adult had a mean fundamental frequency range of 32 semitones and the younger adults showed a mean fundamental frequency range of 38 semitones. There is a half an octave difference between the two populations. Peterson and Barney (1952) listed the fundamental frequency for a man for the vowel [i] to be 136 Hz. A woman was listed at 235 Hz and a child at 272 Hz.

Mysak (1959) studied the pitch and duration characteristics of 80 year old males and found they showed a significantly higher pitch level and a greater pitch variability than those between 65 and 79 years of age. A study done by McGlone and Hollien (1963) on aged women showed no significant difference in the voice characteristics between older and younger women. Mueller (1982) found that there was a reduction in maximum phonation time in both men and women for the vowel [a] compared to that of younger males and females. Wilcox and Horii (1980) found a greater amount of vocal jitter among older adults than younger adults.

In the area of age recognition from voice, Ptacek and Sander (1966) and Shipp and Hollien (1969) have shown that listeners are able to correctly judge the age of a speaker. Ryan (1972) found the following items helpful in

the identification of the aged voice, 1) laryngeal air loss, 2) imprecise articulation, 3) a slowing of the speech rate, 4) voice tremors and 5) a change in the fundamental frequency.

It is seen that data in the recent literature presents evidence that there is a difference in the vocal folds in older males and younger males and older females and younger females. It is seen that the vocal folds of a man become thinner and the vocal folds of a woman become thicker, thus indicating that as males and females become older their voices tend to go toward the midline, i.e., males and females tend to sound more alike (Honjo & Isshiki, 1980). It has also been noted that there is a significant difference in the younger male and the older male but no significant difference in the older female and the younger female.

Abnormal Voice Data for Older Adults

Knowledge of voice disorders in older adults is limited because there is no method that is presently in use to determine whether, as a person ages, voice disorders become more noticeable. For older adults, the data that are available are scarce. The data are limited primarily to those who seek help from a physician or a speech-language pathologist. Since there are no voice screening procedures for adults, it would be presumptuous

to state the incidence and types of voice disorders that occur with aging (Meyerson & Shanks, 1981).

There are a few voice disorders that are more common with older adults. These are laryngectomy, vocal fold paralysis and dysarthria, and are due to progressive neurological conditions or trauma. A progressive neurological disorder might be Parkinson's disease which results in vocal cord paralysis and/or paresis. A laryngectomy might be considered an example of trauma (Meyerson & Shanks, 1981).

Williams and Seaver (1984) studied 28 adults, seven with Broca's aphasia, seven with conduction aphasia, seven with Wernicke's aphasia and seven normal speakers. They found that across the board there was no difference in the duration of vowels or consonants.

Logemann, Fisher, Boshes and Blonsky (1978) found in their study that out of 200 patients with Parkinson's disease 89% of these showed a phonatory dysfunction. This dysfunction was stated as being breathy, hoarse, tremulous and rough. Canter (1963) found patients with Parkinson's disease to have a pitch range which is reduced and also a reduction in the range of vocal intensity and sustained phonation.

Voice disorders that are currently identified in older populations are due to related medical pathologies rather than being disorders in and of themselves. The voice

difficulties are but symptoms of a larger medical problem. For example, a person with Amytrophic Lateral Sclerosis may have a voice that is weak, quiet and strident; however, the voice disorder is not a problem in itself but is a result of a larger medical problem. Normative data for voice characteristics of older adults are needed to 1) determine unique voice disorders not related to medical pathologies, 2) aid medical personnel in identifying symptoms of medical disorders earlier, and 3) for better selection and treatment of voice disorders.

Summary

While a few studies have been conducted regarding voice characteristics of normal older males and females, the studies are largely inconclusive, often contradictory and are far from offering speech-language pathologists a reservoir of information regarding normative voice characteristics to draw upon when selecting potential patients and establishing appropriate programs of treatment. Further study is needed in this area.

CHAPTER 3

PROCEDURES

Best (1970) describes three basic types of research designs: 1) historical, 2) experimental and 3) descriptive. This study exemplifies the characteristics of a descriptive design as it involved "the description, recording, analysis, and interpretation of conditions that now exist" (p. 14).

This study examined the voice characteristics of one hundred normal adults aged 65-80. While normative data exists for children and adults younger than 65, there has been little research in the area of normal voice characteristics for the normal older adult (Boone, 1983; Eisenson & Ogilvie, 1977). The subjects were administered an oral questionnaire to determine eligibility for inclusion in this study. With voice assessing instruments the average volume, maximum volume, fundamental frequency, duration of [i], and duration of combined words were examined.

Subjects

Fifty males and fifty females, aged 65-80 were examined in this study. The subjects were selected from Alamance, Avery, Watauga and Wilkes Counties. The

selection was as follows: 1) nine from Alamance Senior Center, in Alamance County, 2) ten from Newland Senior Center, in Avery County, 3) thirty-one from Watauga Senior Center, fifteen from Cove Creek Senior Center, seven from Watauga Village Apartments, five from Hi Lands Rest Home, in Watauga County, and 4) twenty-three from Wilkes Senior Center in Wilkes County.

Criteria for Assessment

The subjects were selected from the age of 65 to the age of 80. The age selection of 65-80 was arbitrarily chosen with the reasoning that this age range was a fair representation of the older population without running the risk of including subjects that had significant medical complications. The average life expectancy is 71.9 years for males and females (Sourcebook on Aging, 1979). The subjects were administered an oral questionnaire (Appendix A) that consisted of the following 1) name, 2) age, 3) have you ever suffered a stroke or CVA, 4) do you have any neurological disorders, e.g. Parkinson's, and 5) do you wear a hearing aid. If the subjects answered questions 3, 4, and 5 with a negative response and their age was appropriate then the testing began.

Design

Areas of examination in the study were 1) average volume, the average volume at which a person phonates, 2) maximum volume, the loudest level at which a person

phonates, 3) fundamental frequency, the lowest frequency that an individual uses, 4) duration of [i], the length that a person could sustain the vowel [i], and 5) duration of words, the length of time a person could speak on inhalation.

The instruments of assessment were 1) Bruel and Kjaer Sound Pressure Level Meter, Type 2203. The sound pressure level meter is used to provide an estimation of the sound pressure level of noise. When sound is presented to the sound pressure level meter it is converted to an electrical signal which is amplified and shown on the meter. The components of a sound pressure level meter are a microphone, an attenuator and a series of weighted networks and a meter. The networks are classified as A, B, and C scales. The C-slow scale was used to assess the subjects in this study. The C scale gives a flat response scale; 2) Bruel and Kjaer microphone, Type 4145; 3) SI America Fundamental Frequency Indicator, Type Fo 1, the fundamental frequency indicator isolates the fundamental frequency of a person's voice from other components by using electronic components circuits, and principles including filters and logic circuits (Hanley and Peters, 1971); and 4) an electronic stop watch. The testor was evaluated using these instruments and was proven to be competent.

Procedures for the collection of the data were closely followed for each site to obtain as good a sample as possible. The examiner checked the assessment instruments at each site to assure they were working properly and informally calibrated based on the examiner prior results. The subjects were selected one at a time and given an explanation of the study. The subjects were then asked to participate in the assessment. Once the subject had agreed, the subject was led to a quiet room to begin the assessment. The subject was then administered an oral questionnaire (Appendix A). If the subject had suffered a stroke or CVA, had any neurological/psychological involvement, wore a hearing aid or the subject's age did not fall between 65-80 the procedure ended. If responses all fell within the criteria for acceptance, the procedure continued. The subjects were then asked to give a description of the activities at their particular site. When the subjects began talking an average speaking volume reading and a maximum speaking volume reading were obtained from the sound pressure level meter. Next, the subject was asked to sustain the vowel [i] for as long as possible, to obtain a maximum duration of sound. The maximum duration of sound was recorded with an electronic stop watch. The subjects were asked to begin phonation when they were signaled and were timed until phonation dropped to a

whisper. After measuring the duration of the vowel [i], the subject was then asked to begin with the number one and count until he/she ran out of breath. It was necessary to listen very closely for the second inhalation, as it was found that the subjects didn't realize when the second inhalation was taken. Fundamental frequency was determined next. The subjects were then asked to repeat the vowel [i] while the fundamental frequency microphone was held to their throat.

The data were analyzed in the areas of mean, median, mode, range, and standard deviation. The mean is the arithmetic average of all the scores in the sample. The median represents the exact midpoint, division of the scores into two equal parts. The mode is the number that appears most frequently in the distribution. Range and standard deviation are measures of variability. Range is found by determining the difference between a high number and a low number. Standard deviation is a measure that determines how numbers vary from the mean (Best, 1970).

In the following chapter a report will be made concerning the data in this study. Comparisons will be made with data from other studies dealing with children and adults and also older adults.

CHAPTER 4

RESULTS AND ANALYSIS OF THE DATA

Introduction

The results of this study indicate the normal voice characteristics of males and females aged 65-80. The data are reported relative to mean, median, mode, range, and standard deviation. The areas of reporting are those of average volume, maximum volume, duration of [i], duration of combined words and fundamental frequency.

Results

Fifty males and fifty females were examined in this study. The mean age for males was 71.74; the median was 71.50; and the mode was 75. The range was 65-80 and the standard deviation 4.730. The mean age for females was 70.92; the median was 70; and the mode was 65. The range was 65-80 and the standard deviation was 4.413. The male and female combined mean age was 71.33; the median was 70.50; and the mode was 68. The range was 65-80 and the standard deviation was 4.598. Table 1, Age Values for Males and Females, gives information concerning age in relation to the mean, median, mode, range and standard deviation.

Table 1

Age Values for Males and Females

Age	Male	Female	Combined
Mean	71.74	70.92	71.33
Median	71.50	70.00	70.50
Mode	75.00	65.00	68.00
Range	65-80	65-80	65-80
Standard Deviation	4.730	4.413	4.598

Average volume, the average volume at which a person phonates, was determined with a sound pressure level meter. The fifty males showed a mean of 68.34 dB. The male median was 68 dB and the mode was 64 dB. The range was 61-76 and the standard deviation was 3.414. The average volume for the fifty females showed a mean of 64.2 dB. The female median was 64 dB and the mode was 64 dB. The range was 60-72 and the standard deviation was 3.079. For average volume of males and females combined, the mean was 66.27 dB, the median was 66 dB and the mode was 68 dB. The range was 60-76 and the standard deviation was 3.969. Table 2, Average Speaking Volume Values for Older Males and Females, gives information concerning average volume in

relation to mean, median, mode, range, and standard deviation.

Table 2

Average Speaking Volume Values for Older Males and Females

dB	Male	Female	Combined
Mean	68.34	64.20	66.27
Median	68.00	64.00	66.00
Mode	68.00	64.00	68.00
Range	61-76	60-72	60-76
Standard Deviation	3.414	3.079	3.969

Maximum volume, the loudest level at which a person phonates, was also determined with a sound pressure level meter. For the males the mean for maximum volume was 75.74 dB. The median was 76 dB and the mode was 76 dB. The range of maximum volume for males was 64-81 and the standard deviation was 4.166. Maximum volume for females showed a mean of 72.02 dB. The median was 72 dB and the mode was 70 dB. Range for maximum volume for females was 64-86 and the standard deviation was 4.044. The mean of maximum volume for males and females combined was 73.88 dB. The median was 74 dB and the mode was 72 dB. The range was 64-86 and the standard deviation was 4.294.

Table 3, Maximum Speaking Volume Values for Older Males and Females, gives information concerning maximum volume in relation to mean, median, mode, range, and standard deviation.

Table 3

Maximum Speaking Volume Values for Older Males and Females

dB	Male	Female	Combined
Mean	75.74	72.02	73.88
Median	76.00	72.00	74.00
Mode	76.00	70.00	72.00
Range	64-81	64-86	64-86
Standard Deviation	4.166	4.044	4.294

Duration of the vowel [i], which is the amount of time the [i] can be sustained, was determined with an electronic stop watch. The male mean for duration of [i] was 9.54 seconds. The median was 8 seconds and the mode was 4 seconds. The range was 1-27 and the standard deviation was 5.576. The females showed a mean for duration of [i] of 7.98 seconds. The median was 6 seconds and the mode was 5 seconds. The range for duration of [i] was 1-20 and the standard deviation was 4.817. The mean for the duration of [i] for males and females combined was 8.76 seconds. The

median was 7 seconds and there were two modes, which were 4 seconds and 5 seconds, so it is said to be bimodal. The range was 1-27 and the standard deviation was 4.968. Table 4, Duration of [i] Values for Older Males and Females, gives information concerning duration of [i] in relation to mean, median, mode, range, and standard deviation.

Table 4

Duration of [i] Values for Older Males and Females

seconds	Male	Female	Combined
Mean	9.54	7.98	8.76
Median	8.00	6.00	7.00
Mode	4.00	5.00	4/5
Range	1-27	1-20	1-27
Standard Deviation	5.576	4.817	4.968

Duration of phonation of combined words, the amount of time a person can phonate using combined words, was measured with an electronic stop watch. The males showed a mean of 10.38 seconds for the duration of words. The median was 9.5 seconds and there were two modes which were 6 seconds and 8 seconds, so it is said to be bimodal. The range was 3-26 and the standard deviation was 3.725. For the females the mean was 9.58 seconds for duration of

words. The median was 10 seconds and the mode was 12. The range was 2-18 and the standard deviation was 4.017. Mean for duration of phonation for words for males and females combined was 9.98 seconds. The median was 10 seconds and there were two modes which were 6 seconds and 12 seconds, so it is said to be bimodal. The range was 2-26 and the standard devaiation was 4.772. Table 5, Duration of Phonation for Combined Words for Older Males and Females, gives information concerning duration of phonation of words in relation to mean, median, mode, range and standard deviation.

Table 5

Duration of Phonation for Combined Words for Older Males and Females

seconds	Male	Female	Combined
Mean	10.38	9.58	9.98
Median	9.50	10.00	10.00
Mode	6/8	12.00	6/12
Range	3-26	2-18	2-26
Standard Deviation	3.725	4.017	4.772

Fundamental frequency is the lowest frequency at which a person phonates. The fundamental frequency was

determined with a fundamental frequency indicator. The mean fundamental frequency for the males was 210 Hz. The median was 200 Hz and the mode was 150 Hz. The range was 150-350 and the standard deviation was .5830. The female mean for fundamental frequency was 246 Hz. The median was 250 Hz and the mode was 250 Hz. The range was 150-350 and the standard deviation was .8402. The mean fundamental frequency for males and females combined was 228 Hz. The median was 250 Hz and the mode was 250 Hz. The range was 150-350 and the standard deviation was .5353. Table 6, Fundamental Frequency Values for Older Males and Females, gives information concerning fundamental frequency in relation to mean, median, mode, range, and standard deviation.

Table 6

Fundamental Frequency Values for Older Males and Females

Hz	Male	Female	Combined
Mean	210	246	228
Median	200	250	250
Mode	150	250	250
Range	150-350	150-350	150-350
Standard Deviation	.5830	.8402	.5353

Table 7, Disqualified Subjects, presents information on the subjects that were disqualified. Four subjects, two males and two females were disqualified because of stroke or CVA. There were no subjects disqualified because of neurologic/psychologic involvement, e.g. Parkinson's. Six subjects, five males and one female, were disqualified because they wore a hearing aid. There were 20 subjects, 12 males and 8 females, who were disqualified because of their age.

Table 7

Disqualified Subjects

#	Male	Female	Combined
Hearing Aid	5	1	6
CVA/Stroke	2	2	4
Neurological/ Psychological	0	0	0
Age	12	8	20

The results of this study indicate that an older male has a mean average speaking volume of 68.34 dB and a mean maximum speaking volume of 75.74 dB. An older male can sustain the vowel [i] for a mean value of 9.54 seconds and had a mean duration of phonation for words of 10.38 seconds. Fundamental frequency was 210 Hz.

Older females had a mean average speaking volume of 64.2 dB and a mean maximum speaking volume of 72.02 dB. The female subjects had a mean duration of phonation for [i] of 7.98 seconds and a mean duration of phonation for words of 9.58 seconds. Mean fundamental frequency was 246 Hz.

Comparision to Previous Studies

The data obtained from this study will now be compared to the information reviewed in Chapter 2, Review of Literature. The information will be compared regarding older adults and children and adults under 65.

The current study found the mean fundamental frequency of the vowel [i] for an older male was 210 Hz. Peterson and Barney (1952) in their study found the male fundamental frequency for the vowel [i] at 136 Hz. Studies done by Honjo and Isshiki (1980), Mueller (1982), Hollien and Shipp (1972) and Mysak (1959) concluded that as a man's age increases so does his fundamental frequency. This current study is in agreement with previous studies.

It was found in this study that a woman had a mean fundamental frequency of 246 Hz for the vowel [i]. The results here differ from that of Honjo and Isshiki (1980) which found that women tend to have a lower fundamental frequency as their age increases. Peterson and Barney (1952) reported an adult female fundamental frequency for

the vowel [i] at 235 Hz. The current study shows the older female fundamental frequency is 11 Hz over the norm for the adult female fundamental frequency. McGlone and Hollien (1963) found that as a woman's age increases there is no change in the fundamental frequency. The current study is in greater agreement with the study done by McGlone and Hollien (1963).

The results of this study have shown the mean average volume for a male to be 68.34 dB and for a female 64.2 dB. Yanagihara, Koike, & von Leden (1966) give the average volume for males as 67 dB and for females 64 dB. The current study is in close agreement with Yanagihara, et al. (1966), the only study found dealing with average speaking volume. The results in this study imply that there is little, if any, difference in the average speaking volume of older adults versus children and adults under the age of 65.

The mean maximum loudness in this study was 75.74 dB for the older male. The older female showed a mean maximum loudness of 72.02 dB. "Loud-talking" was reported by Fletcher (1953) as being 86 dB for younger males and females. It appears that in comparing the results of this study with existing data, the maximum volume of older males and females is less than that of younger males and females. By comparing the internal data in the study, it

appears that males have a slightly higher maximum volume than females.

The current study shows a male mean duration of phonation to be 9.54 seconds and a female mean to be 7.98 seconds. Ptacek and Sander (1963) listed 25 seconds as the duration of phonation for adult males and 17 seconds for adult females. Finnegan (1980), who studied children's duration of phonation, stated that as age increases from three years-six months to seventeen years-eleven months so does duration of phonation. The maximum duration for a seventeen year old was 26.15 seconds. The current study shows a decrease in phonation time which is in agreement with Mueller (1982), who found the mean phonation time for older males to be 13 seconds and older females at 10 seconds.

CHAPTER 5

SUMMARY, IMPLICATIONS AND RECOMMENDATIONS

Introduction

This chapter will review the current study. Conclusions, implications and recommendations will be made in relation to normal male and female voice characteristics of those aged 65-80.

Summary

This study examined the voice characteristics of normal older males and females. Fifty males and fifty females, aged 65-80 were examined in this study. The areas of average speaking volume, maximum speaking volume, duration of phonation for the vowel [i] and for words, and fundamental frequency were assessed. Persons having any history of stroke or CVA, neurologic/psychologic involvement or having a hearing aid were excluded. The instruments used for assessment were 1) sound pressure level meter, 2) fundamental frequency indicator and 3) an electronic stop watch.

Conclusions

This study revealed the typical voice characteristics for the "normal" older adult. The mean age for males was 71.74 and the mean age for females was 70.92. The males

have a mean average speaking volume of 68.34 dB and the females have a mean average speaking volume of 64.2 dB. The males exhibited a mean maximum volume of 75.74 dB and the females have a mean maximum volume of 72.02 dB. The area of duration of phonation showed the males had a mean of 9.54 seconds for the vowel [i] and 10.38 seconds for combined words. The female showed a mean duration of phonation of 7.98 seconds for the vowel [i] and 9.58 seconds for combined words. Mean fundamental frequency for males was 210 Hz and females was 246 Hz.

The current study reveals that as a male's age increases, his fundamental frequency also increases. Volume increases slightly and maximum volume decreases. Duration of phonation for males also decreases. Females in the current study had a fundamental frequency that was slightly higher than that of younger adults for the same vowel. The average volume for females was the same and maximum volume was slightly lower. Duration of phonation for females decreased by one half.

Implications

In examining the current study, it can be said that the fundamental frequency of "normal" older males and females changes minimally from that of younger males and females. The average volume of older males and females showed little difference than that of younger males and females. Maximum volume was less for both older males and

females than that of their younger counterparts. The older males and females showed a substantial difference in the area of duration of phonation when compared to younger males and females, decreasing by almost one-half in duration of phonation. Thus, it can be stated that, according to the current study older male voices exhibit change, sometimes minimally so, in the areas of fundamental frequency, maximum volume and duration of phonation but remain the same for average volume. Older females exhibit changes in the areas of maximum volume and duration of phonation but remain the same for fundamental frequency and average volume.

Recommendations for Further Research

1. Replicate the existing study as is.
2. Replicate the existing study with an expanded sample.
3. Replicate the existing study and add a comparable number of younger adults for comparison.
4. Replicate the existing study and show a comparison between those who live independently and those who live in rest homes and nursing homes.
5. Replicate the existing study of age to determine if significant differences occur between age ranges of 65-70, 70-75, 75-80.
6. Replicate the existing study and add latency of response.

7. Replicate the existing study and compare smokers to nonsmokers.

8. Replicate the existing study and compare normal older adults to adults suffering from Parkinson's Disease.

9. Replicate the existing study and compare normal older adults to those suffering from Huntington's Chorea.

10. Replicate the existing study and compare normal older adults to those suffering from Emphysema.

11. Replicate the existing study and eliminate and compare to adults who suffer from heart problems.

12. Replicate the existing study and compare normal older adults to those with known hearing problems.

13. Conduct a study comparing voice samples of older and younger adults.

14. Conduct a study comparing spectrograms of older and younger adults.

15. Conduct a study in which samples of older and younger adults' voices are described by listeners.

16. Conduct a study in which listeners attempt to identify a voice as being that of an aged person.

17. Replicate the existing study in different areas of the state and make comparisons.

18. Replicate the existing study in different areas of the country and make comparisons.

Summary of the Study

This study measured the normal voice characteristics of the older adult. Characteristics of normal voice were determined for the areas of average volume, maximum volume, duration of [i], duration of words, and fundamental frequency. The results of this study will help speech-language pathologists to provide 1) more accurate diagnoses of normal versus pathologic and psychogenic voice disorders, 2) more appropriate treatment to the disordered group with more realistic goals for treatment. When examining an older adult for possible placement in speech therapy the speech-language pathologist can better determine: 1) whether an older adult does exhibit a voice disorder, 2) the degree of severity of the disorder, 3) realistic goals and objectives for treatment and 4) more appropriate methods of treatment. The use of the results of the current study by speech-language pathologists will help in making judgments about what is abnormal in the area of voice characteristics of the older adult.

In general, older males have essentially the same voice characteristics as their younger adult counterpart with relation to average volume. Older males have slightly lower maximum volume, significantly higher fundamental frequency and drastically lower duration of phonation. Older females have the same voice characteristics in the

area of fundamental frequency and average volume as their younger adult counterpart, but show differences in maximum volume and duration of phonation.

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APPENDIX A

VOICE CHARACTERISTICS OF THE AGED

PERSONAL INFORMATION

APPENDIX A
VOICE CHARACTERISTICS OF OLDER ADULTS
PERSONAL INFORMATION

Name _____

Date of birth/age _____

- -

1) Have you ever had a stroke (CVA)?

2) Do you have an neurological disorder? e.g. Parkinson's

3) Do you have a severe hearing loss? Do you wear a hearing aid?

- -

Fundamental Frequency _____

Average Volume _____

Maximum Volume _____

Duration of Phonation [i] _____

Duration of Phonation/words _____

VITA

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