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A Study of the Reading and Speaking Fundamental Vocal Frequency of Aging Black Adults.

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A STUDY OF THE READING AND SPEAKING FUNDAMENTAL VOCAL FREQUENCY OF AGING BLACK ADULTS

A Dissertation

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Louisiana State University and
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in

The Department of Speech Communication,
Theater, and Communicative Disorders

by

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ABSTRACT

The present study explored the relationships between fundamental frequency means and range extents for black adults in three decade intervals from 50-79 years of age during two speaking tasks. One hundred thirty-three males and 144 females participated in a spontaneous speaking task. Only 28 males and 65 females were able to participate in the reading activity.

The results of the reading central tendencies for males suggested that the mean fundamental frequency increases with age for each decade interval (107.14 Hz, 111.00 Hz, and 129.09 Hz, respectively). The males in the 50- and 60-year decades had significantly lower means than the 70-year decade group. The mean reading ranges were 80.71 - 157.14 Hz, 76.50 - 185.50 Hz and 89.54 - 178.63 Hz for the three decade groups, respectively. The range of the 60-year decade group was significantly wider than that of the 50-year decade group. No other significant differences in reading ranges for males were found.

Results of the mean speaking fundamental frequency values for males for each of the decade groups (118.13 Hz, 113.33 Hz, and 116.33 Hz, respectively) indicated no significant differences between the means. There was no significant difference in the mean speaking ranges of 74.76 - 216.51 Hz, 76.44 - 209.11 Hz and 72.44 - 217.44 Hz for the three decade groups, respectively.

For females, the mean reading fundamental vocal frequencies decreased across the three respective decades (170.43 Hz, 165.00 Hz, and 155.35 Hz). However, these differences in the means were not statistically significant. Also, there were no significant differences in the mean reading ranges of 118.26 - 258.04 Hz, 107.67 - 252.67 Hz and 103.57 - 262.14 Hz for the three decade groups, respectively.

The female mean speaking fundamental frequency values systematically decreased with advancing age (168.22 Hz, 163.26 Hz, and 150.46 Hz, respectively). The differences in these mean values were not statistically significant. There was no significant difference in the mean reading ranges 98.64 - 297.50 Hz, 95.00 - 305.30 Hz and 82.23 - 290.31 Hz for the three decade groups, respectively.

Reading and speaking values were compared in this investigation. In addition, results for the present study were compared to past research. Clinical implications and future research needs were also discussed.

CHAPTER I

INTRODUCTION

One of the most important aspects of laryngeal activity during the oral expression of language is the fundamental frequency of vocal fold vibration, or the rate at which glottal pulses are released into the vocal tract. The fundamental frequency will vary considerably during speech, although in an adult it usually varies approximately one octave in extent, with the major working time of the larnyx occurring in the lower part of the individual's total range (Fry, 1979). The average speaking fundamental frequency depends upon various factors specific to each speaker, but, in general, children use the highest range while men use the lowest and women use an intermediate range.

If the fundamental frequency of vocal fold vibration is subjectively determined by listening, it is referred to as the pitch of the voice. The listener perceives a rise in pitch when frequency increases, and, conversely, decreases in frequency are heard as a lowering of pitch. While pitch is a subjective phenomenon, it can be objectively quantified through measurements of the fundamental frequency. Fundamental vocal frequency, and its subjective correlate of pitch are characteristics of the prosody of the speech signal, with prosody also encompassing stress patterns and intonation of a language.

There are three basic parameters of voice which can be identified in addition to the fundamental vocal frequency. These parameters are those of phonetic duration, wave form composition, and intensity level. While all of these four vocal elements are important in the perception of voice, it is the fundamental frequency which will be further considered here because of its importance in providing information regarding emotional state or personality, chronological age, sex, and race of the speaker as well as the type of speech activity in which the speaker is participating.

Fundamental frequency or pitch as an indicator of the emotional state or personality of a speaker has been studied by various researchers. Fairbanks and Pronovost (1939) demonstrated that judges were able to identify five different emotions (contempt, anger, fear, grief, indifference) in an actor's voice, with measurable differences in frequency characteristics existing between the emotional portrayals. It was found that (1) extremely wide downward inflections at the ends of phrases characterized contempt; (2) anger curves contained a large proportion of upward inflections; (3) fear was characterized by a disintegrated pattern; (4) pitch levels for anger and fear were approximately one octave higher than those used to convey contempt, grief, or indifference; (5) falling intonation was demonstrative of grief; and, (6) indifference lacked a

definitive pitch pattern. Davitz (1964) as well as Williams and Stevens (1972) agreed with the above findings that grief or sadness is generally expressed in a lower pitch range, while fear tends to be exhibited by a relatively high-pitched voice. Fonagy (1978) used laryngographic recordings to demonstrate that prosodic features, notably mean vocal fundamental frequency and its range, play a dominant role in conveying such emotive attitudes of the speaker as coquetry (flirtation), joy, longing, sorrow, fear, and anger. His findings agree with those of Fairbanks and Pronovost (1939), Davitz (1964) and Williams and Stevens (1972) regarding the low average pitch levels which depict sorrow as well as the higher pitch levels associated with fear. Like Fairbanks and Pronovost (1939), Fonagy found that anger was characterized by a sudden rise in fundamental frequency. In addition, Fonagy (1978) found that joy was revealed through a high pitch level and large melodic intervals while coquetry was indicated by a quick tonal rise in the last syllable of a phrase and longing was exhibited by a slow, weak rise in fundamental frequency.

Considerable attention has also been paid to the relationship between personality and voice. Theorists and investigators in this aspect of voice have included Moses (1954), Barbara (1958), Rousey and Moriarty (1965), and Aronovitch (1976). Pitch level was one of the acoustic

dimensions which Moses (1954) suggested was useful in interpreting personality through a subjective clinical technique which he calls "creative hearing." He reported that "honest," "warm" personalities were revealed in voices which were produced in a natural chest register while higher voices indicated insincerity or artificiality. Another example of Moses' beliefs can be seen in his observation that a persistent falsetto voice is a schizoid symptom in a young adolescent who persists in maintaining a child-like attitude. Barbara (1958) related personality to voice by characterizing individuals as self-effacing, expansive, resigned, parrot-like, or "ivory-tower" speakers. Rousey and Moriarty (1965) observed that pitch level deviations and restricted pitch range can be found in individuals with personality disorders which included symptoms of poor sexual identity or drive. Aronovitch (1976) found that judgments from voice, particularly for pitch and associated loudness cues, were significantly correlated with personality for the traits of self-doubting/self-confident, bold/cautious, and mature/immature.

The data with respect to the relationship of fundamental frequency to chronological age, sex, race, and type of speech activity are summarized in Appendix A and Appendix B. The principal investigators and the instrumentation

that was utilized in the studies are also included in these tables. A review of these tables reveals that (1) the age of the subjects ranged from birth to 89 years; (2) Hertz, as a measure of central tendency, is, to a certain extent, inversely related to age; (3) there have been more studies of males than of females; (4) there have been more studies of whites than blacks; (5) various types of vocalization samples (i.e., reading, spontaneous speech, infant crying and vowel production) have been utilized in these studies; (6) a variety of instrumentation has been employed in measuring the vocal frequency; and (7) certain investigators, such as Fairbanks and Hollien, have been prominent in fundamental vocal frequency research.

Vocal characteristics of the pre-adolescent age group have been studied by Curry (1940); Fairbanks (1942); Pedrey (1945); Fairbanks, Wiley, and Lassman (1949); Fairbanks, Herbert, and Hammond (1949); Hollien and Malcik (1962); Ringel and Kluppel (1964); Hollien, Malcik, and Hollien (1965); McGlone (1966); Hollien and Malcik (1967); Duffy (1970); Prescott (1975); Laufer and Horii (1977); Murry, Amundson, and Hollien (1977); Schmitt and Cooper (1978); and, Gilbert and Campbell (1980). In infants, the presence of a high average pitch and an extensive pitch range has been reported. A review of the data presented in Appendix A and Appendix B reveals that the mean fundamental frequency of the infants studied ranged from 335 to 556 Hz. The

majority of these infant studies did not indicate separate measurements for males and females. In the Murry, et al., (1977) study in which the cries of male and female infants were measured separately, the male infants were found to produce a higher mean fundamental frequency than the female infants. For all of the infants in the Murry, et al., study, the mean cry for hunger was highest, followed by the mean fundamental frequency for pain. Startle-evoked cries were measured as the lowest mean fundamental frequency for the group.

Within the total pre-adolescent group, the summaries of these studies indicate that the mean fundamental vocal frequency varies considerably; that is, there is a systematic decrease in the mean fundamental on the order of one octave from infancy through 10 years of age. Also, as the child grows older, the extent of the range is reduced from approximately five octaves to one octave and a decrease occurs in the fundamental frequency values marking the extremes of the range. That is, both the highs and the lows shift downward.

Studies of the vocal characteristics of 13 to 18 year olds were undertaken by Curry (1940); Pronovost (1942); Hollien and Malcik (1962); Hollien, Malcik, and Hollien (1965); Hollien and Malcik (1967); Michel, Hollien, and Moore (1966); Hollien and Paul (1969); Duffy (1970); and

Gilbert and Campbell (1980). The results of these studies indicate that the fundamental vocal frequency for both males and females shows a rather abrupt or prominent decrease in this age group, with the pitch level for males dropping approximately one octave below that of females by the time they are 18 years old. In the study by Curry (1940), the major shift in the pitch of males was found to occur between 14 and 18 years of age. Studies by Hollien and Malcik (1962) and Hollien, Malcik and Hollien (1965) revealed, however, that voice change in adolescent males occurs before 14 years of age. An earlier physiologic maturation of the males in these latter two studies in the 1960's might account for the voice change at an age younger than that found in the males in Curry's study published in 1940. For females, the post-menarchial period appears to play a critical role in the alteration of pitch level. Hollien and Paul (1969) found that females exhibit a stable adult voice during the immediate post-pubescent period. Michel, Hollien and Moore (1966) concluded that most females by 15 years of age have attained fundamental frequency levels comparable to the adult female voice. For both males and females, voice change in the adolescent age period has been related to growth of the respiratory, phonatory and resonatory anatomy as well as to hormonal changes which affect vocal fold mass and length.

Measures of central tendency relative to the average pitch level or fundamental vocal frequency in adults have been discussed by Weaver (1924); Murry and Tiffin (1934); Cowan (1936); McIntosh (1939); Curry (1940); Philhour (1948); Snidecor (1951); Mysak (1959); McGlone and Hollien (1963); von Leden (1977); Ptacek, Sander, Maloney, and Jackson (1966); Saxman and Burk (1967); Duffy (1970); Fitch and Holbrook (1970); Segre (1971); Majewski, Hollien and Zalewski (1972); Ryan (1972); Hollien and Shipp (1972); Linke (1973); Whitehead and Emanuel (1974); Boe and Rakotofiringa (1975); Horii (1975); Kelley (1977); Emanuel and Scarizini (1979; 1980); Honjo and Isshiki (1980); Stoicheff (1981); and, Hudson and Holbrook (1981; 1982). The results of these studies indicate that there is an inverse relationship between the average fundamental vocal frequency and age in that the fundamental frequency decreases as there is an increase in age. For adult white males, the average fundamental decreases throughout middle age, but begins to increase after that time (Curry; 1940; Mysak, 1959; Ptacek, et al., 1966; Segre, 1971; Hollien and Shipp, 1972; Majewski, Hollien and Zalewski, 1972; Ryan, 1972; von Leden, 1977; and Honjo and Isshiki, 1980). Hollien and Shipp (1972) found that there is progressive lowering of fundamental frequency in males until the 40 to 50 year age range, at which time there is a progressively rising trend until old age. The 80 year olds in Hollien and Shipp's

study exhibited a mean fundamental frequency 30 Hz higher than that found in the 50 year old subjects. Mysak (1959) and Segre (1971) reported that the fundamental frequency of males lowers in reading and speaking throughout adulthood until approximately 60 years of age, after which a rise in fundamental frequency occurs.

There are fewer studies of the fundamental vocal frequency of females than there are for males in the adult range. Reports by Saxman and Burk (1967) and Honjo and Isshiki (1980) indicate that the average fundamental frequency for females begins to decrease during the thirties and continues to decrease gradually with age. Stoicheff (1981) reported that when the smoking variable is controlled, the speaking fundamental frequency is relatively stable from post-adolescence through the fourth decade, but there is a decrease in the mean speaking fundamental frequency in the 50 to 59 year age group. The mean fundamental frequency value obtained for the 60 to 82 year old females in this study was essentially the same as that obtained for the 50 to 59 year old females. McGlone and Hollien (1963) did not find any statistically significant difference in speaking fundamental frequency between the two groups of women in their study with mean ages of 72.6 and 85.0 years, nor between these two groups and the young females of Linke's (1973) study. Charlip (1968) found that

there is no systematic change in the fundamental frequency of the female voice as age increases.

Investigators have discussed various factors related to changes in the laryngeal mechanism which can result in acoustical and perceptual vocal differences from early to later adulthood. Anatomical and physiological alterations of the laryngeal area, and consequently fundamental vocal frequency, have been specifically mentioned in a number of reports (Mysak, 1959; McGlone and Hollien, 1963; Luchsinger and Arnold, 1965; von Leden, 1977; Ptacek, et al., 1966; Fletcher, 1968; Shipp and Hollien, 1969; Segre, 1971; Hollien and Shipp, 1972; Ryan, 1972; Ryan and Burk, 1974; Ryan and Capadano, 1978; Hartman, 1979; and Hooper, 1979). Anatomically, the structure for phonation ages in a speaker due to several factors, including calcification and ossification of laryngeal cartilages; erosion of joint surfaces; changes in blood vessels, muscles, mucous membranes, and nerve endings; as well as hormonal changes that may cause differences in vocal fold mass. These anatomical differences cause physiological changes in that the age-altered structure functions differently in producing alterations in the length, tension, and mass of the vocal folds. The result is that acoustic and consequently the perceptual differences in the aged adult become evident. Acoustically, fundamental frequency, fundamental frequency variability, intensity, and spectral

variations can be measured. Perceptually, changes include those of pitch, pitch variability, loudness, and quality.

Most of the studies of fundamental vocal frequency have used white subjects. Hollien and Malcik (1962) and Hudson and Holbrook (1981; 1982) have reported measures of central tendency and variability for fundamental vocal frequency in blacks, with 10-14-18 year-olds being studied by Hollien and Malcik and young adults in the 18-29 year old range being studied by Hudson and Holbrook. In those groups, the blacks appeared to have a lower mean fundamental than that which had been found in white subjects of similar age and speaking activity.

In all of the previously described studies of fundamental frequency, one or a variety of types of vocal activities have been utilized for analysis. Researchers have used reading passages, spontaneous speech, various types of infant cries and vowel prolongation in order to evaluate the voice. The results of several studies have indicated that the fundamental vocal frequency central tendency in reading is higher than in spontaneous speech (Snidecor, 1943; Hanley, 1951; Mysak, 1959; Hollien and Jackson, 1973; Schultz-Coulon, 1975; Richardson, 1979; and, Hudson and Holbrook, 1981 and 1982). It has been suggested that the speaker required to read a passage may feel constrained or pressed to maximize his speaking behavior which may lead

to, among other things, a change in the mean speaking frequency through altered laryngeal dynamics (Hartman, 1979).

A variety of instrumentation has been utilized in assessing fundamental vocal frequency. These devices vary in the amount of time required to analyze a speech sample of a given length. Some of the early investigators studying fundamental vocal frequency chose a limited number of subjects for their research because of the extensive amount of time required for analysis with the instrumentation that was available to them. In the following paragraphs, descriptions will be provided of the design and construction of the instruments pertinent to fundamental vocal frequency research.

Metfessel (1926) developed a phonophotographic technique which involved photographing flashes of light which corresponded to major fluctuations in the sound wave. By photographing the flashes as they were seen through a stroboscopic disc containing 66 rows of holes at specific distances from each other, frequency could be calculated when the speed of rotation of the disc, the number of holes per row, and the speed of the film movement were known. Thus, a wave by wave photographic record to measure sound wave lengths was provided to the researcher. This phonophotographic technique, which was quite time consuming, was later modified by Cowan (1936). Hollien,

Malcik, and Hollien (1965) constructed a device similar to Cowan's with the exception that it was motor driven and contained components which were available commercially.

In 1946, Koenig, Dunn, and Lacy reported the development of the sound spectrographic analyzer. With the sound spectrograph as it exists today, the speech signal is recorded on a tape band which is part of the instrument. The signal is then passed through a narrow (45Hz) or broad (300Hz) band-pass filter that is moved upward through the frequency range. An electric spark is produced by a stylus on heat sensitive recording paper when energy is detected in the signal being analyzed. The result is a fine black line on the recording paper of the spectrographic unit. Thus, a permanent visual record of the distribution of energy with respect to both frequency and time is produced. Through a time-consuming procedure, the fundamental frequency can be extracted from the complex graphic display of the speech signal. The fundamental frequency on the spectrogram is the lowest component of the energy distribution and can be measured by comparing the speech signal to a reference frequency.

In 1950, development of the Purdue Pitch Meter, designed to provide for a more rapid extraction of the fundamental vocal frequency from complex wave forms, was reported by Dempsey, Draegert, Siskind, and Steer. Equali-

zer circuits, which amplified the lowest frequency component present while attenuating or rejecting the higher harmonics, made this extraction possible. The amplified fundamental frequency was then counted and presented on a meter calibrated in cycles per second.

In the years following development of the instruments discussed above, more sophisticated high speed switching devices were developed. These high speed switching devices allowed for instruments to be developed which greatly reduced the analysis time per subject so that the size of the sample under investigation could be substantially increased. Two of these instruments will be discussed below.

The Fundamental Frequency Indicator (FFI) was developed at the University of Florida. A description of this instrument was reported in the literature in 1966 by Michel, Hollien, and Moore, and in 1969 by Hollien and Paul. The FFI is comprised of a group of successive low-pass filters with cut-offs at half-octave intervals coupled with high-speed switching circuits controlled by a logic unit. This logic system operates by continuously extracting the fundamental period from complex speech waves. The period values are then processed digitally to yield the geometric mean frequency level and standard deviation of the frequency distribution. A digital readout of fundamental frequency is provided by a tracking device contained in the FFI.

Another device which was designed to rapidly extract the fundamental vocal frequency from the complex wave form was developed in 1968 at the Florida State University Speech Research Laboratory. It was developed by Anthony Holbrook, Ph.D., and was referred to as FLORIDA, an acronym for Frequency Lowering or Raising Intensity Determining Apparataus. This instrument identifies the fundamental in a complex wave form as that frequency having the greatest amplitude and also analyzes the duration of fundamental frequency energy occurring within a given band-pass. As described by Holbrook and Meador (1969), FLORIDA is an electronic device consisting of a set of variable band-pass filters connected to a relay system which triggers an electronic stop-clock. Through activation of the clock, the total duration of sound energy within each frequency band-pass for the message being analyzed can be measured. A 20 Hz band-pass is utilized for males while one of 30 Hz is utilized for females. The modal fundamental vocal frequency on the FLORIDA apparatus is represented by the center frequency of the band-pass having the greatest duration. The fundamental vocal frequency range can be quickly determined by scanning above and below the mode until no energy is detected.

The early or experimental version of the FLORIDA apparatus described above was limited to a one octave analy-

sis because it had no provision for suppression of the upper vocal harmonics. Because the second harmonic of the lowest frequency analyzed would coincide with a fundamental frequency one octave higher, measurement beyond a range of one octave was rendered impossible. In order to eliminate this problem as well as to eliminate the band-pass filters and to operate as a Hertz-to-direct-current converter, the experimental FLORIDA device was refined. The entire fundamental vocal frequency distribution can be analyzed with this unit (FLORIDA I) because it provides for automatic harmonic suppression. The duration of fundamental vocal frequency energy which falls within a preset band-pass can be registered by the unit.

Further description of FLORIDA I is provided by Hudson and Holbrook (1981; 1982). They report that the recorded speech sample is repeatedly presented to the analyzer as the frequency levels are varied systematically. FLORIDA I sweeps a subject's speech sample several times at each band-pass, starting with a band-pass having a center frequency at the estimated mode, and ascending until no energy is observed, then returning to the band-pass which contains the central frequency of the estimated mode and descending until energy is no longer observed. Depending upon the phase of the analysis, each sweep of the subject's speech sample occurs at a band-pass which has a center frequency which is 10Hz above or below the previous sweep.

On either side of the estimated mode and at the extremes of the range, a five-Hz increment or decrement is used in order to be certain that an accurate assessment is obtained with no energy present outside of the extremes of the range and with the modal frequency being the one having maximum duration. FLORIDA I uses a wider (30 Hz) band-pass for females than for males (20 Hz) in order to detect energy present at the higher female frequencies without error resulting from a delay in circuit response time.

In an effort to validate FLORIDA procedures, Fitch (1968) compared analyses of the fundamental obtained via the FLORIDA device with those obtained by sound spectrography. He found that the FLORIDA analyzer revealed results comparable to the sound spectrograph. Fitch and Holbrook (1970) further investigated validation of the FLORIDA apparatus prior to a study involving the measurement of the modal fundamental vocal frequency of 100 male and 100 female young white adults. They compared measures of fundamental frequency obtained with the FLORIDA instrument to those obtained through the use of sound spectrograms and the Fundamental Frequency Indicator. No significant difference was found by Fitch and Holbrook between measurements of cental tendency for these three methods of determining the fundamental vocal frequency. FLORIDA,

then, was shown conclusively to provide a valid method for analysis of the fundamental vocal frequency.

FLORIDA has been used for both clinical as well as research purposes. Clinically, this instrument can be used to modify undesirable vocal behavior or to improve vocal effectiveness by means of response-contingent lights which allow a subject to be signalled visually contingent upon the vocal frequency falling within a preset specified range. Roll (1965), Moore (1968) and Moore and Holbrook (1971) utilized various reinforcement schedules in order to modify the vocal frequency of normal subjects who were trained to use abnormally high or low pitch levels. Roll (1968) also conditioned another group of subjects exhibiting functional voice disorders to use more appropriate pitch. Holbrook (1970; 1972) and Holbrook and Crawford (1970) reported that deaf subjects utilizing the FLORIDA device were successful in lowering abnormally high pitch levels. Using the modified FLORIDA instrument, Howard and Holbrook (1973) changed the pitch characteristics of actors in his study in order to enhance their stage performance. Holbrook (1977) has more recently discussed this system and its application to various speech disorders.

In addition to its clinical use, FLORIDA has been utilized in normative studies of fundamental vocal frequency by Fitch and Holbrook (1970) and by Hudson and Hol-

brook (1981; 1982). Fitch and Holbrook measured the reading fundamental vocal frequency of 17-25 year old white adults, with the results indicating a mean fundamental of 116 Hz for the males and 217 Hz for the females. Hudson and Holbrook (1981; 1982) investigated the fundamental vocal frequency of young black adults in the 18-29 year age range. They found that males had mean modal fundamentals of 108.50 Hz and 110.50 Hz during speaking and oral reading, respectively, while females had mean modal fundamentals of 188.85 Hz and 193.10 Hz during speaking and oral reading, respectively.

With an instrument such as FLORIDA I available, it is possible to analyze voice samples accurately and rapidly in order to determine the fundamental frequency distribution and central tendency. As mentioned previously, blacks have been the subjects of only three studies of fundamental frequency (Hollien and Malcik, 1962; Hudson and Holbrook, 1981; 1982), with these studies revealing that blacks in the 10-29 year age range have a lower average fundamental vocal frequency than whites in a similar age range. Increased data regarding black adults 30 years of age and older are needed in order to ascertain whether or not there is a significant difference between the fundamental vocal frequency of blacks and whites throughout the adult years, and also to determine if black and white males and females

show similar inverse relationships between fundamental vocal frequency and age. These data would allow more appropriate service to be rendered by professionals who evaluate and provide therapy to black individuals with voice disorders involving pitch deviations.

It is the purpose of the present study to investigate a large normative sample of black adults along an age continuum from 50-79 years in order to determine the fundamental vocal frequency characteristics (dispersion and central tendency) in reading and spontaneous speaking, and also to compare the results to other research in which whites of comparable age performed similar tasks. Additionally, comparisons within race will be made to younger black males and females for both reading and speaking tasks.

CHAPTER II

PROCEDURE

Two hundred and seventy-seven adult volunteers were chosen from the staff and outpatient population at Earl K. Long Memorial Hospital in Baton Rouge, Louisiana, as well as from relatives of patients being served at this facility. The subjects ranged in age from 50 to 79 years. A total of 144 females and 133 males participated in this study. Each subject was questioned regarding height, weight, medical history and current medications as well as history of cigarette, cigar or pipe smoking. The International Classification of Diseases (1978) was used as a basis for classifying the health variables for illness. Each drug was assigned a place in a system based on a generic classification described in Facts and Comparisons (Kastrup, 1975).

Three judges who held the Certificate of Clinical Competence of the American Speech and Hearing Association and who had experience working in a predominantly black environment were instructed to listen to the recording of each subject and determine the adequacy of speech and vocal characteristics. Each subject was judged to either "pass" or "fail." Those subjects who were judged to have speech disorders were excluded from the study. Additionally, those volunteers who reported that they had previously had an

appreciable amount of formal voice training were also excluded.

Only those volunteers who were judged to have speech and hearing characteristics within a normal range were selected as subjects. Dialectal variations consistent with established descriptions (Williams and Wolfram, 1977) of Black English were considered acceptable. Subjects exhibiting the "Cajun" dialect of south Louisiana were excluded from the study primarily because of prosodic differences with both standard and Black English. Those subjects perceived to exhibit significant deviations in fluency or in vocal pitch, loudness, quality, and/or resonance, were also eliminated from this investigation. In addition, individuals chosen to participate in this study were required to pass a hearing screening test. Pure tone air conduction audiometric thresholds were obtained bilaterally for the frequencies 500, 1000, 2000, 4000 and 6000 Hz on a portable audiometer (Beltone 12-D) in an acoustically treated environment. Thresholds rather than a pass/fail rating at a fixed intensity level were obtained at five frequencies in order to provide the individuals willing to participate in this study with greater information regarding their hearing status for their own and/or their physician's use. The frequency of 250 Hz was not utilized during testing because it has been reported to be of little

significance in identification audiometry; and, 6000 Hz was substituted for 8000 Hz due to the difficulty of maintaining calibration on a portable audiometer of this latter frequency (Rose, 1971). The failure of a subject to demonstrate a pure tone average of 30 dB or better in one ear for the speech frequencies 500-2000 Hz constituted a failure on the hearing test. The 30 dB average was chosen in order to account for average hearing threshold levels reported to occur in the majority of black adults over the age of 45 years (Rowland, 1977). The 30 dB or better level of hearing acuity for the frequencies 500-2000 Hz in at least one ear was also the level specified for the subjects in the study by McGlone and Hollien (1963).

Stimulus Material

Reading. The stimulus material for the oral reading sample for this study was "Jesse Owens", a phonetically balanced prose passage adapted from the Reader's Digest Skill Builders series (1965). The "Jesse Owens" passage (Appendix C) was chosen in order to take into account the anticipated interest and varying reading levels of potential subjects. A large number of subjects (105 males and 79 females) did not participate in the oral reading portion of this study because of inability to read or because of problems associated with vision (i.e., problems with or failure to bring eyeglasses; cataracts; glaucoma; and so

on). The difficulty with reading experienced by these subjects can be explained, at least in part, by their age and/or by the paucity of education available to them when they were children.

The "Jesse Owens" passage consisted of six sentences having a total of 82 words. Each phoneme in the paragraph was ranked according to frequency of occurrence and compared to the phoneme frequency of occurrence norms of Tobias (1959), Faircloth and Faircloth (1973), and Dorn (1974). These three investigations showed similar rank orderings of consonants and vowels in multisyllabic contexts; these rank orderings represent frequency of occurrence of such phones. Utilizing the Spearman-rho technique (Guilford and Fruchter, 1978), the correlations of the phoneme ranks of the "Jesse Owens" passage with the ranks of Tobias, Faircloth and Faircloth, and Dorn were .76, .75, and .72, respectively, at a 0.05 significance level.

For comparison with previous studies of fundamental frequency, some subjects in the present study were also asked to read the first paragraph of "The Rainbow Passage" (Appendix D) aloud for recording and later analysis and comparison to their vocal fundamental frequency on the "Jesse Owens" selection. "The Rainbow Passage" is well-known as a phonetically balanced paragraph published by Fairbanks (1960). Spearman-rho correlations of the ranked phoneme frequency of occurrence in "The Rainbow Passage"

with the ranks of Tobias (1959), Faircloth and Faircloth (1973), and Dorn (1974) were .72, .79, and .77, respectively, at a 0.05 significance level. In comparing the ranks of phonemes in "The Rainbow Passage" with the "Jesse Owens" passage adapted for the present study, a Spearman-rho correlation of .83 was obtained, suggesting that there is a high positive correlation with respect to the phonemes present in the two passages.

Each subject participating in the oral reading data collection was instructed to read one or both of the above-mentioned paragraphs aloud three times prior to being recorded to insure familiarity with the words. In an effort to eliminate the starting and ending effects on the fundamental frequency, the first and last sentences were then edited out of the tape, and only the middle 55 words were used for analysis. This portion of the passages contains at least one example of each phoneme of the General American dialect.

Fundamental frequency varies significantly as a function of linguistic intent, even when the length of material to be read and/or spoken is constant. The samples used in this study were fixed linguistic units containing a pre-determined number of syllables and requiring approximately 15 to 20 seconds to read. Horii (1975) investigated the statistical stability of fundamental vocal

frequency for oral readings in which fixed intervals versus varying passage length were used. He concluded that the selection of a fixed linguistic unit, rather than samples of equivalent duration without respect to linguistic content, allowed for a significant reduction in the magnitude of error. He further determined that a specified linguistic unit of approximately 14 seconds in duration was accurate to 3.2 Hz.

Speaking. In order to obtain the spontaneous speaking samples, each subject received instructions to respond to one or more of the following questions: (1) "How is life today for children growing up compared to when you were a child?"; (2) "How do the prices of food and clothes today compare to when you were growing up?"; (3) "How did people go about raising and putting up food (i.e., meats, vegetables or fruit) when you were a child?"; (4) "What's something a young person could or should do to prepare for older age?"; (5) "What kinds of things do you do to help yourself stay within your budget?"; and, (6) "If you could talk to the President of the United States, what would you tell him to do in order to make your life easier?".

A two-minute sample of each subject's response was recorded. Many subjects provided two minutes of spontaneous speech in response to only one question, while the majority of subjects produced a two-minute speaking sample in their

responses to two of the above questions. Occasionally a subject was asked more than two questions in order to elicit speech of a sufficient duration for analysis. After deleting the first and last segments and editing out pauses, approximately 30 seconds of articulation time were reserved for analysis.

Apparatus

Reading. A Sony Electret Condenser (frequency response: 40-16,000 Hz), model ECM 270, unidirectional microphone was positioned approximately 4 inches (10 centimeters) in front of and just below the chin of the subject. The microphone was coupled to a Nagra 4.2 tape recorder which was operated at a tape speed of 7 1/2 ips.

Speaking. The subject's voice was recorded on the system described above. The procedure was designed to facilitate a two-way conversation in which only the response of the subject, and not the interrogator's questioning, was recorded. The interrogator faced the subject during the recording, while the tape recorder was screened from the subject so that the subject was not aware of the point at which the tape recording was begun. A remote control was coupled to the Nagra recorder and was not within the subject's viewing range. This allowed the interrogator to turn the recorder off or on as needed without the movement being observed by the subject.

Recording Procedures

All speech samples were obtained as each subject was seated in an acoustically treated room, which was utilized in order to reduce the effects of ambient noise on the recorded samples.

Reading. Each subject was allowed a practice session in order to become familiar with the passage before recordings were made. In order to obtain a sample free from reading errors and nervous or extraneous mannerisms, each subject was initially instructed to read the passage silently. The subject was then instructed to read the sample passage aloud three times upon the presentation of a visual cue (head nod from the interrogator). The first sample was carefully monitored by the investigator and corrections in pronunciation were made. The second sample was again carefully monitored in order to make sure that the subject made all of the required corrections. In all instances, the third sample was recorded. Appropriate editing was accomplished so that the middle 55 word sample was prepared for measurement.

Speaking. The interrogator faced the subject and attempted to elicit a usual conversational interaction. The subject's voice was recorded in full fidelity on the tape recorder, and all the appearances of a usual spontaneous

conversation were achieved. The investigator judged that the conversational characteristics were sufficiently spontaneous and representative of the subject's usual manner of speaking and that the conditions of the study did not significantly modify the vocal performance of the subject being interviewed.

Measurement

FLORIDA IB, Channel 1 was used to analyze the fundamental vocal frequency mode and range for each subject. A description of this type of instrument has been presented in the introduction of this paper.

A 30 Hz band-pass for females and a 20 Hz band-pass for males was used for the measurement. Since the rate of vocal frequency change as a function of time is approximately twice that for females than that for males, the wider band-pass enabled the machine to have sufficient signal duration to be able to detect the energy present at the higher frequencies characteristic of the female voice. If a 20 Hz band-pass were used for both sexes, the more rapid rate of female pitch change would not be adequately measured. This failure would occur because the machine would not have sufficient time to respond to such a signal since it does not respond instantaneously. Such a lag in the circuit's response time would thereby induce an error in measurement. A 30 Hz band-pass, however, enables the machine to respond

to the female voice, which is passing through a given frequency region more rapidly than the male voice.

The Nagra tape recorder provided the source of input of the recorded speech samples to FLORIDA IB. Each sample (reading passage or spontaneous speech) was then systematically analyzed in 10 Hz steps for all frequencies other than the mode and range extremes, where five Hz steps were used. The obtained values represented duration in seconds of the energy within the band-pass as the band-pass was systematically shifted through the range of frequencies in order to obtain the upper and lower limits of the range. Each sample was measured three times per band-pass in order to check the random fluctuations which occur in electronic switches of this type. The average duration of the fundamental frequency within each band-pass was then calculated and constituted the data to be analyzed. The center frequency of the band-pass containing the greatest signal duration was designated as the modal fundamental vocal frequency. The FLORIDA IB fundamental frequency analysis form is shown in Appendix E.

Calibration

Prior to the experiment, FLORIDA IB was calibrated for frequency response, and the results are shown in Appendix F. The instrumentation which was utilized for these calibration procedures is presented in Figure I below.

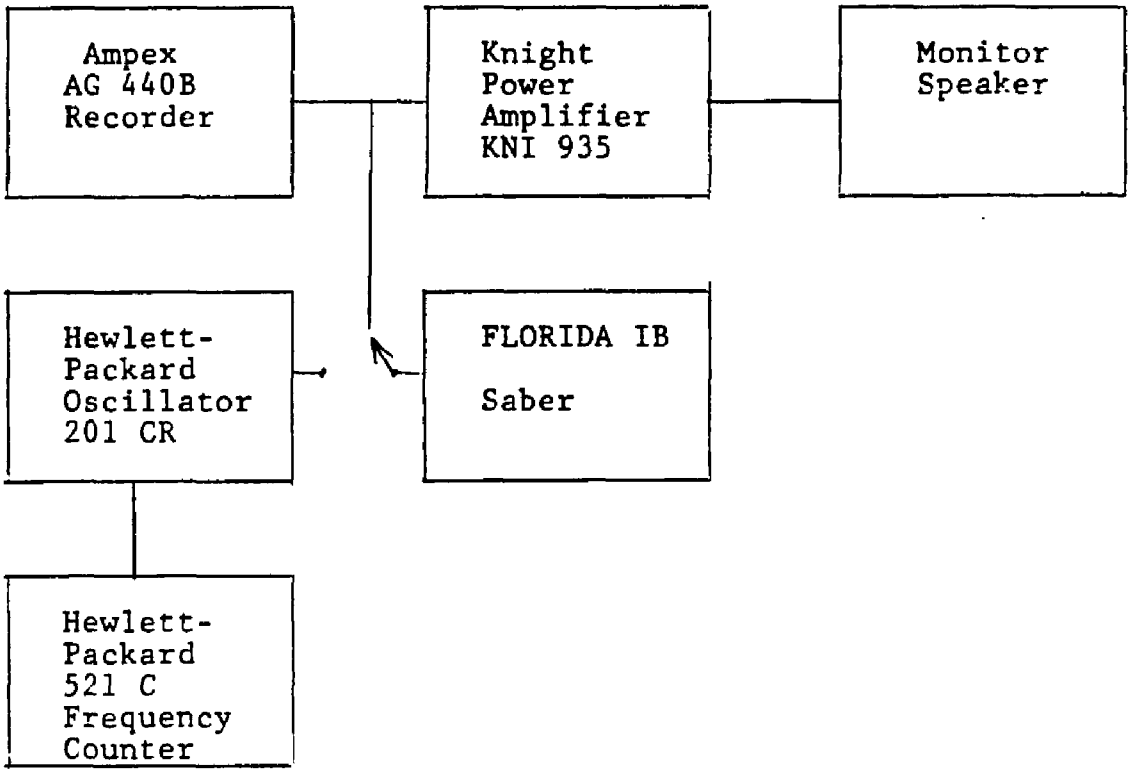

Figure 1: Instrumentation for Calibration.

Since the Ampex and Nagra are equivalent units, the Nagra was selected for recording because of its portable characteristics while the Ampex was selected for analysis and FLORIDA I calibration. Calibration and alignment data for the Nagra are shown in Appendix G.

Design and Statistical Analysis

Frequency measures of individual subject central tendencies and ranges, as well as measures of male and female composite central tendency and dispersion values were determined for each of the three decades (50-59, 60-69, and 70-79 years). One-way analyses of variance were used to assess the significance of differences in fundamental frequency across decade intervals. Coefficients of correlation were computed in order to determine whether there was a relationship between age in decades and fundamental frequency. An analysis of variance was completed to investigate the fundamental frequency differences among one-year age intervals across the distribution of subject ages. A significance level of 0.05 was utilized throughout this study.

CHAPTER III

RESULTS

Age, Height, Weight Data

The central tendency (mean) and dispersion values (standard deviation and/or range) were calculated for all 277 subjects for age, height, and weight. Of the 133 males who participated in this study, 43 were in the 50-59-year age group. The mean age of all male subjects in this decade interval was 55.2 years with a range from 50.1 to 59.8 years. In the 60-69-year age group, there were 45 males. The mean age of males in this decade interval was 64.8 years with a range from 60.2 to 69.9 years. There were 45 males in the 70-79-year age group. The mean age of males in this decade interval was 75.6 years with a range extending from 70.0 to 79.9 years.

Of the 144 females who participated in this study, 48 were in the 50-59-year age group. The mean age of female subjects in this decade interval was 55.4 years with a range from 50.0 to 59.7 years. In the 60-69-year age group, there were 49 females. The mean age of females in this decade interval was 65.1 years with a range from 60.3 to 69.7 years. There were 47 females in the 70-79-year age group. The mean age of females in this decade interval was 74.9 years with a range extending from 70.2 to 79.8 years.

Table 1 compares the mean and variability measures for height for males in each of three decade intervals. The 43 males in the 50-59-year age group showed a mean height of 67.88 inches (5.65 feet) with a standard deviation of 2.08 inches. For the 45 males in the 60-69-year age group, a mean height of 67.35 inches (5.61 feet) and a standard deviation of 3.15 inches were obtained. A mean of 68.37 inches (5.69 feet) and a standard deviation of 2.68 inches were obtained for the 45 males in the 70-79 decade interval.

Table 2 compares the mean and dispersion values for height of females in each of three decade intervals. The 48 females in the 50-59-year age group showed a mean height of 63.83 inches (5.32 feet) with a standard deviation of 2.08 inches. For the 49 females in the 60-69-year age group, a mean height of 63.61 inches (5.30 feet) and a standard deviation of 2.25 inches were obtained. A mean of 63.04 inches (5.25 feet) and a standard deviation of 2.59 inches were obtained for the 47 females in the 70-79 decade interval.

A comparison of the heights for males and females indicated that the central tendency values showed a difference of four-to-five inches with similar standard deviation values. For this study, the males were, on the average, about four inches taller than the females.

Table 1. Height in Inches for Males.

Age	Total #	Mean in Inches (ft)	SD
50-59	43	67.88 (5.65)	2.08
60-69	45	67.35 (5.61)	3.15
70-79	45	68.37 (5.69)	2.68

Table 2. Height in Inches for Females.

Age	Total #	Mean in Inches (ft)	SD
50-59	48	63.83 (5.32)	2.08
60-69	49	63.61 (5.30)	2.25
70-79	47	63.04 (5.25)	2.59

Table 3 compares the mean and variability measures for males' weight in each of the three decade intervals. Of the 43 males in the 50-59-year age group, a mean of 168.62 pounds and a standard deviation of 20.44 pounds were obtained. The 45 males in the 60-69-year age group had a mean weight of 163.84 pounds with a standard deviation of 24.72 pounds. A mean weight of 166.17 pounds and a standard deviation of 16.66 pounds were obtained for the 45 males in the 70-79 decade interval.

Table 4 compares mean and dispersion values for females' weight in each of three decade intervals. The 48 females in the 50-59-year age group showed a mean weight of 158.45 pounds and a standard deviation of 36.20 pounds. For the 49 females in the 60-69-year age group, a mean weight of 158.02 pounds and a standard deviation of 37.66 pounds were obtained. A mean weight of 143.59 pounds and a standard deviation of 25.55 pounds were obtained for the 47 females in the 70-79 decade interval.

In general, the males in this study weighed approximately 10-20 pounds more than the females. The standard deviations for the females were greater than those of the males, indicating more weight variability for the females.

The height and weight data were presented above in order to provide the reader with a more complete description of the physical characteristics of the subjects

Table 3. Weight in Pounds for Males.

Age	Total #	Mean in Pounds	SD
50-59	43	168.62	20.44
60-69	45	163.84	24.72
70-79	45	166.17	16.66

Table 4. Weight in Pounds for Females.

Age	Total #	Mean in Pounds	SD
50-59	48	158.45	36.20
60-69	49	158.02	37.66
70-79	47	143.59	25.55

who participated in this study. While it was not the purpose of the present study to investigate the relationship between height and weight and fundamental frequency, it should be noted that previous investigators (Hollien, 1960) have suggested the possibility that fundamental vocal frequency decreases as the size of the individual increases. Statistically significant relationships between height/weight and fundamental frequency have not been found, however (Hollien, 1960).

Health Variables

Appendix H summarizes the distribution of illnesses, drugs, and smoking habits for males and females in each of the three decade intervals. Information regarding these health variables was obtained in order to provide the reader of this paper with a more complete description of the characteristics of the subjects who participated in this study. It was not the purpose of the present investigation to determine relationships between specific health variables and fundamental vocal frequency.

For males, the following variables for illness had a frequency of occurrence of 10 or less for the three decade groups combined: 1) Infective and parasitic diseases; 2) neoplasms; 3) diabetes and thyroid disease in the endocrine and metabolic disease category; 4) disorders of blood and blood forming organs; 5) mental disorders; 6) diseases of the nervous system and sense organs;

7) cerebrovascular disease in the circulatory system disorders category; 8) diseases of the respiratory system; 9) diseases of the digestive system; 10) diseases of the genitourinary system; 11) diseases of the skin and subcutaneous tissues; 12) systemic lupus erythematosis and amputations in the musculoskeletal and connective tissue disease category; 13) symptoms of ill-defined conditions; 14) accidents, poisoning, and violence; and, 15) surgery, diagnostic and therapeutic techniques.

Five conditions existed in the male group with a frequency of 10 or more. Obesity (endocrine and metabolic diseases) was noted or reported in three males in the 50-59-year old group, 18 in the 60-69-year-old group, and seven in the 70-79-year-old group. There was a total of 28 obese males in all three decades studied. A history of hypertension (diseases of the circulatory system category) was reported by 18 of the 50-59-year-old men, 15 of the 60-69-year old group, and 17 of the 70-79-year-old group, for a total of 50 for males in all three decades. All but two males reported that their blood pressure was presently under control on medication and/or diet. These two individuals indicated that they had only mild, occasional elevations of their blood pressure. Heart disease (diseases of the circulatory system category) was reported by four of the males in the 50-59-year-old group, two in the 60-69 year old group, and seven in the 70-79-year-old group, for

a total of 13 for males in all three decades. Ateriosclerosis (diseases of the circulatory system category) was reported by none of the males in the 50-year decade, and by two and nine of the males in the 60- and 70-year decades, respectively. A total of 11 males reported having arteriosclerosis. Arthritis (diseases of the musculoskeletal and connective tissues) was cited as a health problem by two of the males in the 50-59-year-old group, nine in the 60-69-year-old group, and 11 in the 70-79-year-old group, for a total of 30 for males in all three decades studied.

In the drug categories listed in Appendix H, a frequency of occurrence of zero to 10 was found for this group of males with respect to ingestion of the following medications: 1) Blood modifiers; 2) hormones; 3) central nervous system drugs; and 4) gastrointestinal drugs. A total of 12 males in this sample reported that they were taking nutritional products (two, three and seven in the 50-, 60-, 70-year decades, respectively). Diuretics and cardiovascular agents were reported to be medications for fifty of the men (18, 13 and 19 the 50-, 60-, 70-year decades, respectively). Autonomic drugs were listed for 28 males (seven, nine and 12 in the 50-, 60-, 70-year decades, respectively). Fifty males (six, 11 and 23 in the 50-, 60-, 70-year decades, respectively) reported usage of miscellaneous medicinal products. A total of 170 drugs in

nine generic classifications were used by males in this study. Forty-nine drugs were taken by those in the 50-year decade, 50 drugs by those in the 60-year decade and 71 drugs by those in the 70-year decade.

Smoking habits for the males as illustrated in Appendix H suggest that few of the males in this study (29 of 133) smoked cigarettes, cigars or pipes or admitted to doing such at the time of participation in this study. It is possible that many of the men did not report smoking because of the fact that data for this investigation was gathered in a health-related institution where smoking is discouraged. Three of the men reported that they had previously smoked but that they had not smoked in 15 years or more. The reliability of data obtained from the men about their smoking habits is questionable.

A summary of the health data for males indicated that the total number of illnesses increased the age increased. The men in the 50-year group reported 37 medical conditions, while 47 and 115 conditions were tabulated for the men in the 60- and 70-year groups, respectively. Likewise, the number of drugs used increased as age increased, as previously discussed.

For females, the following variables for illness had a frequency of occurrence of 10 or less for the three decade groups combined: 1) infective and parasitic

diseases; 2) neoplasms; 3) disorders of blood and blood forming organs; 4) mental disorders; 5) diseases of the nervous system and sense organs; 6) cerebrovascular disease, heart disease and arteriosclerosis in the circulatory system disorders category; 7) diseases of the respiratory system; 8) diseases of the digestive tract; 9) diseases of the genitourinary system; 10) diseases of the skin and subcutaneous tissues; 11) systemic lupus erythematosis and amputations in the musculoskeletal and connective tissue disease category; 12) symptoms of ill-defined conditions; 13) accidents, poisoning, and violence; and 14) surgery, diagnostic and therapeutic techniques.

Five conditions existed in the female group with a frequency of zero to 10. Diabetes was reported with a frequency of four for the 50-59-year old females, nine for the 60-69 year old group, and seven for the 70-79-year-old group, for a total of 20 for females in all three decades. A history of thyroid disease (endocrine and metabolic diseases) was reported by five females in the 50-year decade, five in the 60-year decade, and three in the 70-year decade, for a total of 13 for all of the females. At the time of this study, those with a history of thyroid disease reported normal thyroid functioning with or without the need to take exogenous thyroid hormones or thyroid

suppression medication. Obesity (endocrine and metabolic diseases) was observed with a frequency of 52 for all of the females in this sample, six in the 50-year decade, 36 in the 60-year decade, and 10 in the 70-year decade. A history of hypertension (diseases of the circulatory system) was reported by six of the 50-59-year-old females, 11 of the 60-69-year olds, and seven of the 70-79-year-olds, for a total of 24 females across the three decades studied. All but one female reported that her blood pressure was under control by medication and/or diet. Arthritis (musculoskeletal and connective tissue diseases) was cited as a health problem by four females in the 50-year decade, 16 in the 60-year decade, and 19 in the 70-year group, for a total of 39 females across the three decades.

In the drug categories listed in Appendix H, a frequency of occurrence of 10 or less was found for this sample of females with respect to the usage of the following medications: 1) Blood modifiers; 2) autonomic drugs; 3) central nervous system drugs; 4) gastrointestinal drugs; and 5) anti-infectives. A total of 17 females in the group studies reported that they were taking nutritional products (four, four and nine in each of the decades, respectively). Hormones (insulin and/or thyroid supplements) were listed as medications for 25 of the females (four, 10 and 11 in

each decade, respectively). Diuretics and cardiovascular agents were reported to be medications for 12 of the women (two, five and five in each decade, respectively). Forty-nine females (14,18 and 17 in each decade, respectively) indicated usage of miscellaneous medicinal products. A total of 128 drugs in nine generic classifications were used by females in this study. Thirty drugs were taken by those in the 50-year decade, 47 drugs by those in the 60-year decade and 51 drugs by those in the 70-year decade, for a total of 128 drugs for all 144 women.

Smoking habits for the females as displayed in Appendix H suggested that few of them (four of 144) smoked cigarettes or other tobacco products at the time of their participation in this study. As with the males, it is possible that many of the females did not report smoking because of the fact that this investigation was conducted in a clinic/hospital environment where smoking is discouraged. Two of the females reported that they had previously smoked but had not done so in 15 years or more. The reliability of data obtained from the women about their smoking habits is questionable.

In summarizing the health data for females, it can be seen that the greatest number of illnesses was reported for the 60-year decade group, followed by the 70- and 50-year groups. One hundred seven illnesses were listed

for the 60-year group, while 73 and 49 medical conditions were tabulated for the 70- and 50-year-old females, respectively. As with the males, the number of drugs used by the females increased as age increased, as indicated by the frequency of occurrence cited in a previous section of this report.

Regarding the health variables discussed above for males and females, it should be noted that acutely ill or injured individuals were automatically excluded from this study. Prospective subjects with colds or obvious respiratory diseases were not allowed to participate. Also, individuals with observable characteristics of central nervous system disease or deafness were excluded. For reasons such as those just mentioned, the number of illnesses and drugs reported by the subjects in each age group was generally small. Because the total number of diseases, drugs or smoking habits reported in each group was so small, the statistical significance of the health variables in relationship to measures of the fundamental vocal frequency could not be reliably determined.

Table 5 shows the mean bilateral thresholds in dB HL for males for five test frequencies: 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, and 6000 Hz. For the 50-59-year-old males, it is shown that hearing was roughly equivalent and that thresholds for the lower frequencies (500 and 1000 Hz)

were consistently better than those for the higher frequencies (2000, 4000 and 6000 Hz) with approximately an 18 dB difference. For the 60-69-year-old males, it can be observed that the dB values for each ear are similar. It is also shown that the dB values systematically increase with an increase in frequency. However, the difference between the lowest and the highest thresholds was approximately 25 dB in the 60-69-year-old males as compared to the 18 dB difference in the 50-59-year-old males. For the 70-79-year-old males, the dB values appear similar for both ears. However, it can be noted that the dB values for the low frequency thresholds of this group are greater (poorer) than values for the other two groups of males. It can further be seen that, as with the other two groups of males, the dB values for this group systematically increase as the frequency increases with a difference between the average thresholds for the lowest and highest test frequencies exceeding 30 dB.

A summary of the hearing threshold data for males in this study suggests that there is an inverse relationship between age and hearing acuity as well as between frequency and hearing acuity. That is, as age increases, hearing acuity systematically decreases and as

Table 5. Mean Thresholds in dB (HL) for Intervals 500-6000 Hz for Males and Females.

	Left Ear Means (dB)					Right Ear Means (dB)				
	500Hz	1000Hz	2000Hz	4000Hz	6000Hz	500Hz	1000Hz	2000Hz	4000Hz	6000Hz
Males										
50 - 59 years	18.9	16.6	20.8	30.6	36.6	18.9	18.0	19.6	29.4	36.0
60 - 69 years	18.6	19.3	28.7	42.7	47.2	18.5	20.5	25.7	37.2	43.8
70 - 79 years	26.2	29.3	35.1	48.6	59.7	25.3	26.0	31.7	44.7	54.1
Females										
50 - 59 years	20.0	18.2	18.8	22.0	31.8	21.0	20.7	21.2	22.1	30.5
60 - 69 years	24.5	22.4	27.7	29.7	41.9	22.9	22.3	25.7	29.0	38.2
70 - 79 years	28.1	26.1	28.2	32.7	44.2	26.1	25.7	27.4	32.9	43.8

frequency increases so do the thresholds which suggests a decrease in hearing acuity.

The mean thresholds bilaterally for females are also displayed in Table 5. For the 50-59-year-old females, it can be seen that threshold values systematically increase as the test frequency increases with a 10 dB difference between dB averages for low frequencies and those for high frequencies. For the 60-69-year-old females, the same trend of an increase in mean dB values along with increase in test frequencies was also observed for both ears with the difference of 16 dB in the threshold values between low and high frequencies. For the 70-79-year age group, there were similar patterns of poorer thresholds for the higher frequencies and better thresholds for the lower frequencies. However, all thresholds for this group were poorer than for the other two groups of females. Again the difference between the threshold values for the low and the high frequencies was approximately 16 dB.

For females in this study, it is shown that the thresholds for the same test frequencies systematically increase as age increases. Additionally, it is shown that as the value of the test frequency increases so do the dB values, indicating poorer auditory responses for the higher frequencies.

Similar trends regarding hearing acuity are shown for both males and females. That is, for both sexes, there is an inverse relationship between hearing acuity and age as well as between hearing acuity and test frequency. Similar results were found by Rowland (1977).

Reliability of Judgments

Three of the 280 subjects recorded for this study were eliminated from the final analysis because their speaking and vocal characteristics were judged on a pass/fail basis to be unacceptable by at least two of the three ASHA-certified judges who had experience working with black individuals. A Pearson Product-Moment correlation was used to determine the degree of similarity of speaker acceptability ratings among the judges. A high positive correlation of .97 ($p \leq .001$) was found for all three judges, indicating that overall ratings were similar.

Dynamic Properties of the Fundamental Vocal Frequency

In the remaining portions of this chapter, the dynamic properties of the fundamental vocal frequency will be discussed by decade intervals for male and female subjects and for reading and speaking. It must be remembered that the fundamental vocal frequency as measured in Hertz is the prime physical determinant for pitch perception. During speaking activities, the fundamental vocal frequency consistently and rapidly changes so that

its variation will extend over a range of an octave or more. Within this range of fundamentals, there will be a specific fundamental vocal frequency region which will occur more often than any others, and, consequently, will account for the greatest duration of phonation, i.e., will represent the greatest working time of the larynx. For each subject, that fundamental frequency region having the greatest duration was statistically specified as the modal fundamental frequency. In a typical vocal profile, the duration of fundamental frequencies above and below the mode will decrease rapidly toward the end of the range. For each subject, the fundamental vocal frequency mode and range were measured. The mean of the modes then constituted the measure of central tendency for the grouped data. The range for the group was derived by calculating a mean of all individual high range values and a mean of all individual low range values.

Results for Male Subjects: Reading

Table 6 presents a summary of central tendency and dispersion values by decade intervals for males for reading. Seven of the 43 males in the 50-59 year old age group were able to read the "Jesse Owens" phonetically balanced reading passage. For these subjects, a mean modal fundamental vocal frequency for reading of 107.14 Hz with a standard deviation of 6.98 Hz and a mean range of 80.71 to

Table 6. For Males, Mean Modal Fundamental Vocal Frequency, Standard Deviation and Mean Frequency Range Limit Values in Hz for Reading. Mean Frequency Range Extent in Tones and Octaves. Lowest and Highest Individual Range Limit Values in Hz.

	50-59-year-olds (N=7)	60-69-year-olds (N=10)	70-79-year-olds (N=11)
Reading			
Mean mode in Hz	107.14	111.00	129.09
SD in Hz	6.98	15.77	14.96
Mean range limit in Hz	80.71 - 157.14	76.50 - 185.50	89.54 - 178.63
Mean range extent(t)	5.73	7.64	5.95
Mean range extent (oct)	.95	1.27	.99
Lowest individual range limit in Hz	75	60	70
Highest individual range limit in Hz	180	215	210

157.14 Hz was obtained. This range in Hertz represents a mean range extent of .95 octaves (5.73 tones) for this group. The lowest individual fundamental for any male in the 50-59 decade interval was 75 Hz, while the highest individual fundamental produced in this decade interval was 180 Hz.

Ten of the 45 male subjects in the 60-69 decade interval were able to read the "Jesse Owens" passage. These subjects exhibited a mean modal fundamental vocal frequency of 111.00 Hz with a standard deviation of 15.77 Hz and a mean range limit of 76.50 to 185.50 Hz. This range in Hertz indicates a mean range extent of 1.27 octaves (7.64 tones) for this group. The lowest individual fundamental for any male in the 60-69 decade was 60 Hz, and the highest individual fundamental frequency value was 215 Hz.

Eleven of the 45 males in the 70-79-year-age group read the "Jesse Owens" passage. For these subjects, a mean modal fundamental vocal frequency of 129.09 Hz with a standard deviation of 14.96 Hz and a mean range limit of 89.54 to 178.63 Hz was obtained. This range in Hertz reveals a mean range extent of .99 octaves (5.95 tones). The lowest individual fundamental for any male in the 70-79-year decade was 70 Hz, while the highest individual range limit was 210 Hz.

Summarizing the reading fundamental vocal frequency data across decade intervals for males, it can be seen that the reading mean mode increases with age as does the standard deviation. The mean range limits, however, show fairly uniform trends across decades with each range extending just under or just over one octave.

Table 7 shows the distribution of frequencies above and below the mean fundamental frequency for reading for males in each of the decade intervals. As expected, there is a larger Hertz difference above the mean mode than below it in each decade interval. Using the mean and range values in Hertz, octaves and tones were calculated to indicate similarities or differences in pitch variability above and below the mean modal fundamental vocal frequency. For the 50-59-year-old males, the mean range interval above the mean mode for reading was 3.27 tones (.54 octaves), while the mean range interval below the mean mode for reading was 2.40 tones (.40 octaves). In the 60-69-year-old males, the mean range interval above the mean mode was 4.43 tones (.73 octaves), while the mean range below the mean mode was 3.21 tones (.53 octaves). Finally, in the 70-79-year group of males, the ranges as previously described above and below the mean mode for reading were 2.78 tones (.46 octaves) and 3.15 tones (.52 octaves), respectively. These results suggest that, although a

Table 7. Distribution of the Interval Between the Mean Fundamental Vocal Frequency Range Limits Above and Below the Mean Modal Frequency in Hz, Tones and Octaves for Males for Reading.

	50-59-year-olds (N=7)	60-69-year-olds (N=10)	70-79-year-olds (N=11)
Reading			
Mean Range Interval Above the Mean Mode			
Hz	50.00	74.50	49.54
Octaves	.54	.73	.46
Tones	3.27	4.43	2.78
Mean Range Interval Below the Mean Mode			
Hz	26.43	34.50	39.55
Octaves	.40	.53	.52
Tones	2.40	3.21	3.15

slightly wider range in tones and octaves was found above the mean mode than below it for the 50- and 60- decade interval groups, the reverse would be true for the 70-79-year-old group in the study.

With the limited number of subjects and the descriptive statistics presented above, only trends regarding the fundamental vocal frequency for reading by males in the three decade intervals have been discussed. However, in order to determine whether or not the differences shown in these trends across the decades were statistically significant, one-way analyses of variance (ANOVA) were applied to the reading mean and range data.

Results of a one-way ANOVA indicated a significant F-value for decade differences in the mean fundamental vocal frequency for reading ($F = 6.933$, $df = 2$; $p < 0.05$). Using a least significant difference test of the significance of difference among the means ($LSD = 2.80$, $df = 2$; $p < 0.05$), significant differences in the mean fundamental vocal frequency for reading were found specifically between the 50-59- and 70-79-year-olds as well as between the 60-69- and 70-79- decade intervals. However, there was not a significant difference between the 50-59- and 60-69-year olds with respect to their mean fundamental vocal frequency for reading.

A significant F-value was found for the fundamental vocal frequency ranges for reading ($F = 4.253$, $df = 2$,

$p < 0.05$). Using a least significant difference test of the significance of difference among the ranges (LSD = 2.91, df = 2; $p < 0.05$) significant differences were found specifically between the mean reading ranges of the 50-59- and the 60-69- year groups. There were no significant differences in the mean reading ranges, however, between the 50-59- and 70-79-year olds or between the 60-69- and 70-79-year olds.

A summary of the statistical treatment of the fundamental vocal frequency mean and range data for males in the three decade groups indicates that the mean reading mode of 107.14 Hz for the 50-59-year-old males was significantly different from the mean reading fundamental of 129.09 Hz obtained for the 70-79-year-olds. Also, the mean reading mode of 111.00 Hz for the 60-69-year-old males was significantly different from the mean reading fundamental of 129.09 Hz obtained for the 70-79-year-olds. There were no statistically significant differences, however, between the mean reading fundamental of 107.14 Hz in the 50-year decade and that of 111.00 Hz, the mean reading fundamental to the 60-year decade. The mean reading fundamental vocal frequency range of 76.43 Hz (80.71-157.14 Hz) for the 50-year decade males was significantly different from the 109.00 Hz (76.50-185.50 Hz) reading range obtained for the 60-year decade. There were no significant differences between the mean reading fundamental vocal frequency range

of 76.43 Hz (80.71-157.14 Hz) for the 50-year decade when compared to that for the 70-year decade which was 89.09 Hz (89.54-178.63 Hz). There were also no significant differences between the mean reading fundamental vocal frequency range of 109.00 Hz (76.50-185.50 Hz) for the 60-year decade when compared to that for the 70-year decade which was 89.09 Hz (89.54-178.63 Hz).

Since the number of subjects in each decade interval who were able to read was small (7 of 43, 10 of 45, and 11 of 45 subjects in the 50-, 60-, 70-year decades, respectively), the above data should be interpreted with caution. These data, however, suggest that the mean reading fundamental for both the 50- and 60-year old males is significantly lower than that of the group in the 70-year interval. These data showed that the reading fundamental frequency range of the 60- year decade group was significantly wider than that of the 50-year decade group.

Results for Male Subjects: Speaking

Table 8 presents the central tendency and dispersion fundamental frequency values for prompted spontaneous speech for males at the three previously mentioned decade intervals. The results show that the 43 males in the 50-59-year age group had a speaking mean modal fundamental vocal frequency of 118.13 Hz with a standard deviation of

Table 8. For Males, Mean Modal Fundamental Vocal Frequency, Standard Deviation and Mean Frequency Range Limit Values in Hz for Speaking. Mean Frequency Range Extent in Tones and Octaves. Lowest and Highest Individual Range Limit Values in Hz.

	50-59 years (N=43)	60-69 years (N=45)	70-79 years (N=45)
Speaking			
Mean mode in Hz	118.13	113.33	116.33
SD in Hz	23.17	18.73	16.63
Mean range limit in Hz	74.76 - 216.51	76.44 - 209.11	72.44 - 217.44
Mean range extent (t)	9.18	8.69	9.50
Mean range extent (oct)	1.53	1.45	1.58
Lowest individual range limit in Hz	55	55	70
Highest individual range limit in Hz	220	270	225

23.17 Hz and a mean range limit of 74.76 to 216.51 Hz. The range values convert to 1.53 octaves (9.18 tones). The lowest individual fundamental produced by a subject in this age group was 55 Hz, while the highest fundamental frequency produced by any male individual in this age group was 220 Hz.

For the 45 males in the 60-69 decade interval, the mean modal speaking fundamental vocal frequency was 113.33 Hz with a standard deviation of 18.73 Hz and a mean range limit of 76.44 to 209.11 Hz. This range represents a mean extent of 1.45 octaves (8.69 tones). In this age group of males, the lowest individual fundamental was 55 Hz, while the highest individual fundamental was 270 Hz.

In the 70-79-year age group, the mean modal speaking fundamental frequency of the 45 males was 116.33 Hz. The standard deviation of this group was 16.63 Hz and the mean range limit was 72.44 to 217.44 Hz, indicating a mean range extent for speaking of 1.58 octaves (9.50 tones). The lowest individual fundamental produced within this age interval was 70 Hz, and the highest individual fundamental produced was 225 Hz.

When the mean range is divided into intervals above and below the mean mode, it can be seen in Table 9 that the Hertz difference for the upper range interval is consistently greater than the difference expressed in Hertz

for the lower mean range interval. When these linear values (Hertz) are then converted to musical scale values (octaves and tones), such curvilinear units provide the reader of this paper with an indication of real differences as they might be detected by the auditory system. It can also be seen in Table 9 that there will be a greater variation in the range interval above the mean mode than below the mean mode for all age groups. In the 50-59-year age group, the mean range interval above the mean mode is 5.22 tones (.87 octaves), while the mean range interval below the mean mode is 3.95 tones (.65 octaves). For the 60-69 year old males, the same mean range interval above the mean mode is 5.27 tones (.87 octaves) , and the mean range interval below the mean mode is 3.39 tones (.56 octaves). In the 70-79-year group, the mean range intervals above and below the mean modes are 5.36 tones (.89 octaves) and 4.06 tones (.67 octaves), respectively.

Results of a one-way ANOVA indicated no significant differences ($F = 0.674$, $df = 2$, $p > 0.05$) in the mean speaking fundamental vocal frequency or range in Hertz as a function of age (in decades).

Due to the small number of males participating in reading, no statistical determination could be made regarding the relationship between age and mean modal fundamental vocal frequency for reading. However, Pearson product-moment correlations were computed to determine

Table 9. Distribution of the Interval Between the Mean Fundamental Vocal Frequency Range Limits Above and Below the Mean Modal Frequency in Hz, Tones and Octaves for Males for Speaking.

	50-59-year-olds (N=43)	60-69-year-olds (N=45)	70-79-year-olds (N=45)
Speaking			
Mean Range Interval Above the Mean Mode			
Hz	98.38	95.78	101.11
Octaves	.87	.87	.89
Tones	5.22	5.27	5.36
Mean Range Interval Below the Mean Mode			
Hz	43.37	36.89	43.89
Octaves	.65	.56	.67
Tones	3.95	3.39	4.06

possible relationships between mean fundamental speaking values and age. No significant correlation ($r = -.02$) was found between the mean speaking fundamental frequency and age. Within the restrictions of this study, these data suggest that for males there is no significant change in the mean fundamental associated with advancing age.

Because the Pearson product-moment coefficient of correlation did not reveal a significant relationship between fundamental frequency and age, it was decided to determine if there were any significant differences among the one-year age groups and fundamental frequency. Table 10 summarizes the results of an analysis of variance testing the differences for the male mean speaking fundamental frequencies by age in years. The non-significant F-value obtained ($F = .09211$, $df = 1$, $p > 0.05$) indicates that there were no significant differences between speaking fundamental frequency and age in years in the male subjects studied.

In summary, the preceding statistical analyses indicate that the mean speaking fundamental vocal frequencies for the 50-year decade group (118.13 Hz), the 60-year decade group (113.33 Hz), and the 70-year decade group (116.33) were not significantly different. These analyses also suggest that the mean range limits for the 50-year decade group (216.51 - 74.76 = 141.75 Hz), the 60-year decade group (209.11 - 76.44 = 132.67 Hz), and the

Table 10. Analysis of Variance to Test the Significance of the Relationship Between Fundamental Frequency and Chronological Age in Years for Males While Speaking.

ANOVA	df	SUM OF SQUARES	F
Regression	1	31.75	.08211
Residual	131	50659.97	

F value is not significant $p > 0.05$

70-year decade group (214.44 - 72.44 = 145.00 Hz) did not differ significantly. These data indicate that the mean values as well as the range values across the three decade intervals are similar.

Comparisons of Reading and Speaking Data for Males

A review of the descriptive data for males for reading and speaking reveals that the mean modal fundamental vocal frequency for reading is lower than that exhibited during prompted spontaneous speech for the subjects in the 50-59 and 60-69 year age groups. However, for the 70-79-year-old males, the mean modal fundamental vocal frequency for reading was higher than that for speaking. Comparison of the mean modal fundamental vocal frequency across decades shows that for reading there is a systematic increase in the mean modal fundamental frequency (107.14 Hz, 111.00 Hz, and 129.09 Hz) as age increases. However, for speaking, this trend was not observed. In fact, there was only about a 5 Hz difference in the three means across decades (118.13 Hz, 113.33 Hz, and 116.33 Hz, respectively) and the highest value occurred in the youngest age group.

Comparisons of the mean ranges for reading across decades suggest that they are restricted to just under or just over one octave (.95 octaves, 1.27 octaves, and .99 octaves), whereas for speaking, the mean ranges were

typically one-and-a-half octaves (1.53 octaves, 1.45 octaves and 1.58 octaves). Comparisons of the mean low range limits across decades generally show lower values expressed in Hertz for speaking than for reading. The upper mean range limits show consistently higher fundamentals for speaking than for reading. These descriptive data do not support restrictions in mean ranges as a function of age, but rather as a function of the tasks, speaking or reading. In fact, for prompted spontaneous speech the mean range limit was slightly greater for the 70-79-year-old group as compared to the other two age groups. The restriction in reading range in comparison to the spontaneous speaking range may be a result of two conditions: 1) The limited number of subjects from which these data were derived; and, 2) the general difficulty experienced by the subjects during the reading tasks. Those subjects in this study who participated in the reading task frequently read in a slow controlled manner in which less attention was given to variability in prosodic elements than to vocabulary recognition.

In order to determine significant differences among the mean fundamentals for reading and speaking for males across decades, three $\underline{t}$ tests for related measures were used. For each of the three $\underline{t}$ tests, mean reading and speaking values were calculated in each decade interval only for those subjects who provided both reading and

spontaneous speaking samples. There were seven males in the 50-59-year group, 10 in the 60-69-year interval, and 11 in the 70-79-year group. Inspection of the results summarized in Table 11 indicates that for the 50-59-year old group, the mean modal values were significantly lower for speaking than for reading ($\underline{t} = 3.24$, $df = 6$, $p < 0.05$). In the 60-69-year-old group, no significant differences ($\underline{t} = 1.35$, $df = 9$, $p > 0.05$) were found between the mean modal fundamentals for speaking and reading. For the 70-79-year olds, the mean modal values were significantly lower for speaking than for reading ($\underline{t} = 3.82$, $df = 10$, $p < 0.05$).

Table 11. Significance of Reading versus Speaking for Males.

Age: 50-59 years	N	Mean f_o	SD	SE	t value	df
f_o speaking	7	102.14	8.09	3.05	3.24*	6
f_o reading	7	107.14	6.98	2.64		
* p = < 0.05						
Age: 60-69 years	**N**	**Mean f_o**	**SD**	**SE**	**t value**	**df**
f_o speaking	10	107.00	18.88	5.97	1.35	9
f_o reading	10	111.00	15.77	4.98		
* p = > 0.05						
Age: 70-79 years	**N**	**Mean f_o**	**SD**	**SE**	**t value**	**df**
f_o speaking	11	122.72	11.90	3.59	3.82*	10
f_o reading	11	129.09	14.97	4.51		
* p = < 0.05						

f_o = Mean fundamental vocal frequency

Results for Female Subjects: Reading

Table 12 presents a summary of central tendency and dispersion values by decade intervals for females for reading. Twenty-three of the 48 females in the 50-59 year age group were able to read the "Jesse Owens" passage. For these subjects, the mean modal fundamental vocal frequency was 170.43 with a standard deviation of 16.23 Hz and a mean range limit of 118.26 to 258.04 Hz. The mean range extent was 1.12 octaves (6.74 tones). The lowest individual fundamental produced by any female subject during reading was 85 Hz, and the highest individual fundamental produced by any female subject was 315 Hz.

Twenty-eight of the 49 females in the 60-69 year decade interval were able to read the "Jesse Owens" passage. These subjects exhibited a mean modal fundamental vocal frequency of 165.00 Hz with a standard deviation of 27.08 Hz and mean range limits of 107.67 to 252.67 Hz. The mean range extent was 1.22 octaves (7.35 tones), while the lowest and highest individual fundamental vocal frequencies produced by any subject were 55 Hz and 305 Hz, respectively.

Fourteen of the 47 females in the 70-79-year age group read the "Jesse Owens" passage. For these subjects, a mean modal fundamental vocal frequency of 155.35 Hz with a standard deviation of 21.43 Hz and a mean range limit of 103.57 to 262.14 Hz was obtained. Results also indicated

Table 12. For Females, Mean Modal Fundamental Vocal Frequency, Standard Deviation, and Mean Frequency Range Limit Values in Hz for Reading. Mean Frequency Range Extent in Tones and Octaves. Lowest and Highest Individual Range Limit Values in Hz.

	50-59-year-olds (N=23)	60-69-year-olds (N=28)	70-79-year-olds (N=14)
Reading			
Mean mode in Hz	170.43	165.00	155.35
SD in Hz	16.23	27.08	21.43
Mean range limit in Hz	118.26-258.04	107.67-252.67	103.57-262.14
Mean range extent (t)	6.74	7.35	8.02
Mean range extent (oct)	1.12	1.22	1.33
Lowest individual range limit in Hz	85	55	75
Highest individual range limit in Hz	315	305	310

mean range extent of 1.33 octaves (8.02 tones). The lowest individual fundamental for any female in the 70-79-year age group was 75 Hz, while the highest individual range limit was 310 Hz.

Summarizing the reading fundamental vocal frequency data across decades for females, it can be seen that the reading mean modal fundamental frequency decreases as age increases. Although the maximum difference among the standard deviations is 11 Hz for the three decade groups studied, there was no specific pattern to the Hertz values. The mean range limits as expressed in Hertz appear essentially equivalent, and the mean range extent as expressed in octaves supports this observation. Across decade intervals, the mean range extent as expressed in octaves shows very gradual broadening (1.12 octaves, 1.22 octaves, and 1.33 octaves).

Table 13 shows the distribution of reading frequencies above and below the mean fundamental frequency for females in each of the three decade intervals. Across the decade intervals, the mean range interval in Hertz above the mean mode was 30-50 Hz greater than the mean range interval expressed in Hertz below the mode. The mean and range Hertz values were used to calculate octaves and tones. It can be seen that the mean range interval above the mean mode across decade intervals was also consistently

Table 13. Distribution of the Interval Between the Mean Fundamental Vocal Frequency Range Limits Above and Below the Mean Modal Frequency in Hz, Tones and Octaves for Females for Reading.

	50-59-year-olds (N=23)	60-69-year-olds (N=28)	70-79-year-olds (N=14)
Reading			
Mean Range Interval Above the Mean Mode			
Hz	87.61	87.67	106.79
Octaves	.59	.61	.74
Tones	3.56	3.69	4.48
Mean Range Interval Below the Mean Mode			
Hz	52.17	57.33	51.78
Octaves	.52	.61	.57
Tones	3.15	3.67	3.45

greater than the mean range interval below the mean mode. For the 50-59-year-old females, the mean range interval above the mean mode was 3.56 tones (.59 octaves), and the mean range interval below the mean mode is 3.15 tones (.52 octaves).

For the 60-69-year-old females, the mean range interval above the mean mode was 3.69 tones (.61 octaves), while the mean range below the mean mode was 3.67 tones(.61 octaves). For the last decade interval (70-79 years), the mean range interval above the mean mode was 4.48 tones (.74 octaves), while the mean range interval below the mean mode was 3.45 tones (.57 octaves). These data suggest that for reading there was a tendency for greater excursion above the mean mode than below it. These results are interpreted to mean that, for these female subjects during reading, there was a greater tendency to inflect from their modal value upward and from the upper interval of their range back to the mode than from the mode downward and back up.

With the limited number of subjects and the descriptive statistics presented above, only trends regarding the fundamental vocal frequency for reading by females in the three decade intervals have been discussed. However, in order to determine whether or not the differences shown in these trends across the decades were statistically significant, one-way analyses of variance (ANOVA) were applied to the reading mean and range data.

Results of a one-way ANOVA indicated no significant differences ($F = 1.944$, $df = 2$, $p > 0.05$) among the mean reading fundamental vocal frequency for females in the 50-59- and 60-69-year-olds, the 60-69- and 70-79-year olds, or the 50-59- and 70-79-year olds. There also were no significant differences among the reading fundamental vocal frequency mean ranges for the 50- and 60-year decade groups, the 60- and 70-year decade groups, or the 50- and 70-year decade groups.

In summary, the preceding statistical analyses indicate that the mean reading fundamental vocal frequencies for the females in the 50-year decade (170.43 Hz), the 60-year decade (165.00 Hz), and the 70-year decade (155.35 Hz) were not significantly different. These analyses also indicate that the mean range limits for the 50-year group (118.26-258.04 Hz), the 60-year group (107.67-252.67 Hz), and the 70-year group (103.57-262.14 Hz) did not differ significantly. Since the number of subjects in each decade interval who were able to participate in the reading task was so small (23 of 48, 28 of 49, and 14 of 47 subjects for each decade, respectively), caution must be applied when interpreting the above data as they relate to this population.

Results for Female Subjects:
Speaking

Table 14 displays the central tendency and dispersion values for the speaking fundamental of females across the three decade intervals. The results show that the 48 females in the 50-59-year age group had a speaking mean modal fundamental frequency of 168.22 Hz, a standard deviation of 48.32 Hz, and a mean range limit of 98.64 to 297.50 Hz. The mean range extent was 1.58 octaves (9.53 tones). The lowest individual fundamental produced by a subject in the group was 60 Hz, while the highest individual fundamental produced by any subject in this age group was 380 Hz.

For the 49 females in the 60-69-year interval, the mean modal speaking fundamental vocal frequency was 163.26 Hz with a standard deviation of 28.01 Hz and a mean range limit of 95.00 to 305.30 Hz. This range represents a mean extent of 1.68 octaves (10.08 tones). In this age group, the lowest individual speaking fundamental of any female subject was 50 Hz, while the highest individual fundamental was 365 Hz.

In the 70-79 year age group of females, the mean modal speaking fundamental frequency was 150.46 Hz with a standard deviation of 25.48 Hz and a mean range limit of 82.23 to 290.31 Hz. This range in Hertz was converted to nonlinear values indicating a mean extent of 1.81 octaves

Table 14. For Females, Mean Modal Fundamental Vocal Frequency, Standard Deviation, and Mean Frequency Range Limit Values in Hz for Speaking. Mean Frequency Range Extent in Tones and Octaves. Lowest and Highest Individual Range Limit Values in Hz.

	50-59-year-olds (N=48)	60-69-year-olds (N=49)	70-79-year-olds (N=47)
Speaking			
Mean mode in Hz	168.22	163.26	150.46
SD in Hz	48.32	28.01	25.48
Mean range limit in Hz	98.64-297.50	95.00-305.30	82.23-290.31
Mean range extent (t)	9.53	10.08	10.91
Mean range extent (oct)	1.58	1.68	1.81
Lowest individual range limit in Hz	60	50	65
Highest individual range limit in Hz	380	365	430

(10.91 tones). The lowest individual fundamental produced within this age interval was 65 Hz, and the highest individual fundamental produced was 430 Hz.

Table 15 displays the distribution of the interval between the mean fundamental vocal frequency range limits above and below the mean modal frequency in Hertz, tones, and octaves of females for speaking. The Hertz values displayed for each of the decade intervals appear to be twice as great for the range interval above the mean mode (129.28 Hz, 142.04 Hz, and 139.85 Hz) as for the range interval below the mean mode (69.58 Hz, 68.26 Hz, and 68.23 Hz). When each of these Hertz values is converted to non-linear measures (tones and octaves), they then represent units of pitch difference as detected by the auditory mechanism. It can be seen that the rather large linear differences in Hertz values do not convert to measures of equal proportion in tones and octaves. It can be seen that the mean range interval above the mean mode as expressed in tones will systematically increase from 4.89 tones (.81 octaves) in the 50-59-year decade to 5.41 tones (.90 octaves) in the 60-69-year age group, and to 5.74 tones (.94 octaves) in the 70-79-year olds. A similar tonal increment by decade interval is shown for the mean range interval below the mean mode. The youngest decade interval (50-59 years) shows a lower mean range interval of

Table 15. Distribution of the Interval Between the Mean Fundamental Vocal Frequency Range Limits Above and Below the Mean Modal Frequency in Hz, Tones and Octaves for Females for Speaking.

	50-59-year-olds (N=48)	60-69-year-olds (N=49)	70-79-year-olds (N=47)
Speaking			
Mean Range Interval Above the Mean Mode			
Hz	129.28	142.04	139.85
Octaves	.81	.90	.94
Tones	4.89	5.41	5.74
Mean Range Interval Below the Mean Mode			
Hz	69.58	68.26	68.23
Octaves	.76	.77	.86
Tones	4.58	4.64	5.18

4.58 tones (.76 octaves), the middle decade group (60-69 years) shows a lower mean range interval of 4.64 tones (.77 octaves), and the oldest age group (70-79 years) shows a lower mean range interval of 5.18 tones (.86 octaves).

Results of a one-way ANOVA indicated a significant F-value for decade differences in the mean fundamental vocal frequency for speaking ($F = 3.166$, $df = 2$, p 0.05). Using a least significant difference test of the significance of difference among the means ($LSD = 2.80$, $df = 2$, p 0.05), significant differences in the mean speaking fundamental frequency were found specifically between the 50-year and 70-year decade females. There were no significant differences in the mean speaking fundamental frequency between the 50-year and 60-year decade intervals or between the 60-year and 70-year decade intervals. A statistical analysis of the speaking fundamental frequency ranges of females in each of the three decade intervals showed that range differences were not significant among these groups.

No statistical determination was made regarding the relationship between age and mean modal fundamental vocal frequency of females for reading because of the limited number of subjects who were able to read the text passage. However, Pearson product-moment correlations were computed to determine the possible relationships between mean fundamental speaking values and age. A negative correlation ($r = -.18$) was found between the mean speaking

fundamental and age. For the females studied, these data suggest that there is an inverse relationship between the mean fundamental and age in decades. That is, as age increases, the mean fundamental decreases. This finding was further substantiated by an analysis of variance testing the differences for the female mean fundamental frequencies by age in years. The results as summarized in Table 16 show a significant F value ($F = 5.2254$, $df = 1$, $p < 0.05$), indicating significant differences between mean speaking fundamental frequency and age in years for the female subjects in the present study.

In summary, the preceding data suggested that the mean female speaking fundamental frequency for the 50-year decade (168.22 Hz) was significantly higher than that of the 70-year decade (150.46 Hz). However, comparisons of the means for the other pairings of decade intervals were not significant. For the female subjects in the present study, the mean speaking fundamental frequency for the 50-year decade interval (168.22 Hz) was not significantly different from the mean speaking fundamental frequency for the 60-year decade group (163.26 Hz). Also, no significant differences were found between the mean speaking fundamental frequency for the 60-year decade interval (163.26 Hz) and the 70-year decade interval (150.46 Hz). In addition, an analysis of the speaking fundamental frequency range showed no significant difference for each of the

Table 16. Analysis of Variance to Test the Significance of the Relationship Between Fundamental Frequency and Chronological Age in Years for Females While Speaking.

ANOVA	df	SUM OF SQUARES	F
Regression	1	6576.76	5.2254
Residual	142	178722.72	

F value is significant $p < 0.05$

three pairings of decade intervals. For the females studied, the mean speaking range for the 50-year decade (98.64-297.50 Hz) was not significantly different from the mean speaking range of the 60-year decade (95.00-305.30 Hz); the mean speaking range of the 60-year group (95.00--305.30 Hz) was not significantly different from the mean speaking range of females in the 70-year decade interval (82.23-290.31 Hz); the speaking range for the 50-year decade group (98.64-297.50 Hz) was not significantly different from the speaking range for the 70-year olds (82.23-290.31 Hz).

Comparison of Reading and Speaking Data for Females

Comparisons of the descriptive data for females for reading and speaking reveal that the mean modal values for speaking are consistently lower across decade intervals than those for reading. Additionally, it is shown that for both reading and speaking the mean modal fundamental frequency systematically decreases from the younger to the older age intervals. A review of the mean ranges for reading across decades indicates that they are all just in excess of one octave with small octave increments systematically occurring from the younger to the older decade intervals. On the other hand, the mean ranges for speaking across decades show the typical range extent to be approximately one-and-a-half octaves. Also, as the decade

interval increases, so do the octave increments (1.58 octaves, 1.68 octaves, and 1.81 octaves). Comparison of the females' mean low range limit across decades generally shows lower Hertz values for speaking than for reading. The upper mean range limits were consistently higher for speaking than for reading. These descriptive data do not support restrictions in mean ranges as a function of age but rather as a function of the task, speaking or reading. In fact, as expressed in octaves, the mean range limit for prompted spontaneous speech was slightly greater for the 70-79-year-olds as compared to the other two age groups. As with males, the restriction in reading range as compared to the spontaneous speaking range might be an artifact of the number of subjects in each age interval who were able to read as well as the difficulty in reading experienced by these female subjects.

In order to determine significant differences between the mean fundamental for reading and speaking for females across decades, three t tests for related measures were used. For each of these three t tests, mean reading and speaking values were calculated in each decade interval only for those subjects who participated in both the reading and speaking tasks. There were 23 females in the 50-59-year group, 28 in the 60-69-year interval, and 14 in the 70-79-year group. Inspection of the results summarized in Table 17 indicates that, for the 50-59-year-old group,

Table 17. Significance of Reading versus Speaking for Females.

Age: 50-59 years	N	Mean f_o	SD	SE	t value	df
f_o speaking	23	178.26	64.74	13.50	.61	22
f_o reading	23	170.43	16.23	3.38		

$p = > 0.05$

Age: 60-69 years	N	Mean f_o	SD	SE	t value	df
f_o speaking	28	159.28	30.11	5.69	4.01*	27
f_o reading	28	165.00	27.08	5.11		

* $p = < 0.05$

Age: 70-79 years	N	Mean f_o	SD	SE	t value	df
f_o speaking	14	151.78	23.33	6.23	1.30	13
f_o reading	14	155.35	21.43	5.72		

$p = > 0.05$

f_o = Mean fundamental vocal frequency

the mean modal values were not significantly different (t = .61, df = 27, $p > 0.05$). In the 60-69-year old group, significant differences (t = 4.01, df = 27, $p < 0.05$) were found between the mean modal fundamentals for speaking and reading. The reading fundamental vocal frequency was higher than that for spontaneous speech. For the 70-79-year-olds, the mean modal values were not significantly different (t = 1.30, df = 13, $p > 0.05$) for speaking and reading.

CHAPTER IV

SUMMARY AND CONCLUSIONS

The present study explored the relationships between fundamental vocal frequency characteristics of black adults as a function of age and speaking task. Specifically, the differences between the fundamental vocal frequency mean and range extent during reading and prompted spontaneous speech for males and females in three decade intervals from 50-79 years of age were investigated. Two hundred seventy-seven black adults (133 males, 144 females) participated in the prompted spontaneous speaking task. Only 28 males and 65 females were able to participate in the reading activity for this study.

Males: Reading Fundamental Vocal Frequency

The reading fundamental vocal frequency characteristics were studied for 7 males in the 50-59- year decade, 10 males in the 60-69-year decade, and 11 males in the 70-79-year decade. These numbers of subjects were small because of the reading restrictions of these males primarily as a function of educational experience. The "Rainbow Passage," which has been traditionally used as the stimulus material for reading fundamental vocal frequency measures, could not be used with this group because of the relatively large proportion of unfamiliar reading vocabulary contained in the paragraph. For this reason,

the "Jesse Owens" passage adapted from the Reader's Digest Skill Builders series (1965) was utilized in this study. Comparison of the consonant and vowel phonemes in each of these reading passages revealed that the relative frequency of occurrence of consonant and vowels was similar. A phonetically balanced passage was used in the present study primarily because previous investigations in the area of fundamental frequency had utilized such a passage.

The results of the reading central tendencies suggested that the mean fundamental frequency increases with age for each decade interval (107.14 Hz, 111.00 Hz, and 129.09 Hz, respectively). The males in the 50-year decade had significantly lower central tendencies than the 70-year olds, and the 60-year decade group had significantly lower central tendencies than the 70-year decade group. The mean range limits for reading were 80.71 - 157.14 Hz (.95 octaves), 76.50 - 185.50 Hz (1.27 octaves) and 89.54 - 178.63 Hz (.99 octaves) for the decade groups, respectively. Statistical analysis comparing differences in ranges between the decade intervals indicated that the range of the 60-year decade group was significantly wider than that of the 50-year decade group. However, no significant differences between the 50-and 70- and 60- and 70-year decade groups were found.

Previous data obtained for white males regarding reading fundamental vocal frequency as a function of age

suggest findings similar to the present study in that the reading central tendency has been found to increase as a function of age (Hollien and Shipp, 1972; and Mysak, 1959). The range data of Hollien and Shipp (1972) as well as that of Mysak (1959) show ranges for reading which extend about one octave, a finding which was similar to that of the present study.

Comparing reading central tendency values of the older black adults to those of young black adults in the Hudson and Holbrook (1981) study, it is noted that the reading central tendency for the latter group was slightly higher (110.50 Hz) than that for the 50-year-old males (107.14 Hz), about the same as that for the 60-year decade group (111.00 Hz), and lower than that for the 70-year group (129.09 Hz). These trends for changes in central tendency in blacks appear to be similar to those for whites. That is, males' reading central tendencies tend to slowly decrease from young adulthood through approximately the 60-year decade, after which time they begin to rise. For black males on reading tasks, there tends to be more variation above the mean mode than below it. This trend tends to be reversed in whites.

Males: Speaking Fundamental Frequency Values

Of the 133 males who participated in the spontaneous speaking portion of this study, 43 were in the 50-year

group, 45 were in the 60-year group, and 45 were in the 70-year group. Results of the mean speaking fundamental frequency values and the statistical treatment of them indicated no differences (118.13 Hz, 113.33 Hz, and 116.33 Hz) between each age group, respectively. These data do not show a definite trend toward central tendency increases or decreases with age. Statistical analysis of the mean speaking range extent for males across decade intervals (1.53 octaves, 1.45 octaves, 1.58 octaves, respectively) indicated no differences. In comparing fundamental frequency dispersion above and below the speaking central tendency, it was determined that greater variability for all decade intervals exists above the mean mode rather than below it for the subjects in the present study.

Comparison of these speaking data to published data available for these age groups is difficult because of the paucity of speaking fundamental frequency data in the literature. Only the study by Mysak (1959) of the speaking fundamental for three groups of white males with mean ages of 47, 73, and 85 years, suggests that as age increases so does the fundamental frequency (107 Hz, 120 Hz, and 136 Hz, respectively).

Comparison of the speaking fundamental frequency of younger black adults (Hudson and Holbrook, 1982) indicates the mean central tendency of the younger group (108.50 Hz) to be lower than the central tendency for any of the older

groups (118.13 Hz, 113.33 Hz, and 116.33 Hz). The speaking range, however, for the group of younger black adults was slightly more restricted than that of the older group. That is, for the young black males, the mean range low was higher and the mean range high was lower than that of any of the males in the older groups.

Males: Reading versus Speaking

In general, for the black males participating in this study, it can be said that for two of the decade intervals (50-59 and 70-79) there was a statistically significant difference between the speaking and reading values. For the 50-59-year group, the speaking values were significantly higher than the reading values. This trend was reversed for the 70-79-year group, with the reading values being significantly higher than the speaking values For the 60-69-year group, however, there was no significant difference shown between the two speaking activities, suggesting the two to be quite similar.

In comparing these reading and speaking data to similar data for white males, it was noted that none of the investigators exploring fundamental vocal frequency for aging males looked at both reading and speaking behaviors for a sample of individuals such as those selected for the present study. Within the decade intervals used in the present study, there have been no investigations of the

fundamental frequency for both reading and speaking; however, there was one investigation by Mysak (1959) with three groups of white males having mean ages of 47,73, and 85 years, respectively. For the youngest group of males in Mysak's study, the speaking central tendency was lower and the range wider than that found for reading. For the middle group of males studied by Mysak (1959), the reading central tendency was higher and the range was essentially the same as that for speaking. For the older group of white males which he studied, Mysak (1959) concluded that the speaking means were slightly lower than those for reading, with ranges for the two activities being quite similar (i.e., just in excess of one octave).

Studies of younger white males (Snidecor, 1943; Hanley, 1951; Hollien and Jackson, 1973; and Schultz-Coulon, 1975) suggest that, in general, the fundamental vocal frequency in speaking is lower than that in reading, while the ranges for the two activities tend to be quite similar and are approximately an octave in extent.

The only normative studies found by this investigator regarding fundamental vocal frequency characteristics for reading and speaking for black adult males were those of Hudson and Holbrook (1981; 1982). These investigators found central tendency values for speaking, in general, to be lower than reading, with the ranges for both activities being approximately one octave in extent.

Females: Reading Fundamental Frequency Values

The reading fundamental vocal frequency characteristics were studied for 23 females in the 50-59-year age group, 28 females in the 60-69-year age group, and 14 females in the 70-79-year age group. Although more females participated in the reading portion of the study than males, the numbers per decade were still small in comparison to the numbers participating in the speaking activity. As with the males, the females had significant difficulty reading the "Rainbow Passage." Because of this, the "Jesse Owens" selection was used as the phonetically balanced passage from which reading central tendency and dispersion values were derived.The results of the reading central tendencies for females across decade intervals showed an inverse relationship between fundamental frequency and age. As age increased, central tendency values for reading decreased across the respective decades (170.43 Hz, 165.00 Hz, and 155.35 Hz). The differences in the reading central tendencies for females across decades were not statistically significant, however. Likewise, the mean reading ranges for females across decade intervals (1.12 octaves, 1.22 octaves, and 1.33 octaves, respectively), were not statistically significant. However, inspection of the range limits presented in Hertz shows that, as age increases, the low end of the range

decreases and the high end of the range increases, so that the range for the 70-year group is wider than that of either of the other two. As with the male group, variations in the fundamental frequency above the central tendency were greater than or equal to those below the central tendency.

Similar reading data for white females in the same age range as the females in the present study is difficult to evaluate because of the disparities in subject numbers, analysis procedures, and criteria for subject participation. General descriptions for changes in the fundamental frequency of females as a function of age usually suggest the tendency for an inverse relationship between age and fundamental frequency.

Comparing reading central tendency values of the older black females in the present investigation to those of young black females in the Hudson and Holbrook (1981) study, it is noted that the reading central tendency (193.10 Hz) for the young black females was higher than the reading central tendencies for females in three decade intervals (170.43 Hz, 165.00 Hz, and 155.35 Hz, respectively). In general, it can also be seen that the average low end of the range for the young black females was higher than the low end of the range for any of the females in the three older groups. Also, the high end of the range for the young black females was higher than the

high end of the range for any of the females in the three older groups. However, the reading range values for both older and younger black females would tend to be similar (i.e., about one octave in extent).

Females: Speaking Fundamental Frequency Values

Of the 144 females who participated in the spontaneous speaking portion of this study, 48 were in the 50-year group, 49 were in the 60-year group, and 47 were in the 70-year group. Results of the female mean speaking fundamental frequency values indicated a systematic decrease associated with advancing age (168.22 Hz, 163.26 Hz, and 150.46 Hz, respectively). The differences in these mean values between decade interval groups were not statistically significant. However, when these data were correlated for speaking and age on an interval scale, a negative correlation was found, indicating that as age increased fundamental decreased. Although for the females in this study there was a consistent trend for the mean range expressed in octaves to increase as age increased (1.58 octaves, 1.68 octaves, and 1.81 octaves), the differences between these ranges were not statistically significant. Comparisons of the fundamental frequency dispersion above and below the central tendency indicated that there were consistently wider variations above the mean mode than below it for females in all decade

intervals. A similar trend was observed with males in this study.

As with reading, there is little normative data on the speaking fundamental frequency of white female adults. However, age groups similar to those of the present study were investigated by Charlip (1968) and Kelley (1977). In both of these studies, as with the present one, fundamental frequency was shown to be inversely related to age.

Comparison of the speaking fundamental for younger black adult females (Hudson and Holbrook, 1982) indicated that the mean central tendency (188.85 Hz) of the younger group to be higher than the central tendency for any of the older groups (168.22 Hz, 163.26 Hz, and 150.46 Hz) in this study. However, for the group of younger black females, the speaking range (approximately one octave) was slightly more restricted than that of the older group (1.5 octaves, 1.68 octaves, and 1.81 octaves). Additionally, comparisons of range limits in Hertz of the older and younger black females showed that the low end of the range for the young adults (132.55 Hz) was higher than the low range limit for the older groups (98.64 Hz, 95.00 Hz, and 82.23 Hz). Also, the high end of the range for the younger females (270.10 Hz) was lower than the high range limit for the older groups (297.50 Hz, 305.30 Hz, and 290.31 Hz).

Females: Reading versus Speaking

Statistical analysis of female reading and speaking fundamental frequency data across the three decade intervals indicated significant differences in reading and speaking values for only one decade interval, the 60-69 year group. The results specifically show a higher central tendency for reading than for speaking. General comparisons of these reading and speaking data to those for the same decade intervals for white females (Charlip, 1968) show that reading central tendencies were consistently higher than speaking central tendency.

In comparing the reading and speaking data obtained for these older black females with the younger black females studied by Hudson and Holbrook (1981; 1982), it can be seen that the trends were consistent for both groups. That is, reading central tendency values were again higher than the speaking values.

Males and Females: Comparisons of the Reading and Speaking Fundamental Vocal Frequency

The reading fundamental vocal frequency means for the 50-, 60-, and 70-year decade subjects were 107.14 Hz, 111.00 Hz and 129.09 Hz for the males and 170.43 Hz, 165.00 Hz and 155.35 Hz for the females across the decade intervals, respectively, indicating a lower reading mean fundamental frequency for males than for females. The reading fundamental vocal frequency mean ranges revealed

lower mean low and high range limits for the males than for the females. Across the three decade groups, males exhibited wider mean range extents (1.53 octaves, 1.45 octaves and 1.58 octaves) than the females (1.12 octaves, 1.22 octaves and 1.33 octaves) for reading.

The speaking fundamental vocal frequency means for the 50-, 60-, and 70-year decade subjects were 118.13 Hz, 113.33 Hz and 116.33 Hz for the males and 168.22 Hz, 163.26 Hz and 150.46 Hz for the females across the decade intervals, respectively, indicating a lower speaking fundamental frequency for males than for females. The speaking fundamental vocal frequency ranges for the males revealed lower mean low and high range limits than those for the females. Both males and females exhibited a wider fundamental frequency range for spontaneous speech than for reading. Across the three decade groups, females exhibited wider mean range extents for speaking (1.58 octaves, 1.68 octaves and 1.81 octaves) than the males (1.53 octaves, 1.45 octaves and 1.58 octaves).

Clinical Implications

Speech pathologists have a particular interest in ascertaining and specifying the characteristics of the communicative skills of individuals seeking their professional services. The specification of whether communication is an acceptable or unacceptable range is contingent

upon knowledge of what constitutes normal limits. This knowledge should be based on normative data in order to increase the validity and reliability of clinical judgments.

If it is determined that an individual is exhibiting a disorder of one or more of the processes of communication, a therapeutic program under the auspices of the speech pathologist can be instituted in order to modify the abnormal behavior and increase the target behavior. The determination of the existence of the problem as well as goals for therapy can only be accurately specified if normative data is available for comparative purpose. Data for the black population, however, is lacking in many areas of speech science. One such area is that which is concerned with the acoustic variables of speech, including information regarding fundamental vocal frequency characteristics.

Without data for the black population with respect to fundamental vocal frequency, clinicians can only make assumptions about the fundamental vocal frequency of their black clients. These assumptions would perhaps be at least partly based on data for the white population. Utilizing standards for white speakers to judge the speech of blacks is inappropriate. Therefore, normative data such as that obtained for black adults in this study can enhance the

quality of diagnostic and therapeutic services to the black population.

Research Needs

Additional investigations of the central tendency and dispersion characteristics of the fundamental vocal frequency for the black population are needed across the age continuum. Data for males and females for the following groups and vocal activities are particularly needed for blacks: 1) Infants' (zero-to-one year of age) cries; 2) one-to-three-year-old children producing vowel sounds; (3) three-to-eight-year-old children engaged in spontaneous speech; 4) nine-to-18-year-olds' production of spontaneous speech and oral reading; 5) 30-to-49-year-old adults engaged in spontaneous speech and oral reading; and, 6) adults 80 years of age and older producing spontaneous speech, and, if possible, oral reading samples. The oral reading samples might be difficult to obtain with some of these older adults because of a decrease of visual acuity with aging and/or because of the possibility that many will have difficulty reading because of lack of educational opportunities.

Future investigators in the area of fundamental vocal frequency in blacks will want to pay close attention to the number of subjects selected for the sample. Further research should be considered to investigate the

relationship between fundamental frequency and laryngeal structure and vocal fold dimensions. In addition, socioeconomic status should be considered since it is possible that socioeconomic status plays a part in the speaking characteristics of some black people. Generally, the individuals in the present study were either in what would be considered a poverty classification or lower "middle class."

Further research in the area of fundamental vocal frequency in blacks is essential if quality service by speech pathologists for voice disorders is to be provided to that population.

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Appendix A. Male Fundamental Frequency (Hz) as a Function of Age, Race, Geographical Area or Linguistic Background, and Speech Activity.

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
Infant (4-40 hrs)	W	4	Northern U.S.			$\bar{X}$=413 R=4.85 oct	Phonophotography	Ringel and Kluppel, 1964
Infant	W	1	Northern U.S.			$\bar{X}$=556 (hunger cry) R=63-2631; 32.69t	Phonophotography	Fairbanks, 1942
Infant (1 wk. -6 mos.)	W	2	Northern U.S.			$\bar{X}$=335 R*=317-342	Frequency Analyzing Computer (Hz to DC converter)	Laufer and Horii, 1977
Infant (4-6 wks.)	W	10	General U.S.			$\bar{X}$=453	Spectrography	Prescott, 1975

Appendix A (Continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
Infant (3-6 mos.)	W	4	Northern U.S.			$\bar{X}$=457 (pain cry) R=375-810 (pain cry) $\bar{X}$=451 (hunger cry) R=200-725 (hunger cry) $\bar{X}$=442 (Startle cry) R=275-825 (Startle cry)	Visicorder	Murry, Amundson, and Hollien, 1977.

Appendix A (Continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
Infant (6-8 mos.)	W	10	General U.S.			$\bar{X}$=495	Spectro-graphy	Prescott, 1975
1-2 yrs.	W	3	Northern U.S.			$\bar{X}$=443 R=16.20t	Visicorder	McGlone, 1966
4-6 yrs.	W	10	Northern U.S.	$\bar{X}$=273 R=189-486			FFI	Gilbert and Campbell, 1980
7 yrs.	W	15	Northern U.S.		$\bar{X}$=294 R=9.8t		Phonopho-tography	Fairbanks, Wiley and Lassman, 1949
8 yrs.	W	15	Northern U.S.	$\bar{X}$=297 R=9.7t			Phonopho-tography	Fairbanks, Wiley and Lassman, 1949

Appendix A (Continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
8-10 yrs.	W	6	Northern U.S.	$\bar{M}$=263 R*=201-323			FFI	Gilbert and Campbell, 1980
10 yrs.	W	6	Northern U.S.		$\bar{X}$=263 R=104-523		Phonopho-tography	Curry, 1940
10 yrs.	B	6	Southern U.S.		$\bar{X}$=210 SD=1.90t		Phonopho-tography	Hollien and Malcik, 1962
10 yrs.	W	6	Southern U.S.		$\bar{X}$=235 SD=4.02t		Phonopho-tography	Hollien, Malcik and Hollien, 1965
10 yrs.	W	6	Northern U.S.		$\bar{X}$=226 R=6.12t		Phonopho-tography	Hollien and Malcik, 1967

Appendix A (Continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
14 yrs.	W	6	Northern U.S.		$\bar{M}$=232 R=125-458		Phonophotography	Curry, 1940
14 yrs.	B	6	Southern U.S.		$\bar{X}$=158 SD=1.20t		Phonophotography	Hollien and Malcik, 1962
14 yrs.	W	6	Southern U.S.		$\bar{X}$=185 R=5.46t		Phonophotography	Hollien, Malcik, and Hollien, 1965
14 yrs.	W	6	Northern U.S.		$\bar{X}$=184 SD=3.70t		Phonophotography	Hollien and Malcik, 1967
17-20 yrs.	W	157	Southern U.S.	$\bar{X}$=123.3 R*=90.5-165.2	$\bar{X}$=129.4 R=92.6-178.1		FFI	Hollien and Jackson, 1973
17-25 yrs.	W	100	Southern U.S.		$\bar{X}$=116 R=85-155		Florida I	Fitch and Holbrook, 1970

Appendix A (Continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
18 yrs.	W	6	Northern U.S.		$\bar{M}$=133 R=82-327		Phonophotography	Curry, 1940
18 yrs.	W	6	Northern U.S.		$\bar{X}$=132 R*=121.5-142.9		Phonophotography	Pronovost, 1942
18 yrs.	B	6	Southern U.S.		$\bar{X}$=121 SD=1.42t		Phonophotography	Hollien and Malcik, 1962
18 yrs.	W	6	Southern U.S.		$\bar{X}$=115 R=7.52t		Phonophotography	Hollien, Malcik and Hollien, 1965
18-29 yrs.	B	100	Southern U.S.	$\bar{X}$=108.5 R=80.70-166.65	$\bar{X}$=110.5 R=81.95-158.50		Florida I	Hudson and Holbrook, 1981 and 1982

Appendix A (Continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
20-29 yrs.	W	24	Northern U.S.	$\bar{X}$=132 R*=104.4-190.4; 9.08t			Phonophotography	Philhour, 1948
20-29 yrs.	W	25	General U.S.	$\bar{X}$=120 R=98-145			FFI	Hollien and Shipp, 1972
20-55 yrs.	W	29	European (German)	M=107	M=117	M=110	Frequency Analyzing Computer (H_2 to DC converter)	Schultz-Coulon, 1975
21-35 yrs.	W	15	Northern U.S.			$\bar{X}$=116 R=89-153	Spectrography	Emanuel and Scarinzi, 1980

Appendix A (Continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
23-34 yrs.	W	20	Northern U.S.			$\bar{X}$=114 R=94-153	Frequency Analyzing Computer (H_2 to DC converter)	Whitehead and Emmanuel, 1974
26-79 yrs.	W	65	Northern U.S.		$\bar{X}$=112.5 R=84-151		Frequency Analyzing Computer (H_z to DC converter)	Horii, 1975
Young Adult	W	103	European (Polish)	$\bar{X}$=137.6 R=93.1-195.0			FFI	Majewski, Hollien and Zalewski, 1972
Young Adult	W	6	Northern U.S.		$\bar{X}$=132 R=10.57t		Phonophotography	McIntosh, 1939

Appendix A (Continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
Adult	W	27	Northern U.S.		$\bar{X}$=128.8 SD=4.50t		Phonophotography	Murray and Tiffin, 1934
Adult	W	23	Northern U.S.	$\bar{X}$=151.7 R=100-320			Phonophotography	Weaver, 1924
Adult	W	3	Northern U.S.	$\bar{X}$=138.1 R=2.06 octaves			Phonophotography	Cowan, 1936
Adult	W	6	Northern U.S.	$\bar{X}$=120 R=8.42t	$\bar{X}$=132 R=9.89t		Phonophotography	Snidecor, 1943
Adult	W	9	General U.S.	$\bar{X}$=114 R=17.5 sts; 8t	$\bar{X}$=119 R=20.1 sts; 10t		Phonophotography	Hanley, 1951

Appendix A (Continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
Adult	W	11	Southern U.S.	$\bar{X}$=136 R=16.6 sts; 8t	$\bar{X}$=134 R=16.8 sts; 8t		Phonophotography	Hanley, 1951
Adult	W	7	Northeastern U.S.	$\bar{X}$=117 R=16.5 sts	$\bar{X}$=122 R=18.6 sts		Phonophotography	Hanley, 1951
Adult	W,B, Or	31	European (non-French) Asian, American, African			$\bar{X}$=118 R=73-162	Frequency Analyzing Computer (Hz to DC converter)	Boe and Rakotofiringa, 1975
Adult	W	25	European (French)			$\bar{X}$=116 R*=108-124	Frequency Analyzing Computer (Hz to DC converter)	Boe and Rakotofiringa, 1975

Appendix A (Continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
30-39 yrs.	W	25	General U.S.		$\bar{X}$=112 R*=88-150		FFI	Hollien and Shipp, 1972
40-49 yrs.	W	25	General U.S.		$\bar{X}$=107 R*=85-142		FFI	Hollien and Shipp, 1972
47 yrs.	W	15	Northern U.S.	$\bar{X}$=107 R=17.5 sts	$\bar{X}$=110 R=16.9 sts		Dempsey Recorder	Mysak, 1959
50-59 yrs.	W	25	General U.S.		$\bar{X}$=118 R*=100-152		FFI	Hollien and Shipp, 1972
60-69 yrs.	W	25	General U.S.		$\bar{X}$=112 R*=86-148		FFI	Hollien and Shipp, 1972
65-87 yrs.	W	20	General U.S.			$\bar{X}$=131 R=138-241	Spectro-graphy	Hooper, 1979

Appendix A (Continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
69-85 yrs.	Or	20	Asian (Japanese)	$\bar{X}$=162		$\bar{X}$=162	Frequency Analyzing Computer (Hz to Dc Converter)	Honj and Isshiki, 1980
70-79 yrs.	W	25	General U.S.		$\bar{X}$=132 R*=112-178		FFI	Hollien and Shipp, 1972
73 yrs.	W	12	Northern U.S.	$\bar{X}$=120 R=17.0 sts	$\bar{X}$=124 R=17.7 sts		Dempsey Recorder	Mysak, 1959
80-89 yrs.	W	25	General U.S.		$\bar{X}$=146 R*=88-195		FFI	Hollien and Shipp, 1972

Appendix A (Continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
85 yrs.	W	12	Northern U.S.	$\bar{X}$=136 R=19.4 sts	$\bar{X}$=141 R=19.6 sts		Dempsey Recorder	Mysak, 1959

Abbreviations:

W=white
B=black
Or=oriental

N=number
t=tones
sts=semitones
oct=octaves

$\bar{X}$=mean
M=median
R=range
R*=range of the means
SD=standard deviation of the means

Appendix B. Female Fundamental Frequency (Hz) as a Function of Age, Race, Geographical Area or Linguistic Background, and Speech.

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
Infant (4-40 hrs.)	W	6	Northern U.S.			$\bar{X}$=413 R=4.85 oct	Phonopho-tography	Ringel and Kluppal, 1964
Infant	W	1	Northern U.S.			$\bar{X}$=556 R=63-2631	Phonopho-tography	Fairbanks, 1942
Infant (1 wk.- 6 mos.)	W	2	Northern U.S.			$\bar{X}$=335 R*=317-342	Frequency Analyzing Computer (Hz to Dc converter)	Laufer and Horii, 1977
Infant (4-6 wks.)	W	10	General U.S.			$\bar{X}$=453	Spectro-graphy	Prescott, 1975

Appendix B (continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
Infant (3-6 mos.)	W	4	Northern U.S.			$\bar{X}$=441 pain cry R=150-850 X=421 (Hunger cry) R=220-800 X=421 (Startle cry) R=120-725	Visicorder	Murry, Amundson
Infant (6-8 mos.)	W	10	General U.S.			$\bar{X}$=495	Spectro-graphy	Prescott, 1966
1-2 yrs.	W	3	Northern U.S.			$\bar{X}$=443 R=16.02+	Visicorder	McGlone, 1966

Appendix B (continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
4-6 yrs.	W	10	Northern U.S.	$\bar{X}$=289 R=217-425			FFI	Gilbert and Campbell 1980
7 yrs.	W	15	Northern U.S.		$\bar{X}$=281 R=10.30t		Phonophotography	Fairbanks, Herbert and Hammond, 1949
8 yrs.	W	15	Northern U.S.		$\bar{X}$=288 R=10.03t		Phonophotography	Fairbanks, Herbert and Hammond, 1949
8-10 yrs.	W	10	Northern U.S.	$\bar{X}$=266 R=186-349			FFI	Gilbert and Campbell, 1980
11 yrs.	W	6	Northern U.S.		$\bar{X}$=258 R=18.5 sts		Phonophotography	Duffy, 1970

Appendix B(continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
13 yrs. (premen-arche)	W	6	Northern U.S.		$\bar{X}$=251 R=18.50 s+s		Phonopho-tography	Duffy, 1970
13 yrs. (post-menarche)	W	6	Northern U.S.		$\bar{X}$=237 R=29.68 s+s		Phonopho-tography	Duffy, 1970
15 yrs.	W	6	Northern U.S.		$\bar{X}$=229 R=23.28 s+s		Phonopho-tography	Duffy, 1970
15 yrs.	W	44	Southern U.S.		$\bar{X}$=207 R*=158.6-259.6		FFI	Michel, Hollien and Moore, 1966
15 yrs.	W	89	Southern U.S.		$\bar{X}$=215 R*=158.6-259.6		FFI	Hollien and Paul, 1969

Appendix B (continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
16-35 yrs.	W	51	European (German)			$\bar{X}$=246	Frequency Analyzing Computer (Hz to DC converter)	Bastian, Sasama and Unger, 1978
16 yrs.	W	115	Southern U.S.		$\bar{X}$=207 R*=143.7-254.7		FFI	Michel, Hollien and Moore, 1966.
16 yrs.	W	185	Southern U.S.		$\bar{X}$=213 R*=153.7-225.4		FFI	Hollien and Paul, 1969
17 yrs.	W	148	Southern U.S.		$\bar{X}$=207 R*=127.3-263.1		FFI	Michel, Hollien and Moore, 1966

Appendix B (continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
17 yrs.	W	193	Southern U.S.		$\bar{X}$=221 R=127.3 263.1		FFI	Hollien and Paul 1969
17-25 yrs.	W	100	Southern U.S.		$\bar{X}$=217 R=165- 255		FLORIDA I	Fitch and Holbrook, 1970
18-28 yrs.	B	100	Southern U.S.	$\bar{X}$=188.85 R=132.55 270.10	$\bar{X}$=193.10 R=139.05 266.10		FLORIDA I	Hudson and Holbrook, 1981 and 1982
20-55 yrs.	W	58	European (German)	M=191	M=208	M=198	Frequency Analyzing Computer (Hz to Dc converter)	Schultz-Coulon, 1975

Appendix B (continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
20-29 yrs.	W	21	General American		$\bar{X}$=224.3 R*=192.2-275.4		FFI	Stoicheff, 1981
20-29 yrs.	W	10	Southern U.S.	$\bar{X}$=227			-------	Kelley, 1977
20-30 yrs.	W	15	Northern U.S.			$\bar{X}$=218 R=169-271	Spectrography	Emanuel and Scarinzi, 1979
Young Adult	W	27	Northern U.S.		$\bar{X}$=199 R=11.66 sts		Phonophotography	Linke, 1973
Adult	W	7	Northern U.S.	$\bar{X}$=234 R=1.93 octaves			Phonophotography	Cowan, 1936

Appendix B (continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
Adult	W	19	Northern U.S.	$\bar{X}$=318 R*=250 400			Phonopho-tography	Weaver, 1924
Adult	W	27	European (French)			$\bar{X}$=209 R*=202-216	Frequency Analyzing Computer (Hz to DC converter)	Boe and Rakotofiringa, 1975
Adult	W,B, Or	31	European (non-French) Asian, American African			$\bar{X}$=210 R=129-291	Frequency Analyzing Computer (Hz to DC converter)	Boe and Rakotofiringa, 1975
30-39 yrs.	W	18	General American		$\bar{X}$=213.3 R*=181.0-240.6		FFI	Stoicheff, 1981

Appendix B (continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
30-39 yrs.	W	9	Northern U.S.		$\bar{X}$=196 R*=171-222		FFI	Saxman and Burt, 1967
30-39 yrs.	W	10	Southern U.S.	$\bar{X}$=214			--------	Kelley, 1977
40-49 yrs.	W	10	Southern U.S.	$\bar{X}$-214			---------	Kelley, 1977
40-50 yrs.	W	9	Northern U.S.		$\bar{X}$=189 R*=168-208		FFI	Saxman and Burk, 1967
40-49yrs.	W	21	General American		X=$\bar{2}$20.8 R*=189.8-272.9		FFI	Stoicheff, 1981

Appendix B (continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
40-49 yrs.	W	5	Northern U.S.	$\bar{X}$=175.72 R*=143.80 -209.10	$\bar{X}$=177.63 R*=141.84 -214.04		Visicorder	Charlip, 1968
Adult	W	19	Northern U.S.		$\bar{X}$=242.4		Phonopho-tography	Murray and Tiffin, 1934
Adult	W	6	Northern U.S.		$\bar{X}$=213		Phonopho-tography	Snidecor, 1951
50-59 yrs.	W	5	Northern U.S.	$\bar{X}$=184.73 R*=147.46 -247.74	$\bar{X}$=187.92 R*=155.56 -222.30		Visicorder	Charlip, 1968
50-59yrs.	W	17	----------		$\bar{X}$=199.37 R*=176.4 -241.2		FFI	Stoicheff, 1981
50-59 yrs.	W	10	Southern U.S.	$\bar{X}$=214			--------	Kelley, 1977

Appendix B (continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
60-69 yrs.	W	10	Southern U.S.	$\bar{X}$=209			--------	Kelley, 1977
60-69 yrs.	W	5	Northern U.S.	$\bar{X}$=181.20 R*=166.79 -198.18	$\bar{X}$=194.16 R*=165.99 -211.14		Visicorder	Charlip, 1968
60-69yrs.	W	15	----------		$\bar{X}$=199.7 R*=142.8 -234.9		FFI	Stoicheff, 1981
65-90 yrs.	W	20				$\bar{X}$=189 R=98-212	Frequency Analyzing Computer (Hz to DC converter)	Hooper, 1979
69-85 yrs.	Or	20	Asian (Japanese)	$\bar{X}$=177	$\bar{X}$=165		Frequency Analyzing Computer (Hz to DC converter)	Honjo and Isshiko, 1980

Appendix B (continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
70-79 yrs.	W	10	Southern U.S.	$\bar{X}$=206			--------	Kelley, 1977
70-79 yrs.	W	5	Northern U.S.	$\bar{X}$=173.85 R*=137.53 -215.62	$\bar{X}$=174.13 R*=136.68 -200.99		Visicorder	Charlip, 1968
70-82 yrs.	W	19	----------		$\bar{X}$=202.2 R*=170.0 -248.6		FFI	Stoicheff,
72 yrs.	W	10	----------		$\bar{X}$=196.6 R*=154.5 -264.6		Phonopho-tography	McGlone and Hollien, 1963
80-89 yrs.	W	5	Northern U.S.	$\bar{X}$=176.00 R*=160.73 -184.69	$\bar{X}$=176.33 R*=157.69 -185.93		Visicorder	Charlip, 1968

Appendix B (continued)

Age	Race	N	Geographical Area/ Linguistic Background	Hz Type of speech Activity Speak	Read	Other	Method	Investigator /Date
80-89 yrs.	W	10	Southern U.S.	$\bar{X}$=197			--------	Kelly, 1977
85 yrs.	W	10	----------		$\bar{X}$=199.8 R*=182.9 -225.3		Phonopho-tography	McGlone and Hollien, 1963

Abbreviations:

W=white
B=black
Or=oriental

N=number
t=tones
sts=semitones
oct=octaves

$\bar{X}$=mean
M=median
R=range
R*=range of the means
SD=standard deviation of the means

APPENDIX C

JESSE OWENS

JESSE OWENS, AN OLYMPIC WINNER IN 1936, SPENT MUCH TIME AND MONEY TO GIVE CHICAGO'S BOYS A CHANCE IN LIFE.

OWENS TAUGHT THE BOYS HOW TO LOSE AS WELL AS WIN. HE LOOKED FOR JOBS FOR THEM. HE ALSO WORKED TO TEACH THEM RIGHT FROM WRONG. AND, IF THEY DID GET IN TROUBLE, HE WOULD HELP THEM OUT WHEN NECESSARY. FOR HIS WORK WITH THEIR YOUNGSTERS, OWENS IS DEEPLY LOVED BY THE PEOPLE OF CHICAGO. HE IS, THEY SAY, TRULY A WINNER.

APPENDIX D

THE RAINBOW PASSAGE

WHEN THE SUNLIGHT STRIKES RAINDROPS IN THE AIR, THEY ACT LIKE A PRISM AND FORM A RAINBOW. THE RAINBOW IS A DIVISION OF WHITE LIGHT INTO MANY BEAUTIFUL COLORS. THESE TAKE THE SHAPE OF A LONG ROUND ARCH, WITH ITS PATH HIGH ABOVE, AND ITS TWO ENDS APPARENTLY BEYOND THE HORIZON. THERE IS, ACCORDING TO LEGEND, A BOILING POT OF GOLD AT ONE END. PEOPLE LOOK, BUT NO ONE EVER FINDS IT. WHEN A MAN LOOKS FOR SOMETHING BEYOND HIS REACH, HIS FRIENDS SAY HE IS LOOKING FOR THE POT OF GOLD AT THE END OF THE RAINBOW.

APPENDIX E
FLORIDA IB

FUNDAMENTAL FREQUENCY ANALYSIS FORM

Name _____ Sex _____ Date _____

Age _____ Height _____ Weight _____ Band Pass: 20, 30 Hz

Any formal voice training? Yes ___ No ___
Any history of speech, voice, hearing problems? Yes ___ No ___
Any speech, voice, hearing problem at present? Yes ___ No ___

Hz	Duration 1	2	3	X	Hz	Duration 1	2	3	X	Hz	Duration 1	2	3	X
50					230					410				
60					240					420				
70					250					430				
80					260					440				
90					270					450				
100					280					460				
110					290					470				
120					300					480				
130					310					490				
140					320					500				
150					330					510				
160					340					520				
170					350					530				
180					360					540				
190					370					550				
200					380					560				
210					390					570				
220					400					580				

5 Hz below mode _____ 5 Hz lower range _____
5 Hz above mode _____ 5 Hz upper range _____
Mode = _____ Range = _____

APPENDIX F

FLORIDA IB Comparison of Frequency Values in Hz To a Frequency Standard

REFERENCE	LOWER CHANNEL	UPPER CHANNEL
50	48	48
75	74	73.5
100	99	98
150	149	147
200	199	197.5
250	249	247.5
300	299	298
350	349	349
400	400.5	399
450	451.5	450
500	503	530

APPENDIX G

Nagra Calibration and Azimuth Alignment Data

HZ	REPRODUCTION	RECORD REPRODUCTION
15,000	+1.5dB	+1.5db
12,000	+0.5	+1.0
10,000	0	+1.0
7,500	0	+1.0
5,000	0	+0.5
2,500	0	0
1,000	0	0
750	0	0
500	0	+0.5
100	+0.5	+0.5
50	+1.0	+1.0
30	+1.0	+1.5

APPENDIX H

Distribution of Illnesses, Drugs, and Smoking Habits

	Infective & Parasitic Diseases	Neoplasms	Endocrine & Metabolic Diseases			Diseases of Blood & Blood Forming Organs
Subjects	(Tuberculosis, Malaria)	(Of GU or GI tracts; breast; thyroid)	Diabetes	Euthyroid with history of hyper/ hypo-thyroidism	Obesity	(Anemia)
Males						
50-59 years	0	0	2	0	3	0
60-69 years	1	0	3	1	18	0
70-79 years	2	1	2	1	7	1
Total	3	1	7	2	28	1
Females						
50-59 years	0	1	4	5	6	2
60-69 years	1	2	9	5	36	3
70-79 years	1	2	7	3	10	2
Total	2	5	20	13	52	7

APPENDIX H (Continued)

	Mental Disorders			Diseases of the Nervous System		
Subjects	Neurosis or Psychosis	Alcoholism	Senility	Hemiplegia	Peripheral Damage	Blindness
Males						
50-59 years	0	0	0	0	0	0
60-69 years	0	0	0	0	1	1
70-79 years	0	0	0	0	1	0
Total	0	0	0	0	2	1
Females						
50-59 years	0	0	0	0	0	0
60-69 years	1	0	0	0	2	0
70-79 years	0	0	0	0	1	0
Total	1	0	0	0	3	0

APPENDIX H (Continued)

Subjects	Diseases of the Circulatory System				Diseases of the Respiratory System	
	Hyper-tension*	Cerebro-vascular Disease	Heart Disease	Arterio-sclerosis	Bronchitis & Asthma	Lung Disease
Males						
50-59 years	18	0	4	0	0	0
60-69 years	15	0	2	2	1	1
70-79 years	17	0	7	9	0	1
Total	50	0	13	11	1	2
Females						
50-59 years	6	0	0	0	1	0
60-69 years	11	0	1	1	1	1
70-79 years	7	0	1	4	1	0
Total	24	0	2	5	3	1

* All but two males and one female reported that their blood pressure was present under control on medication and/or diet. The three who reported that their blood pressure was not under control indicated only mild, occasional elevations.

APPENDIX H (Continued)

	Diseases of the Digestive System		Diseases of the Genitourinary System			Diseases of Skin & Subcutaneous Tissue		
Subjects	Ulcer	Gall Bladder Disease	Kidney and/or Ureter	Male Organs	Bladder	Skin Cancer	Discoid Lupus Eryhtem-atosis	Vitiligo
Males								
50-59 years	2	0	1	1	1	2	0	0
60-69 years	1	0	2	3	2	2	0	1
70-79 years	0	0	1	3	4	4	0	0
Total	3	0	4	7	7	8	0	1
Females								
50-59 years	2	4	1	0	3	0	1	0
60-69 years	0	4	0	0	2	1	0	0
70-79 years	0	1	2	0	2	0	0	1
Total	2	9	3	0	7	1	1	1

APPENDIX H (Continued)

Subjects	Diseases of Musculoskeletal & Connective Tissue			Symptoms of Ill-Defined Conditions			Accidents, Poisoning, & Violence		
	Arthritis	Systemic Lupus Erythem-atosis	Amputation	Dizzi-ness	Aches & Pains	Weight Loss	Fractures	Drug Reaction	Burns (Older)
Males									
50-59 years	2	0	0	0	1	0	0	0	0
60-69 years	11	0	1	0	3	0	0	0	0
70-79 years	17	0	0	1	4	0	1	0	1
Total	30	0	1	1	8	0	1	0	1
Females									
50-59 years	4	1	0	1	2	0	0	0	0
60-69 years	16	0	0	0	2	1	2	0	1
70-79 years	19	0	0	1	5	0	3	0	0
Total	39	1	0	2	9	1	5	0	1

APPENDIX H (Continued)

	Surgery, Diagnosic & Therapeutic Techniques			Drugs					
Subjects	Abdominal Surgery	GU Tract Surgery	Orthopedic Surgery	Nutri-tional Products	Blood Modifiers	Hormones (Insulin, Thyroid)	Diuretics; Cardio-Vascular Agents	Auto-nomic Drugs	Central Nervous System Drugs
Males									
50-59 years	0	0	1	2	1	1	18	7	0
60-69 years	1	1	0	3	5	2	13	9	0
70-79 years	1	0	0	7	4	4	19	12	0
Total	2	1	1	12	10	7	50	28	0
Females									
50-59 years	4	0	1	4	0	4	2	1	0
60-69 years	2	0	2	4	0	10	5	2	1
70-79 years	0	0	0	9	1	11	5	2	0
Total	6	0	3	17	1	25	12	5	1

APPENDIX H (Continued)

Subjects	Drugs				Smoking Habits	
	Gastro-intestinal Drugs	Anti-Infective Drugs	Miscell-aneous Products	Number of Drugs	Smokers	Non-smokers for 15 or more years
Males						
50-59 years	1	4	16	49	10	0
60-69 years	2	6	11	50	9	0
70-79 years	2	3	23	71	10	3
Total	5	13	50	170	29	3
Females						
50-59 years	2	3	14	30	2	0
60-69 years	3	4	18	47	1	1
70-79 years	3	3	17	51	1	1
Total	8	10	49	128	4	2

VITA

Charlotte Anne Ducote was born October 21, 1951, in Baton Rouge, Louisiana. She graduated from Robert E. Lee High School in 1969. In 1972 she received her Bachelor of Arts degree from Louisiana State University. She entered graduate school in August 1972 at Vanderbilt University, and received an Office of Maternal and Child Health Care Administration Services fellowship while enrolled there. In August 1973, she received her Master of Arts degree in Speech and Hearing Sciences. She was employed full-time during the 1973-74 school term as a speech-language clinician in the Metropolitan Schools of Nashville and Davidson County, Tennessee. From August 1974 until August 1978, Ms. Ducote was employed full-time as an instructor and speech-language pathologist at the University of New Orleans. During 1978, she also held a consultantship in the Pediatrics Department/Child Development Center at Ochsner Clinic. From September 1978 until June 1981, Ms. Ducote was employed as a speech-language pathologist at Earl K. Long Memorial Hospital in Baton Rouge, Louisiana. From September 1981 until December 1982, she was employed part-time as a consultant in speech-language pathology at Greenwell Springs Hospital in Greenwell Springs, Louisiana. She also served as a speech-language pathologist from 1981-1982 with several Baton Rouge area home health

agencies. In addition, she was also employed on a part-time basis in 1981-82 as a clinical supervisor at the L.S.U. Speech and Hearing Clinic. Since December 1982 to present, she has been employed full-time as head of the section of speech pathology at the Louisiana Rehabilitation Institute of Charity Hospital in New Orleans. From 1978 to the present she has served as a reviewer of clinical and educational materials for ASHA, a journal of the American Speech, Language and Hearing Association. She is now a candidate for the Doctor of Philosophy degree in Speech Pathology.

EXAMINATION AND THESIS REPORT

Candidate: Charlotte Ann Ducote

Major Field: Speech (Speech Pathology)

Title of Thesis: "A Study of the Reading and Speaking Fundamental Vocal Frequency of Aging Black Adults"

Approved:

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

Date of Examination:

May 2, 1983