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THE PERCEPTUAL IDENTITY AND CHARACTERISTICS OF
AGING IN NORMAL MALE ADULT SPEAKERS

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ABSTRACT

Twenty untrained male and 20 untrained female listeners were required to judge the age of 46 male speakers from tape recordings of conversational speech. Thirty-seven speech samples were judged similarly by the two groups and were therefore provided as listening stimuli for ten trained male and ten trained female listeners. Through an a posteriori schema, trained listeners were required to specify the salient features of speech judged as being characteristic of each speaker's perceived age.

Results of the study indicated that untrained male and female listeners used similar perceptual sets to judge age until after the fiftieth year of life. Regardless of sex, both groups of listeners tended to underestimate the age of the male speakers.

Trained male and female listeners viewed low pitch and hoarseness as being the most salient features of speech for the 37 speakers. Qualitative analysis revealed that the most prominent features indicated by trained listeners could be classified according to "Pitch," "Quality," "Articulation" and "Rate of Speech." Trained male listeners tended to use a greater number of features to describe male speech than did trained female listeners. However, this phenomenon was considered to be a reflection of a greater degree of overlap in terminology used by females, rather than a difference in perceptual referents between the two sexes. Both groups of listeners tended to agree on the characteristic features of speech for a given perceived age decade.

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INTRODUCTION

In recent years, increasing attention has been directed toward the aging process. Coincidental with this research, investigators have noted anatomical and physiological changes in the speaking apparatus. Ptacek, Sander, Maloney and Jackson (1966) studied the changes in the respiratory, phonatory and articulatory mechanisms with advancing age. Their results indicated that geriatric subjects differed significantly from younger adults on all tasks performed, with a general reduction in assessed functioning. Diminished activity on the part of the geriatric group was related to degenerative changes of the respiratory and phonatory muscles which interacted to adversely affect articulation.

In discussing observed changes in the vocal mechanism with age, Levin (1962), Greene (1964), Luchsinger and Arnold (1965), Zemlin (1968) and Kaplan (1971) have indicated that ossification and calcification of the laryngeal cartilages and joints, and involution of the laryngeal muscles causes perceptual changes in the voice. Accordingly, the aging voice has been described as being tremulous, deviant in loudness, limited in range of pitch, and either high or low in habitual pitch.

Mysak (1959) conducted an investigation of the pitch and duration characteristics of males representing the

ages 32 to 92 years. The results indicated that males 80 years and older demonstrated a significantly higher average pitch level and pitch variability than those between 65 and 79 years of age. The data also showed a reduction in rate of speaking and phonation time as a function of age, although the trend was not statistically significant. In a similar study, Hollien and Shipp (1972) examined changes in voice fundamental frequency in males as a function of age. The combined data for subjects between 20 and 89 years showed progressive lowering of fundamental frequency until 40 to 50 years, and then a steadily rising trend until 89 years. The investigators considered the progressive drop in pitch to be caused by rapid laryngeal growth during this period, and by the vocal folds becoming thicker with use. From 50 to 89 years, the pitch rises because of senescent changes in the larynx and the body as a whole.

Ryan (1972) investigated mean vocal intensity, over-all rate in words per minute, and average rate of words per minute per sentence for males ranging in age from 40 to 80 years. It was found that men in the age range of 70 to 80 years exhibited a significant increase in mean vocal intensity for reading and speaking conditions, and a significant decrease in mean and over-all sentence reading rate when compared to younger speakers. In addition,

men in the 60 to 70 year range displayed a significant decrease in mean sentence reading rate when compared to those in the age range of 40 to 50 years. Ryan postulated that the older subjects spoke louder because sensory feedback in the respiratory and phonatory mechanisms subserving speech diminishes with age. Speaking rate becomes slower because of concomitant feedback changes in the articulatory musculature.

Concurrent with research dealing with anatomical and physiological changes in the speaking mechanism with age, investigators have shown that it is possible to differentiate "old" from "young" speakers on the basis of speech alone. Ptacek and Sander (1966) found that listeners were able to differentiate the voices of younger adults (under age 35) from older subjects (over age 65) on the basis of a prolonged vowel, a reading sample played backward, and a reading sample played forward.

Shipp and Hollien (1969) attempted to determine the perceptual identity of the aging voice and to what extent listeners could make valid and reliable age evaluations from a recorded passage of reading. Twenty-five listeners made direct age estimations of 175 male speakers between the ages of 20 and 89 years. The results indicated that listeners could accurately estimate age along a 70 year

continuum.

Ryan and Burk (1974) had listeners make direct age estimates of male speakers between 40 and 80 years who had recorded a specified reading passage. Selected samples were subjected to acoustic analysis. In addition, perceptual judgments were made as to the presence or absence of designated speech characteristics. The data revealed that five perceptual features of speech were strong predictors of perceived age.

From these investigations it can be inferred that the speech signal contains perceptual features which can be used by a listener in making a judgment of a speaker's age. This implies that a listener utilizes variations in acoustic cues which are a direct or indirect result of anatomical and physiological changes associated with the aging process.

Although the inferences set forth by previous research may prove tenable, several important factors have not been considered in the design of these studies. First, the sex of the listener has not been regarded as an active variable. Second, the a priori nature of these investigations may have excluded critical perceptual features from the study. Third, the nature of the speaking task may have influenced the way a speaker operated and therefore how he was perceived. It was the purpose of this study

to investigate these factors in relation to the perception of age from speech.

CHAPTER I

REVIEW OF THE LITERATURE

This chapter discusses the literature concerned with the perception of speech. It includes a review of the research that has considered speaker identification and differentiation from both a perceptual and acoustic framework. Studies dealing with the perception of age from speech are provided, from which the purposes for the present investigation were evolved.

Speaker Identification and Differentiation

The first study concerned with the ability of listeners to differentiate speakers was conducted by McGehee (1937). Male and female listeners were required to determine the sex of a speaker from a reading sample. The results indicated that males were more accurate in their judgments, however, the reliability of this conclusion is questionable as the sexes were not equally represented in either the speaking or listening tasks.

Schwartz (1968) attempted to determine if listeners could differentiate the sex of a speaker from isolated productions of /f/, /θ/, /s/, and /ʃ/. Using equal numbers of male and female speakers, it was found that listeners could differentiate the sex of a speaker accurately 81 per cent of the time for the four phonemes.

Coleman (1971) investigated the ability of listeners to differentiate between male and female speakers when variations in voice fundamental frequency had been eliminated. An artificial larynx modified to produce a steady buzz at a frequency of $\pm$ 85 Hz was used as the vocal sound source. Samples of reading recorded for an equal number of male and female speakers were used as listening stimuli. The results were similar to those of Schwartz in that for the listening groups combined, 88 per cent of the identifications were correct indicating that both sexes were identified correctly a majority of the time.

From these studies it is apparent that listeners are able to differentiate the sex of speakers with a high degree of accuracy, even when the listening stimuli are minute. It is probable that listeners are utilizing specific perceptual parameters of speech, which are characteristic of each sex, in making their judgments. Indeed, Coleman (1973) has indicated that differences in male and female vocal tract configurations may account for the fact that listeners can make this contrast.

A number of investigations have examined how well a listener can identify a speaker from the sound of his voice (e.g., Pollack et al., 1954; Bricker and Pruzansky, 1966). Typically, the task of the listeners was to

identify a speaker from a number of speakers who were familiar to him. Error scores were in the range of five to 19 per cent, depending upon the conditions of the experiment (Bolt et.al., 1970).

Compton (1963) investigated the ability of listeners to identify familiar speakers from filtered and non-filtered tape recorded samples of the vowel /i/. The duration of the speech segments was varied in order to determine the length necessary for speaker identification. The results showed that the greater the severity of the filtering, the greater the duration required for accurate identification of the speakers. However, in the nonfiltered condition, listeners were significantly able to identify speakers from sample durations of 25 msec.

Several experiments have been undertaken to compare the performance of subjects in distinguishing among speakers through (1) direct listening tests, (2) the use of physical measures, such as spectrograms, and (3) the use of psychophysical and semantic differential scales. Stevens et.al. (1968) compared the results obtained from a listening task to those obtained from visual inspection of spectrograms of the same utterances. Eight males between the ages of 20 and 40 years were used as speakers. Three male and three female college students served as subjects for both

the listening and visual identification tasks. In the aural tests, subjects heard a word spoken by one of the eight speakers. They then listened to all eight speakers saying the same word from which they attempted to identify the original speaker. A similar procedure was used for the visual identification tests in which subjects attempted to match spectrograms of the same speaker. The results indicated that the error rates for listening were always lower than for visual identification; with the average error rate being six per cent for the former and 21 per cent for the latter. In further tests using new unknown speakers among the test samples, subjects attempted to determine if a sample was spoken by any of the eight known speakers. Through listening, six to eight per cent of the unknown speakers were incorrectly labelled known; by visual inspection of spectrograms, 31 to 47 per cent of the unknown speakers were labelled known. It was concluded that visual comparisons of spectrograms were a less reliable method of identifying speakers than auditory comparisons.

In a similar study, Clarke and Becker (1969) compared listening tests, scaling tasks and physical measures as devices for differentiating among speakers. Twenty individuals of unknown age and sex were employed as speakers. Five graduate students trained in speech

science were used as listeners. For the listening test, speakers were divided into five groups of four speakers each. Listeners heard a word spoken by one of the four speakers, and then the same word spoken by all four speakers consecutively. The task was to identify the speaker who spoke the stimulus item from the alternatives. The listeners were also asked to develop a scale which was suitable for identifying the speakers. An informal check on agreement between the listeners revealed that pitch, pitch variability, speech rate, sibilant intensity, "click-like" elements (hoarseness, harshness and vocal fry) and breathiness could be used to differentiate speakers. These six features were subjected to physical measurement by uni-graphic techniques. It was found that the listening test yielded an average of 65 per cent correct responses. Listeners indicated that pitch was the most effective feature for differentiating speakers followed by "click-like" elements, sibilant intensity, breathiness, speech rate and pitch variability. Analysis of the speech spectrum revealed little in the way of characteristic patterns that might be used to differentiate speakers.

In an attempt to determine how listeners differentiate among speakers, and those characteristics which they use for differentiation, Holmgren (1967) employed a 12 item semantic

differential scale. The adjective pairs selected on an a priori basis were: intense-mild, hard-soft, sharp-dull, beautiful-ugly, good-bad, clean-dirty, rumbling-whining, deep-shallow, low-high, slow-fast, simple-complex and resting-busy. Speakers consisted of ten individuals of unknown age and sex who read a passage averaging 75 seconds in duration. The listeners were 20 individuals who were asked to rate the speakers on the semantic differential. Following the listening task, physical measurements were taken for (1) the amplitude of unvoiced sounds, (2) the amplitude of voiced sounds, and (3) the voice fundamental frequency. It was found that listeners could reliably differentiate between speakers on the basis of the semantic differential, and that discrepancies existed when perceptual measures were compared to physical measures. For example, the perceptual judgments of "slow-fast" and "resting-busy" were independent of the physical measure of duration. Holmgren concluded that:

Speaker differentiation or recognition on the basis of physical voice measures alone suggests that these measures (found to be independent from judged voice characteristics presently employed) represent cues to which either (1) the listeners were unable to respond judgmentally, or (2) appropriate items were not on the form thus restricting response availability (p. 65).

It is apparent from these investigations that physical measurement of speech as a means of identifying speakers

or describing characteristics of speech is subject to error at a high and undetermined rate. Bolt et.al. (1970) have offered the following criticisms of spectrographic analysis with respect to speaker identification:

Similarities and differences among spectrographic patterns are ambiguous and misleading. Prominent similarities usually indicate that similar sounds were spoken, but do not necessarily imply that they were spoken by the same person; differences in pattern, when words are the same, may reflect differences of speaker or only normal variations in the utterances of a single speaker (p. 602).

Experimental studies of voice identification using visual interpretation of spectrograms by human observers indicate false identification rates ranging from zero to as high as 63 per cent, depending on the type of task set for the observer, the observer's training, and other factors. Reliable machine methods for voice identification have not yet been established (p. 603).

Bolt et.al. concluded their discussion by stating:

We find, in brief, that spectrographic voice identification has inherent difficulties and uncertainties. Anecdotal evidence given in support of the method is not scientifically convincing. The controlled experiments that have been reported give conflicting results (p. 603).

Hecker (1971) has suggested that since perceptual and physical measures are not perfectly correlated, they cannot be measuring the same thing. If they were, physical and perceptual studies would show redundancy in results. He proposed that: "Speaker recognition by listening

appears to be the most accurate and reliable method at the present time" (p. 1).

In terms of aurally judging the features of speech, Moll (1968) has argued that direct measures of nasality from listener judgments are the only measures which are currently valid. Perceptual descriptions demonstrate that the listener is an integral part of the communication process. A similar position was held by Kantner (1948) who stated that: "The human ear is the final detector and arbiter" (p. 219).

In order to determine the perceptual bases of speaker identity, Voiers (1964) had listeners judge speakers on a semantic differential scale. Sixteen men ranging in age from 20 to 35 years recorded an identifying phrase and 24 sentences. Thirty-two individuals between the ages of 23 and 35 years served as listeners. For the listening task, they were told to base their ratings on what they perceived to be the salient characteristics of each speech sample independent of the speech context. The listeners were allowed to describe in longhand the features not included on the scale. The results showed high loadings on four factors. Factor 1 was defined as a dimension of "clarity" or "intelligibility." Factor 2 was labelled "roughness." Factor 3 was defined as "pitch." Factor 4 appeared to be influenced

by, or related to Factor 2, and was labelled "animation." None of the listeners provided features in longhand, which may have been a reflection of unfamiliarity with perceptual labels.

Markel et.al. (1964) investigated the ability of listeners to differentiate schizophrenics from nonschizophrenics on a semantic differential scale when the content of a reading passage was held constant. Ten schizophrenic and 11 nonschizophrenic males between the ages of 21 and 51 years were used as speakers. Twenty-six males and 14 females between 17 and 23 years of age served as listeners. The results indicated that listeners could reliably differentiate between personality types from recorded samples of speech. Presumably because of the unequal sex ratio of listeners, a comparison of male and female judgments was not undertaken.

In summary, it is apparent that listeners can identify and differentiate speakers on the basis of both gross and fine perceptual stimuli. There is also evidence to suggest that the study of speaker recognition through a perceptual rather than an acoustic design provides for more valid and reliable conclusions. In order to maintain this situation, it is essential to investigate the recognition of speakers from a perceptual point of view.

Age Identification and Differentiation

The first in a number of age identification studies was conducted by Ptacek and Sander (1966). Ten graduate students in speech pathology were tested for their ability to differentiate young adults (under age 35) from older subjects (over 65) in three successive listening conditions: (1) a prolonged vowel, (2) a reading sample played backward, and (3) a reading sample played forward. Male and female college students ranging in age from 18 to 35 years served as young speakers. Older speakers consisted of males and females ranging in age from 67 to 87 years. Although 72 speakers participated in the study, the number and sex ratio in each age group was not indicated. Listeners were told the sex of each speaker prior to the listening tasks. They were required to indicate on an answer sheet whether the speaker was under 35 or over 65 years. At the conclusion of the listening tasks, listeners were asked to state what auditory clues they used to make their judgments. The results revealed that listeners could correctly differentiate "young" and "old" speakers at a mean rate of 99 per cent for forward played speech, 87 per cent for backward played speech and 78 per cent for a prolonged vowel. From the recorded passages of reading, listeners mentioned that the older speakers read slower,

were more hesitant, had lower pitches and less pitch variability than the younger speakers. They also indicated that hoarseness, voice breaks, reduced intensity and vocal vitality were perceptual clues used to identify older speakers.

Shipp and Hollien (1969) attempted to determine the perceptual identity of the aging voice and to what extent listeners could make valid and reliable age evaluations from recorded stimuli. The speakers were 175 adult males between the ages of 20 and 89 years. Each decade was represented by 25 subjects distributed by age relatively evenly throughout the ten year span. Each speaker recorded a standard reading passage from which the third sentence was re-recorded on a master listening tape. Listeners consisted of three groups of college students between 20 and 30 years with little or no experience in judging. Prior to the experiment, they were told that the speakers were between 20 and 89 years of age. There were three conditions in this study. In Condition A, 30 listeners determined whether the speech samples they heard were uttered by a young, middle-aged or old speaker. It was found that as the age of the speakers increased, age identification became more accurate. For Condition B, 40 judges assigned a number corresponding to the age decade of the speaker.

The results were in agreement with those of Condition A in that perceived age increased with chronological age. For these two conditions, it was concluded that as a male becomes older, the perception of his age from speech becomes more accurate. In Condition C, 25 listeners made direct estimates of age. The results indicated that although they tended to underestimate age, listeners could significantly identify age from speech along a 70 year continuum. This finding goes beyond the Ptacek and Sander study in that listeners not only could differentiate young from old speakers, but demonstrated agreement for the middle ages.

Ryan and Burk (1974) had 20 untrained listeners make direct estimates of age from recorded speech samples of 80 males 40 to 80 years old. Based upon listener agreement of perceived age, 40 recordings were selected for further perceptual analysis.

For Part One, speakers recorded a paragraph of a standard reading passage from which the fourth and fifth sentences were re-recorded on an experimental listening tape. Listeners were 20 young adult females with no previous judging experience. They were informed that the speakers were male between 40 and 80 years of age. Listeners were instructed to make a direct estimation of the

age of the speaker to the nearest year from each speech sample. The results were in agreement with the findings of Shipp and Hollien (1969) in that as chronological age increased, listeners, on the average, judged the sample as belonging to an older individual.

Forty speakers were characterized by a standard deviation in perceived age of six years or less and were therefore selected for further analysis in Part Two of the study. Each speaker recorded a standard reading passage which was subsequently used for perceptual and acoustic study. Prior to the judging sessions, five speech pathologists listened to the speech samples and indicated ten characteristics which they considered to be present in one or more of the samples. Eleven female and seven male graduate speech clinicians who had been trained in the use of the St. Louis Jewish Hospital Voice Profile (Wilson, 1971) listened to the recorded passages. They were asked to indicate the presence or absence of the ten previously selected speech characteristics for each of the 40 speakers. Upon completion of the listening task, the total number of times each characteristic was judged to be present for each speaker was computed. For acoustic analysis; mean dB SPL, words per minute, words per minute per sentence, mean fundamental frequency and standard deviation of

fundamental frequency was obtained for each speaker. The results revealed that five perceptual features (air loss, laryngeal tension, voice tremor, imprecise consonants and slow rate of articulation) and one acoustic feature (fundamental frequency) were the most effective predictors of perceived age. However, of the six features, mean fundamental frequency was found to be the least important predictor as evidenced by its diminished regression coefficient of .10. In accordance with this finding, it was concluded that:

The major implication is that perceptual variables, rather than individual acoustic measures, may be more helpful in obtaining information about the aging speech mechanism (p. 190).

In a subsequent investigation, Horii and Ryan (1975) found that listeners tended to associate perceived aging with higher average fundamental frequency. However, the correlation between mean fundamental frequency and chronological age was not significant.

To date, only one investigation has considered the ability of listeners to judge age of pathological speakers. Kreul and Hecker (1971) matched five normal adult male speakers and five with cancer of the vocal folds on the basis of chronological age and voice fundamental frequency. All speakers recorded a standard reading passage

from which the second sentence was re-recorded on an experimental listening tape. Listeners were 22 college students with no previous experience in judging. During the listening task, they were asked to (1) estimate the speaker's exact age, (2) rate the adequacy of the speaker's voice on a scale from one to nine, and (3) rate the degree of hoarseness, harshness and breathiness of each speaker's voice. Judgments of age were found to be highly correlated with judgments of adequacy and voice quality for both groups of speakers. However, for three pathological and three normal speakers, the judgments of adequacy, hoarseness, harshness and breathiness differed significantly. This result demonstrated a degree of independence among the judgments of adequacy and voice quality even though they were correlated. Since a force-choice judgment was not required for the quality features, the single feature which predominated in each speech sample was not identified. For the pathological speakers, judgments of age were not correlated with chronological age. Although listeners tended to underestimate the age of normal speakers, the correlation between judged and chronological age was $r=0.80$. It was concluded that accurate judgments of age from speech are dependent upon an intact phonatory mechanism and listener experience with the perceptual

characteristics of speech.

Methodological Problems

In view of the above investigations, it would appear tenable to conclude that both trained and untrained listeners can characteristically identify the age of speakers from recorded samples of speech. However, there are a number of major problems existing in these studies which could affect the validity and reliability of their conclusions.

First, two investigations (Kreul and Hecker, 1971; Ryan and Burk, 1974) have been a priori in nature. That is, limits have been placed on the number of perceptual features a listener is allowed to choose from in making a judgment of age from speech. Since specific parameters of speech were chosen beforehand, certain critical perceptual features may have been excluded from the design of these studies. The sole attempt at an a posteriori description of the perceptual features of aging speech was presented by Ptacek and Sander (1966), who used an informal and nonempirical method to secure information from listeners. Indeed, they reported that: "The perceptual clues of listeners were obtained in a casual manner" (p. 276).

Second, previous research has used a reading passage or a prolonged vowel as the speaking stimulus. An exten-

sive amount of research has shown that the "unnaturalness" of such situations may influence the way a speaker operates and therefore, how he is perceived (Snidecor, 1943; Bricker and Pruzansky, 1966; Tiffany and Hollien, 1968; Michel and Wendahl, 1971; Faircloth et.al., 1974; Singh et.al., 1974). Because of the nature of the task, the speaker may feel pressed to maximize his speaking behavior; leading to over-articulation, changes in habitual pitch, and the like. Furthermore, earlier investigations have not considered reading proficiency as a variable in age identification.

Third, the sex of the listener has not been regarded as an active variable in earlier studies dealing with age recognition. Investigators have reported either using a "group of listeners" without respect to sex, or a homogeneous population of listeners (Ryan and Burk, 1974). It is possible that males use different perceptual features than females in identifying age, and therefore identify it differently.

Fourth, in two studies (Shipp and Hollien, 1969; Ryan and Burk, 1974) listeners have been asked to make a judgment of age in a "closed response" format. That is, listeners were told the upper and lower age limits of the speaker before the experiment. The a priori boundaries placed

upon speaker age restricted listener choice; a factor which could conceivably affect the reliability of these studies.

In order to objectively study the ability of listeners to characteristically identify age from speech, it would appear warranted to (1) allow for an a posteriori description of perceptual features, (2) use speaking situations which permit natural speaker operation, (3) utilize an equal number of male and female listeners and (4) incorporate an "open ended" age response format.

CHAPTER II

STATEMENT OF THE PROBLEM

There is some evidence to suggest that both trained and naive listeners are able to identify the perceptual features of aging speech on an a priori basis. However, because of the inherent limitations of this type of research, a number of important perceptual features may not have been given consideration. The only study which attempted to describe the perceptual characteristics of aging speech through an a posteriori schema was conducted in a casual and nonempirical manner. Due to the restrictions of the a priori investigations, and the ambiguity of the isolated a posteriori study, further inquiry into the perceptual features of aging speech is warranted. In order to accurately disclose these features, it is imperative that an a posteriori experimental design be utilized.

Although it has been shown that artificial speaking tasks, such as reading or prolonging a vowel, may affect speaker performance and hence listener judgment, the effect of spontaneous, unrehearsed speech on the perceptual judgments of listeners has not been investigated. Further research is required in this area.

Previous research which has dealt with the perception of age from speech has not considered the sex of the

listener as a variable. In order to determine if males judge age differently than females, and the perceptual clues they use in making their decisions, further investigation is necessary.

The use of a "closed response" listening format has restricted choice availability in earlier age recognition experiments. In order to increase response utility and therefore the reliability of listener judgments, an "open response" paradigm should be incorporated in additional study of age recognition from speech.

The main purposes of the present investigation were to determine (1) if there was a significant difference in the judgments of untrained male and female listeners in identifying the age of male speakers from spontaneous conversation, (2) the perceptual features of speech that trained male and female listeners identify as being characteristic of a judged speaker's age, and (3) how trained male and female listeners rank these perceptual features on the basis of similarity and frequency of occurrence.

If untrained listeners perceived changes in speech with age, and if males perceived these changes differently than females, the implications would appear relevant for speech pathology, the theater arts, broadcasting and

traditional speaker recognition research.

The study also attempted to describe the normal perceptual changes that occur as a result of changes in the speaking mechanism with age. This knowledge would be useful diagnostically in defining the "normal limits" of speech.

CHAPTER III

METHODS AND PROCEDURES

This chapter presents the research design, methodology and statistical treatments used in this investigation. In order to accomplish the objectives of this study, it was divided into two parts. The character of the second part was dependent upon the findings of the first.

Part One

Selection of Speakers

The speakers consisted of 46 males representing the ages 25 to 70 years. The lower age limit was chosen to insure that pubescent voice change had occurred (Curry, 1940). The upper age limit was selected to insure that speech involution had or was occurring (Greene, 1964; Luchsinger and Arnold, 1965; Zemlin, 1968). Each year was represented by one speaker whose age was within six months of the year indicated. They were selected from the university environment and social/professional organizations within Northwest Ohio. Persons having one or more of the following were excluded from the study: (1) hearing losses greater than 25 dB (poorer ear) at one or more of the following frequencies: 250, 500, 1000, 2000 Hz, (2) bronchial asthma or respiratory infection, (3) emphysema or heart dysfunction, (4) dysphasia, (5) neurological, endocrinological disorders

affecting the speech or phonatory mechanism, (6) clinically obvious speech and/or phonatory disorders unrelated to neurological or endocrinological dysfunction, (7) senile psychosis or psychopathology, (8) dialects other than General American, and (9) less than eight years of formal education.

Speech Samples

Five minutes of conversational speech were tape recorded for each of the 46 speakers. The recording environment was a sound treated room located in the University Speech and Hearing Clinic. Because of the artificiality of the speaking environment, the conversation was initiated by the experimenter in a casual, informal manner. Speakers were informed that the study dealt with the concept of "friendship." Conversation between the speaker and the experimenter was directed toward this topic and the speaker's best friend (Ptacek and Sander, 1966). A Uniplex model 245 S Ceramic microphone was placed six inches from the speaker's mouth. Speech was recorded at approximately 60 dB through a Tandberg model 9141X tape recorder and an Advent Noise Reduction Unit model 100A using the Dolby system.

Listening Stimuli

From each of the 46 five minute taped samples, 30

seconds of continuous speech were randomly selected and spliced together to form the experimental listening tape (Bricker and Pruzansky, 1966; Tiffany and Hollien, 1968; Ryan, 1972). "Continuous speech" was defined as ongoing conversation containing nine seconds or less of pausing (extrapolated from Singh et.al., 1974). As a means of testing intra-judge reliability, six 30 second samples of speech were randomly selected and spliced a second time. The experimental listening tape therefore consisted of 52 stimulus items.

Untrained Listeners

The listeners consisted of 20 male and 20 female college students selected at random from an undergraduate survey course in speech and hearing for non-majors. Criteria for participation included: (1) normal hearing, i.e., threshold levels of at least 25 dB binaurally for the frequencies 250, 500, 1000, 2000 Hz, and (2) no prior knowledge of the research.

Listening Task

Listeners were randomly arranged in groups of six for the listening task. The experiment took place in a listening laboratory divided into individual carrells. Each listener was provided with a pencil and a response sheet. The stimuli were presented binaurally through

TDH-49 earphones at a comfortable loudness level; approximately 70 dB SPL. The instrumentation used for playback of the experimental tape was the same as that used for the recording of speech samples. Listeners were allowed five seconds to make an exact age judgment by year for each 30 second speech sample. Prior to the listening task, the following instructions were given verbally and in writing to the listeners:

You are about to hear a series of recordings of speech. The speakers are males. You are to indicate on the answer sheet the exact age, by year, of each speaker. For example, if you think speaker number 1 is 26 years old, place this age (26) after number 1 on the answer sheet. You will have five seconds to make your decision. Each speaking sample is 30 seconds long. In the box marked Sex of Listener, circle M if you are a male or F if you are a female. Please look up when you are done reading these instructions. Are there any questions?

During the listening task, the experimenter monitored the listening tape in a room adjoining the listening laboratory.

Data Analysis

The format for empirical analysis to determine if males significantly differ from females in their perceptions of age from speech was a multivariate F-test and discriminant analysis (Bruning and Kintz, 1968). The Pearson Product-Moment Correlation Coefficient was

utilized to determine intra-judge reliability (Ferguson, 1971).

Part Two

Selection of Listening Stimuli

In order to identify those speakers who were used for Part Two of the study, the mean perceived age and univariate values of F were determined for the perceived age of each speaker. Speakers whose individual F ratio was at or exceeded the .10 level of confidence were selected for further analysis.

In the case of a significant multivariate F value, speech samples meeting criterion for untrained male listeners were to be used as listening stimuli for trained male listeners. A similar procedure was used for selection and utilization of speech samples for trained female listeners. In the case of a nonsignificant multivariate F value, speech samples meeting criterion for both male and female untrained listeners were to be provided as listening stimuli for the trained listeners irrespective of sex. Speech samples not meeting criterion were extracted from the experimental listening tape. The remaining samples constituted the listening stimuli for Part Two of the study.

Trained Listeners

The listeners consisted of ten male and ten female speech pathologists. Minimum criteria for participation included: (1) normal hearing, i.e., threshold levels of at least 25 dB binaurally for the frequencies 250, 500, 1000, 2000 Hz, (2) a Masters Degree in speech pathology and (3) The Certificate of Clinical Competence in speech pathology, or eligibility for the Clinical Fellowship Year.

Listening Task

The listening environment was the same as that indicated for the listening task in Part One of the study. Prior to listening to each speech sample, listeners were told the mean perceived age of each speaker. The listening task was to orthographically describe, as specifically as possible, the salient characteristics of each speaker's speech in reference to his perceived age. Listeners were allowed 45 seconds to write their descriptions.

The following instructions were given verbally and in writing to the listeners before they heard the experimental listening tape:

You are about to hear a series of recordings of speech. The speakers are males between the ages of 25 and 70 years. On your answer sheet you are given the perceived age (PA) of each speaker. You will also be told the

perceived age of each speaker prior to each speech sample. Your task is to indicate as specifically as possible the salient features of speech that you perceive as being characteristic of the speaker's perceived age. As an analogous example, you may describe a ball as being round, red, bouncy, big, etc. You will have 45 seconds to write your descriptions. Each sample is 30 seconds long and will be played only once. In the box marked Sex of Listener, circle M if you are a male or F if you are a female. Since clarification of a description may be necessary in some cases, please write a phone number where you can be reached in the upper right hand corner of the answer sheet. Please look up when you are done reading these instructions. Are there any questions?

Data Analysis

Immediately following the experimental task, listeners were asked to verbally clarify any descriptions which were considered to be ambiguous by the experimenter. The responses were then assembled according to similarity and frequency of occurrence. The data was also qualitatively compared to the features of speech which have been identified in previous research (i.e., Mysak, 1959; Ptacek and Sander, 1966; Ryan, 1972; Ryan and Burk, 1974).

CHAPTER IV

RESULTS

This chapter presents the results of the data analyses for Part One and Part Two of the study. Reliability data are presented in Part One, as this information is inherent to this portion of the experiment.

Part One

The Pearson Product-Moment Correlation Coefficient was used to determine the reliability of the untrained male and female listeners in making age judgments from speech. For this purpose, the mean perceived age of six original and six duplicated speech samples was compared for both male and female listeners. Correlation coefficients were .93 and .94 for the male and female listeners respectively, indicating a high degree of agreement within and between the listening groups.

The individual age judgments of the untrained male and female listeners were utilized in a multivariate F-test and discriminant analysis in order to determine if there was a significant difference in the perceptions of age between the two groups. Since there were more dependent variables (46 speakers) than subjects (40 subjects), it was necessary to analyze the data through two multivariate F-tests and discriminant analyses.

Therefore, the age judgments for the 46 speakers were divided in half and analyzed in two groups of 23 speakers each. The results revealed a nonsignificant difference in perceptual age judgments between the untrained male and female listeners ($df = 23, 16; F = .70; p < 0.7913$; $df = 23, 16; F = .71; p < 0.7758$). The discriminant analysis supported this finding.

Since the multivariate and discriminant analyses yielded nonsignificance between the two groups of listeners, speakers were selected for analysis in Part Two of the study irrespective of sex. Tables 1 and 2 represent a summary of chronological age, mean perceived age, and the standard deviation in perceived age for the untrained male and female listeners, respectively.

Selection of speakers for the second part of the study was based on univariate F values which met or exceeded the .10 level of confidence. Thirty-seven speakers met this criterion for the untrained listeners and were therefore used in the second part of the experiment. Table 3 shows the hypothesis mean square, the error mean square, the univariate value of F and corresponding confidence levels for the untrained male and female listeners. It can be observed from Tables 1 and 2 that

TABLE 1

Summary of Chronological Age (CA), Mean Perceived Age ($\bar{XPA}$), and the Standard Deviation (SD) in Perceived Age for 46 Speakers as Judged by 20 Untrained Male Listeners. CA is Expressed to the Nearest Year

Spkr #	CA	$\bar{XPA}$	SD	Spkr #	CA	$\bar{XPA}$	SD
1.	50.00	41.55	7.74	24.	67.00	55.90	9.66
2.	53.00	34.45	6.50	25.	30.00	31.15	6.98
3.	38.00	27.80	5.47	26.	64.00	44.05	8.35
4.	48.00	37.40	6.00	27.	36.00	37.10	7.99
5.	70.00	58.50	10.15	28.	59.00	53.15	12.61
6.	26.00	25.20	4.15	29.	44.00	29.80	5.15
7.	49.00	31.35	7.96	30.	66.00	56.15	9.19
8.	57.00	31.60	6.77	31.	54.00	48.05	7.75
9.	65.00	53.65	9.04	32.	46.00	41.50	6.48
10.	27.00	23.55	5.11	33.	33.00	24.75	4.20
11.	25.00	24.60	5.77	34.	28.00	27.75	3.76
12.	51.00	46.85	6.80	35.	60.00	45.15	8.06
13.	42.00	32.65	6.11	36.	56.00	31.35	6.87
14.	31.00	33.25	7.85	37.	68.00	53.85	9.39
15.	34.00	49.35	8.85	38.	39.00	38.95	6.50
16.	29.00	27.25	6.46	39.	58.00	45.60	7.48
17.	41.00	37.30	6.51	40.	55.00	45.95	7.62
18.	45.00	40.35	6.47	41.	43.00	40.85	7.79
19.	63.00	47.05	8.98	42.	40.00	33.25	6.77
20.	37.00	27.95	6.33	43.	32.00	38.20	6.74
21.	47.00	45.35	7.84	44.	52.00	53.00	8.04
22.	62.00	48.90	7.26	45.	61.00	51.00	10.56
23.	35.00	30.80	6.67	46.	69.00	57.15	8.70

TABLE 2

Summary of Chronological Age (CA), Mean Perceived Age ($\bar{X}$ PA), and the Standard Deviation (SD) in Perceived Age for 46 Speakers as Judged by 20 Untrained Female Listeners. CA is Expressed to the Nearest Year

Spkr #	CA	$\bar{X}$ PA	SD	Spkr #	CA	$\bar{X}$ PA	SD
1.	50.00	45.95	5.05	24.	67.00	61.95	8.57
2.	53.00	34.90	6.57	25.	30.00	31.20	5.56
3.	38.00	28.10	6.54	26.	64.00	50.65	5.11
4.	48.00	39.50	7.05	27.	36.00	39.35	5.86
5.	70.00	64.20	7.51	28.	59.00	58.00	5.90
6.	26.00	24.10	4.48	29.	44.00	33.35	7.87
7.	49.00	32.90	9.95	30.	66.00	57.30	7.97
8.	57.00	31.15	5.34	31.	54.00	49.58	8.27
9.	65.00	56.65	7.09	32.	46.00	44.25	6.83
10.	27.00	22.20	3.47	33.	33.00	23.85	3.62
11.	25.00	22.65	2.32	34.	28.00	29.20	5.40
12.	51.00	50.10	4.88	35.	60.00	49.85	6.93
13.	42.00	31.25	6.36	36.	56.00	30.35	5.15
14.	31.00	34.75	5.84	37.	68.00	58.30	6.50
15.	34.00	53.05	8.86	38.	39.00	39.90	6.35
16.	29.00	28.30	5.88	39.	58.00	49.40	4.49
17.	41.00	39.00	6.92	40.	55.00	48.85	5.72
18.	45.00	41.80	9.05	41.	43.00	43.95	5.98
19.	63.00	50.30	6.63	42.	40.00	36.25	4.83
20.	37.00	25.65	4.57	43.	32.00	40.80	6.06
21.	47.00	45.25	6.29	44.	52.00	55.25	4.40
22.	62.00	47.30	6.70	45.	61.00	50.90	6.08
23.	35.00	32.05	6.58	46.	69.00	62.00	7.80

TABLE 3

The Hypothesis Mean Square ($H\bar{X}Sq$), Error Mean Square ($E\bar{X}Sq$), Univariate Value of F (F) and Corresponding Confidence Level ($p \leq .10$) for 46 Speakers as Judged by 20 Untrained Male and Female Listeners

Spkr #	$H\bar{X}Sq$	$E\bar{X}Sq$	F	$p \leq .10$	Spkr #	$H\bar{X}Sq$	$E\bar{X}Sq$	F	$p \leq .10$
1.	193.60	42.68	4.53	.04*	24.	366.02	83.49	4.38	.04*
2.	2.02	42.70	.05	.83	25.	.02	39.83	.0006	.98
3.	.90	36.39	.02	.87	26.	435.60	47.99	9.07	.01*
4.	44.10	42.89	.03	.32	27.	50.62	49.17	1.02	.32
5.	324.90	79.74	.07	.05*	28.	235.22	96.96	2.42	.12
6.	12.10	18.66	.65	.42	29.	126.02	44.31	2.84	.10
7.	24.02	81.22	.29	.59	30.	13.22	73.97	.18	.67
8.	2.02	37.25	.05	.82	31.	32.40	64.25	.50	.48
9.	90.00	66.03	1.36	.25	32.	75.62	44.39	1.70	.20
10.	18.22	19.11	.95	.33	33.	8.10	15.38	.53	.47
11.	38.02	19.35	1.96	.17	34.	21.02	21.71	.97	.33
12.	105.62	35.00	3.02	.09*	35.	220.90	56.50	3.91	.05*
13.	19.60	38.85	.50	.48	36.	10.00	36.92	.27	.60
14.	22.50	47.83	.47	.50	37.	198.02	65.33	3.03	.09*
15.	136.90	78.41	1.74	.19	38.	9.02	41.28	.22	.64
16.	11.02	38.21	.29	.59	39.	144.40	38.09	3.79	.05*
17.	28.90	45.16	.64	.43	40.	84.10	45.41	1.85	.18
18.	21.02	61.94	.34	.56	41.	96.10	48.20	1.99	.17
19.	105.62	62.29	1.69	.20	42.	90.00	34.62	2.60	.11
20.	52.90	30.46	1.74	.19	43.	67.60	41.06	1.65	.21
21.	.10	50.48	.002	.96	44.	50.62	42.04	1.20	.28
22.	25.60	48.84	.52	.47	45.	.10	74.20	.001	.97
23.	15.62	43.90	.35	.55	46.	235.22	68.27	3.44	.07*

*Indicates a significant difference at .10 level of confidence.

both male and female untrained listeners tended generally to underestimate the age of the speakers. This phenomena was noted previously by Shipp and Hollien (1969), although the sex of the listener was not considered to be a variable in their study.

Tables 1, 2, and 3 show that there was no trend in perceiving chronological age for either the male or female untrained listeners until 62 years of age. From this age to 70 years, the female listeners were consistently more accurate in perceiving chronological age than were the male listeners. Furthermore, those ages which showed a significant difference in age judgments between the male and female listeners (ages 50, 51, 58, 60, 64, 67, 68, 69, 70) were at or beyond the fifth decade of life and reflected lower mean perceived age estimations by the male listeners.

In summary, it is apparent that untrained male and female listeners have similar perceptions of aging speech until the fifth decade of life. From this point to the seventh decade, untrained female listeners appear to be more adept at identifying chronological age of male speakers.

Part Two

The features of speech indicated by the trained male and female listeners for the 37 speakers who met criterion

in Part One were assembled according to similarity and frequency of occurrence. Tables 4 through 7 present the incidence with which trained male listeners specified features for the four perceived age decades. For purposes of comparison, the chronological ages of the speakers (CA), and their mean perceived ages ($\bar{X}$ PA) as determined by the 20 untrained male listeners in Part One of the study, are provided. The per cent of trained male listeners who indicated the presence of features for the perceived ages within each decade is also presented. Table 4 reveals that of the 24 features indicated, male listeners specified rapid rate (36%) and high pitch (34%) as the most salient perceptual features of speech for the second perceived age decade. Precise articulation (27%), hypernasality (24%), clear quality (17%) and semantic content (13%) were also judged to be characteristic of speech of the second decade at least ten per cent of the time. Examination of the occurrence of features within the second perceived age decade shows that rapid rate was the best discriminator of speakers whose chronological age was below 30 years, and that high pitch, precise articulation and hypernasality were the best indices for differentiating speakers whose chronological age was above 30. Table 5 shows that of the 26

TABLE 4

Features Indicated by Ten Trained Male Listeners for
Perceived Age Decade 20 to 30 Years

CA	XPA	Features and Incidence of Occurrence in %																							
		Rapid Rate 36	High Pitch 34	Precise Ar- tication 27	Hypernasality 24	Clear Quality 17	Semantic Content 13	Pitch Varia- bility 8	Moderate Pitch 7	Low Volume 6	Laryngeal Tension 5	Denasality 5	Oral Tone Focus 5	Dysfluency 4	Balanced Res- onance 3	Low Pitch 3	Slow Rate 3	Monotone 3	Imprecise Ar- tication 2	Harshness 2	Moderate Rate 2	Pitch Breaks 1	High Volume 1	Limited Pitch Variability 1	Breathiness 1
27.00	23.55	60	40	20	30	10	20		10	20	10	10	10					20		10					
25.00	24.60	40	20	20	20	40	40	10		10	10			10					10		10				
33.00	24.75	20	40	50	20	20		10	30			10					10								
26.00	25.20	60	40	20	10	20	30				10	10	10		20										
29.00	27.25	50	30	30	40	10	10	30	20		10	10													
28.00	27.75	70	20	30	20		10	20	20	10				10	10							10			
38.00	27.80	10	60	20		40				10		10				10	10						10		
37.00	27.95		60	40	30	10		10			10				10				10						
44.00	29.80	20		20	50	10	10	10	20		10		10			20	20			10				10	

TABLE 5

Features Indicated by Ten Trained Male Listeners
for Perceived Age Decade 30 to 40 Years

CA	XPA	Features and Incidence of Occurrence in %																									
		Moderate Rate 16	Low Pitch 16	Moderate Pitch 16	Precise Ar- ticulation 15	Pitch Var- iability 14	Rapid Rate 13	Slow Rate 12	Glottal Fry 11	Clear Quality 10	Hypernasality 9	Balanced Re- sonance 8	High Volume 7	Low Volume 6	Hoarseness 6	Laryngeal Tone Focus 5	Semantic Content 5	Laryngeal Tension 4	Imprecise Ar- ticulation 4	Long Pauses 4	High Pitch 3	Limited Pitch Variability 3	Dysfluency 2	Breathiness 2	Denasality 1	Pitch Breaks .7	Audible In- halation .7
35.00	30.80			20	20	50	30		10	20	10	10	10														10
30.00	31.15	40	20	10	20	20	10		10	10	10	30	30						10				10				
49.00	31.35	10	30	10				30	20				10	30		20	10			10					10		
56.00	31.35			10	30	20	60		10	20	10	10	10							20		10					
57.00	31.60	10	20	30				10	30			10		20		10				10					10	20	
42.00	32.65	20	30	30	10	10				10				10	20	10	20	10	10	10				10			
31.00	33.25	30	20	20	10			10	10	10			10	10		10		10		10							
40.00	33.25	20		10	10	30	10	10		30	20	20	10							10	10						
53.00	34.45	20	30	10	10			30	10		30				20	10		10				20	10				10
36.00	37.10	20		20	20	30	30		10	10	20	10	10		10		20		10		10						
41.00	37.30	10	40	10	10			30	10	10	10	10							10								
48.00	37.40	20		10	30	30		30	20	10					20		10	10		10	10						
32.00	38.20	10		20	30	10	50		20		10	10	10	10	10	10	10	10	10								
39.00	38.95	20	30	20	10			20		10	10	10	10	10	10			10	10			10					

TABLE 6
Features Indicated by Ten Trained Male Listeners
for Perceived Age Decade 40 to 50 Years

CA	XPA	Features and Incidence of Occurrence in %																											
		Low Pitch 32	Glottal Fry 20	Imprecise Articulation 20	Hoarseness 14	Moderate Rate 13	Low Volume 13	Limited Pitch Variability 12	Slow Rate 12	Laryngeal Ten- sion 10	Laryngeal Tone Focus 10	Breathiness 10	Long Pauses 10	Semantic Con- tent 10	Balanced Resonance 7	High Pitch 7	Dysfluency 6	Monotone 6	Clear Quality 4	Pitch Varia- bility 3	Prosodic Variability 3	High Volume 3	Moderate Pitch 3	Audible In- halation 2	Variable Volume 2	Denasality 2	Rapid Rate 2	Hypernasality 1	Precise Artic- ulation 1
45.00	40.35	10		10	10	10		10	10	10			10		20					10	30	10	10	10	20	10	10		
43.00	40.85	50	10	10	10	10	40	10		10		10	10		10			20		10									
46.00	41.50	10	20	30		30		20			20			30	20				10				20						
47.00	45.35	70	20		10	20	30	30	30	10	10	30	10		10														
55.00	45.95	30	40	20	40	10	10	10	10	10	20	10	10		10	10	10							10					
63.00	47.05	40	40	30	30	10	20	10		10	20	20	10	10			10												
54.00	48.05		20	30			10	10		20				30		30	30		20			10					10		
62.00	48.90	30	10	20		10	10	10	50	10			30	10	20	10	10	10	10	10		10				10			10
34.00	49.35	50	20	30	30	20		10	10	10	10	20	20				10	20											

TABLE 7

Features Indicated by Ten Trained Male Listeners
for Perceived Age Decade 50 to 60 Years

CA	XPA	Features and Incidence of Occurrence in %																						
		Imprecise Articulation 34	Breathiness 34	Hoarseness 28	Low Pitch 22	Slow Rate 22	Long Pauses 12	Low Volume 12	Laryngeal Tension 12	Laryngeal Tone Focus 10	Moderate Pitch 6	Pitch Varia- bility 4	Hypernasality 4	Semantic Con- tent 4	Dysfluency 4	Limited Pitch Variability 2	Monotone 2	Glottal Fry 2	Oral Tone Focus 2	Balanced Resonance 2	Moderate Rate 2	Clear Quality 2	Prosodic Variability 2	Audible In- halation 2
61.00	51.00	30	80	30	20	10	20	30	10	10	10				10								10	
52.00	53.00	40		30	40	10	10	20	20	10	10	10	10							10	10			
59.00	53.15	40	10	20	20	60	20		10	10		10	10	10										
65.00	53.65	20	50	50	20	20			10	10	10		10			10		10						
66.00	56.15	40	30	10	10	10	10	10	10	10		10		10			10		10		10		10	

features described, male listeners indicated moderate rate (16%), low pitch (16%) and moderate pitch (16%) as the most salient features of speech for the third perceived age decade. Further examination of the Table reveals that precise articulation (15%), pitch variability (14%), rapid rate (13%), slow rate (12%), glottal fry (11%) and clear quality (10%) were judged to be present at least ten per cent of the time.

A comparison of the data with that for the second perceived age decade shows a general change in the ranking of features. It is also observed that three features indicated for the second decade (oral tone focus, monotone and harshness) were deleted from the third decade. Five features (glottal fry, hoarseness, laryngeal tone focus, long pauses and audible inhalation) were added in the description of speech for the third perceived age decade.

Table 6 reveals that for the 28 features indicated, male listeners specified low pitch (32%) as being most characteristic of speakers in the fourth perceived age decade. Features occurring at least ten per cent of the time included glottal fry (20%), imprecise articulation (20%), hoarseness (14%), moderate rate (13%), low volume (13%), limited pitch variability (12%), slow rate (12%),

laryngeal tension (10%), laryngeal tone focus (10%) breathiness (10%), long pauses (10%) and semantic content (10%). A comparison of the data with that for the third perceived age decade shows a change in the arrangement of features. One feature which had been indicated for the third perceived age decade (pitch breaks), was deleted from the fourth decade. Two features (prosodic variability and variable volume) were added to the delineation of speech for the fourth perceived age decade.

Table 7 shows that of the 23 features of speech identified as being characteristics of the fifth perceived age decade, imprecise articulation (34%) and breathiness (34%) were judged to be most prominent. Hoarseness (28%), low pitch (22%), slow rate (22%), long pauses (12%), low volume (12%), laryngeal tension (12%) and laryngeal tone focus (10%) were noted at least ten per cent of the time.

A comparison of the data with that for the fourth perceived age decade reveals a change in the ranking of features. Five features which had been specified for the fourth perceived age decade (high pitch, high volume, variable volume, denasality and rapid rate) were deleted from the fifth decade. The addition of oral tone focus

was the only supplemental feature for the fifth perceived age decade.

In summary, there appears to be a distinct difference in the ranking and occurrence of speech features across the four perceived age decades. However, examination of the most prominent features for each decade reveals that they may be classified under the general headings of "Pitch," "Quality," "Articulation" and "Rate of Speech." From the judgments of trained male listeners, it can be inferred that these four parameters of speech serve as perceptual guidelines in the description of male speech for a given perceived age decade.

The observation that rapid rate, high pitch, precise articulation and hypernasality were good discriminators of chronological age in the second perceived age decade represents an original finding. It is plausible to conclude that rapid rate, which was the most prominent feature of speakers whose chronological age was below 30 years, is an inherent characteristic of the speech of male speakers in the age range of 25 to 29 years. However, high pitch, precise articulation and hypernasality, which were judged to be the most salient features of speech for males above 30, may be unique characteristics of the speech of these speakers. The incidence of these features was diminished in the succeeding two perceived age decades.

Tables 8 through 11 present the incidence with which trained female listeners specified features for the four perceived age decades. For comparative purposes, the chronological ages of the speakers (CA), and their mean perceived ages ($\bar{X}$ PA) as determined previously by 20 untrained female listeners, are provided. The per cent of trained female listeners who indicated the presence of features for the perceived ages within each decade is also presented.

Table 8 indicates that of the 18 features identified as being characteristic of the second perceived age decade, female listeners considered rapid rate (42%) to be the most salient. Features occurring at least ten per cent of the time included high pitch (35%), clear quality (19%), semantic content (15%) and precise articulation (11%).

Analysis of the features indicated by trained male listeners for the second perceived age decade reveals that rapid rate (36%) and high pitch (34%) were also the most prominent features specified for this period. However, the trend for these features to be good discriminators of chronological age was not as apparent for female listeners.

Table 9 shows that for the 27 features indicated, female listeners identified low pitch (31%) as being the

TABLE 8

Features Indicated by Ten Trained Female Listeners
for Perceived Age Decade 20 to 30 Years

CA	XPA	Features and Incidence of Occurrence in %																	
		Rapid Rate 42	High Pitch 35	Clear Quality 19	Semantic Con- tent 15	Precise Ar- ticulation 11	Hypernasality 9	Pitch Var- iability 9	Low Pitch 7	Vowel Inter- jections 7	High Volume 7	Laryngeal Tension 5	Low Volume 2	Moderate Pitch 2	Audible In- halation 2	Imprecise Ar- ticulation 2	Dysfluency 1	Denasality 1	Slow Rate 1
27.00	22.20	70	30	30	20	20	10						10	10					
25.00	22.65	40	20	20	10	20		10	20	20									
33.00	23.85	30	60		30	10	20	10	10					10					
26.00	24.10	70	40	10	30				10						20	10			
37.00	25.65	40	60			20	20	40	10	10	30								
38.00	28.10	20	50	30				10				20	10						
29.00	28.30	30	20	30	20	10	20	20	10		10						10	10	
28.00	29.20	40		30	10	10		30	10	30	10								

TABLE 9

Features Indicated by Ten Trained Female Listeners
for Perceived Age Decade 30 to 40 Years

CA	XPA	Features and Incidence of Occurrence in %																										
		Low Pitch 31	Precise Ar- ticulation 24	Clear Quality 17	Slow Rate 16	Moderate Rate 11	Pitch Var- iability 11	Hoarseness 11	Glottal Fry 11	Rapid Rate 8	Moderate Pitch 7	High Pitch 7	Long Pauses 7	Dysfluency 5	Moderate Volume 5	Vowel Inter- jections 4	Semantic Con- tent 3	High Volume 3	Low Volume 2	Limited Pitch Variability 2	Monotone 2	Balanced Resonance 2	Laryngeal Tension 1	Hypernasality 1	Breathiness 1	Denasality .7	Imprecise Articulation .7	Audible In- halation .7
56.00	30.35	20			10	10		30	10	30		10	10	30	10	10						10						
57.00	31.15	20	10	20	30	10		10		30				10		20				10						10		10
30.00	31.20	30	10	10	20	10	10	10	20		10							20										
42.00	31.25	30	10	20	20	30		10			10	20	10	10					10				10					
35.00	32.05	10	60	20			20			40	10	20						10		10					10			
49.00	32.90	60	20	10	30	10		10	30					10	10	10			10	10								
44.00	33.35	20	10	10	30				20	10		20	10	10										10				
31.00	34.75	40	50	40	10	30	20		10	10																		
53.00	34.90	70	10	10		10		20	20		20			10	10					10		10						
40.00	36.25	10	20	30	20	20	30				20			10		10			10				10					
41.00	39.00	40	30	30	20			20	10				20		10					20					10			
36.00	39.35	10	40	10	10	10	30	20	10	30		40	10			10	10						10					
48.00	39.50	30	40	10	20		20	10	20			10																
39.00	39.90	40	30	20	10	10	20	20				20				10		20									10	

TABLE 10
Features Indicated by Ten Trained Female Listeners
for Perceived Age Decade 40 to 50 Years

CA	XPA	Features and Incidence of Occurrence in %																					
		Low Pitch 41	Hoarseness 28	Slow Rate 21	Semantic Con- tent 10	Vowel Inter- jections 10	Glottal Fry 9	Dysfluency 9	Imprecise Ar- ticulation 9	Precise Ar- ticulation 9	Low Volume 8	High Volume 8	Moderate Rate 8	Limited Pitch Variability 8	Rapid Rate 8	Clear Quality 6	Monotone 5	Moderate Pitch 4	Hypernasality 4	High Pitch 4	Moderate Volume 3	Breathiness 1	Laryngeal Ten- sion 1
32.00	40.80	40	20			10	10	10		20	10	30			20	20		10					
45.00	41.80	20		10	20	10				10		20	10		10			10	10		10	10	
43.00	43.95	80	30	30	10	20	10			10	30			10			10						
46.00	44.25	10	30	10	10	20	10			10			20	20	10	20	20	10	10		10		
47.00	45.25	90	40	30			10		10	10	20					10	10						
62.00	47.30	60	20	50		10		20	50			10	10										
55.00	48.85	20	60	40	20	10	20	30		10			10	20					20				
54.00	49.58	10	20		20		10	10	10				10	10	20			10	10				

TABLE 11

Features Indicated by Ten Trained Female Listeners
for Perceived Age Decade 50 to 60 Years

CA	XPA	Features and Incidence of Occurrence in %																			
		Hoarseness 53	Low Pitch 31	Imprecise Articulation 18	Slow Rate 18	Low Volume 14	Long Pauses 13	Breathiness 11	Glottal Fry 11	Monotone 10	Pitch Var- iability 8	Semantic Content 6	Vowel Inter- jections 3	Audible In- halation 3	Dysfluency 3	High Pitch 3	Hypernasality 3	Laryngeal Tension 1	High Volume 1	Moderate Volume 1	Moderate Rate 1
63.00	50.30	50	30	10		10			20	20	10		10							10	
61.00	50.90	60	30	20	10	60	10	20	10	20							10			10	
34.00	53.05	60	60	10	20		20		20	10				10	10						
52.00	55.25	40	40	50	30	10	30	10	10	10			10					10	10		
65.00	56.65	70	10	10	20	20	10				10	10				10					
66.00	57.30	50	20	10	20			40	10		40	20				10					
59.00	58.00	40	30	20	30		20	10	10	10		10		10	10		10				

most prominent characteristic of speech for the third perceived age decade. Seven features (precise articulation 24%, clear quality 17%, slow rate 16%, moderate rate 11%, pitch variability 11%, hoarseness 11% and glottal fry 11%) were indicated at least ten per cent of the time.

Comparison of the data with that for the second perceived age decade reveals a change in the arrangement of features. Furthermore, the addition of nine features (moderate rate, hoarseness, glottal fry, long pauses, moderate volume, limited pitch variability, monotone, balanced resonance and breathiness) supplemented those indicated for the second perceived age decade.

Analysis of the features with those indicated by male listeners for the third perceived age decade shows a moderate change in ranking and specification of features. However, low pitch (16%), which was one of the most frequently indicated features by male listeners, was also the most salient for female listeners.

Table 10 reveals that of the 22 features of speech identified as being characteristic of the fourth perceived age decade, female listeners considered low pitch (41%) to be the most prominent. Hoarseness (28%),

slow rate (21%), semantic content (10%) and vowel interjections (10%) were specified at least ten per cent of the time.

Comparison of the data with that for the third perceived age decade shows a general change in the ranking of features. However, low pitch remained the most salient feature for both decades. Five features (pitch variability, long pauses, balanced resonance, denasality and audible inhalation) which had been indicated for the previous decade, were deleted from the fourth perceived age decade.

Collation of the features with those specified by male listeners for the fourth perceived age decade reveals that low pitch (32%) was also the most prevalent index for describing speech of that period. With the exception of this feature, an alteration in the arrangement and specification of features is noted for the fourth perceived age decade.

Table 11 shows that for the 20 features identified, female listeners considered hoarseness (53%) to be the most dominant characteristic of speech for the fifth perceived age decade. Eight features (low pitch 31%, imprecise articulation 18%, slow rate 18%, low volume 14%, long pauses 13%, breathiness 11%, glottal fry 11% and

monotone 10%) were indicated at least ten per cent of the time.

Comparison of the data with that for the fourth perceived age decade reveals an exchange in rank for the two most prominent features; low pitch and hoarseness. Further examination of the data shows a general rearrangement of features. Five features (precise articulation, limited pitch variability, rapid rate, clear quality and moderate pitch) which had been specified for the preceding decade were deleted from the fifth perceived age decade. Three features (long pauses, pitch variability and audible inhalation) were added to those indicated for the fourth perceived age decade.

Analysis of the features with those specified by male listeners for the fifth perceived age decade shows a moderate change in the arrangement of features. However, seven of the features ranked as most prominent by the male listeners were also ranked as most salient by the female listeners.

In summary, the trend noted previously for trained male listeners to differentiate between the four perceived age decades in terms of arrangement and occurrence of speech features was replicated by female listeners. Examination of the most prominent features for each decade

reveals that they may be classified according to "Pitch," "Quality" and Rate of Speech." From the judgments of trained female listeners, it can be inferred that these three parameters of speech serve as the primary perceptual bases for describing the speech of males for a given perceived age decade.

The fact that there was no trend for features to differentiate chronological age within the second perceived age decade is contrary to the findings indicated for male listeners for this period. It could be postulated that female listeners describe male speech differently because of innately different perceptual sets. The observation that the specified features were not good discriminators of chronological age may be an illustration of this difference.

Although commonalities existed in the parameter classifications of speech for male and female listeners, the latter group consistently used a lesser number of features for describing speech across the four perceived age decades. This would account for the fact that "Articulation," a salient parameter for male listeners, was not eminent for female listeners. The application of a decreased number of features by females may be a reflection of innate sex differences in identifying and

describing perceptual features of speech. It could also represent a greater degree of overlap in terminology used by the female listeners.

Table 12 presents the incidence with which the trained male and female listeners specified the same features for the 37 male speakers. For purposes of comparison, the chronological age (CA) and the grand mean perceived age ($G\bar{X}PA$) of each speaker is provided. The per cent of listeners who indicated the presence of a feature for each speaker is also presented.

Table 12 reveals that of the 25 features used by both male and female listeners to describe the speech of the 37 speakers, low pitch (23%) was used most frequently. Hoarseness (15%), rapid rate (14%), precise articulation (13%), slow rate (13%), high pitch (12%) and clear quality (11%) were specified at least ten per cent of the time.

Analysis of features by perceived age reveals that rapid rate, high pitch, precise articulation and clear quality appeared to be the best discriminators of speakers who were judged to be below 30 years. For speakers who were perceived to be between 30 and 40 years, low pitch, precise articulation, clear quality and moderate pitch appeared to be the dominant indices for describing the speech of speakers in this decade. The initial appearance

TABLE 12

Features Indicated by Ten Trained Male and Female
Listeners for 37 Male Speakers

CA	GXPA	Features and Incidence of Occurrence in %																								
		Low Pitch 23	Hoarseness 15	Rapid Rate 14	Precise Ar- tication 13	Slow Rate 13	High Pitch 12	Clear Quality 11	Imprecise Ar- tication 9	Glottal Fry 9	Pitch Var- iability 8	Moderate Rate 8	Semantic Con- tent 8	Moderate Pitch 7	Hypernasality 7	Low Volume 7	Breathiness 6	Long Pauses 5	Laryngeal Ten- sion 5	High Volume 4	Balanced Re- sonance 4	Dysfluency 4	Limited Pitch Variability 4	Monotone 3	Denasality 1	Audible In- halation 1
27.00	22.88			65	20		35	20	10		5	20	5	20	5				10			5			5	5
25.00	23.63	5		40	20		20	30				25	5	10					10	10	5	5			5	5
33.00	24.30	5		25	30		50	10		5		15		20	15									5		5
26.00	24.65			65	10		40	15	10			30		5								10			5	
37.00	26.80			20	30		60	5		25				25					20	5	5				5	
29.00	27.76	5		40	20	5	25	20		25		15	10	30					10					10		
38.00	27.95	5		15	10	5	55	35		5			5		15								5			
28.00	28.48	15		55	20		10	15		10		10	10	10	5				5	20	5					
56.00	30.85	10	15	45	15	5	15	10		10	10	5		5	5			5		5	10	20				
30.00	31.16	25	5	5	15	10		10	5	15	15	25		10	5					25	15	5				
57.00	31.38	20			5	20		10		20		10	10	30		10	5	5	5		5			5	15	5
35.00	31.43	5		35	40		10	20		5	35			20	5		5			10	5		5			5
44.00	31.56	10		15	15	25	10	10		10	5	5	5	10	30		5	5			5	10		10	5	5
42.00	31.95	30	15		10	10	5	15	5		5	25	10	20		10	5	15	10	5		5				
49.00	32.13	45	5		10	30		5		25		10	10	5		20	5	5		5	5		5			
31.00	34.00	30		5	30	10		25		10	10	30		10		5		5	5	5						
53.00	34.66	50	20		10	15		5		15		15		15	15			10	5	5	5	15				
40.00	34.75	5		5	15	15	5	30			30	20	5	15	15	5		5	5	5	10					
41.00	38.15	40	10		20	25		20	5	10		5		5	5		5			5	10	5	10			
36.00	38.23	5	15	30	30	5	25	10	5	10	30	15	15	10	15			5		5	5					
48.00	38.45	15	15		35	25	5	10		20	25	10		5				10	5							
39.00	39.43	35	15		20	15		15	10		10	15		10	5	5		10	5	15	5		5			
32.00	39.50	20	15	35	25			10	5	15	5	5	5	15	5	10			5	20	5	5				

TABLE 12 (Cont.)

CA	GXPA	Features and Incidence of Occurrence in %																								
		Low Pitch 23	Hoarseness 15	Rapid Rate 14	Precise Ar- ticulation 13	Slow Rate 13	High Pitch 12	Clear Qual- ity 11	Imprecise Ar- ticulation 9	Glottal Fry 9	Pitch Var- iability 8	Moderate Rate 8	Semantic Content 8	Moderate Pitch 7	Hypernasal- ity 7	Low Volume 7	Breathiness 6	Long Pauses 5	Laryngeal Tension 5	High Volume 4	Balanced Resonance 4	Dysfluency 4	Limited Pitch Var- iability 3	Monophony 3	Deafness 1	Audible In- halation 1
45.00	41.80	15	5	10	5	10	10		5		5	10	15	10	5				10	15					5	5
43.00	42.40	65	20		5	15			5	10	5	5	5		35	5	5	5		5		10	15			
46.00	42.86	10	15	5	5	5		15	15	15		20	20	15	5					5		10	20	10		
47.00	45.30	80	25		5	30		5	5	15		10			25	15	5	5		5		15	5			
55.00	47.40	25	50		5	25	15		10	30		10	10		5	5	5	5		5	20	15			5	
62.00	48.10	60	10		5	50	5	5	35	5	5	10	5		5	5	5	5	10	10	15	5	5	5		
63.00	48.66	35	40						20	30	5	5	5		15	10	5	5				5	15			
54.00	48.82	5	10	15			20	10	20	15		5	25		5	5			10	5	20	10				
61.00	50.95	25	45			10			25	5		5		5	5	45	50	15	5			5	10			
34.00	51.20	55	45			15			20	20		10					10	20	5		10	5	15		5	
52.00	54.13	40	40			20		5	45	5	5	5		5	5	15	5	20	10	10			5			
65.00	55.15	15	60			20	5		15		5				10	25	5	5					5			
59.00	55.58	25	30			45			30	5				10		10	10	20	5		10		5		5	
66.00	56.73	15	30			15	5		25	10	25		10		5	45	5	5		5	5				5	

of hoarseness, glottal fry, breathiness and long pauses is also recognized during this period. For speakers who were judged to be between 40 and 50 years of age, low pitch, hoarseness, imprecise articulation and moderate rate appeared to be the most representative features of their speech. The dominant features of speech for speakers perceived to be within 50 to 60 years of age appeared to be low pitch, hoarseness, slow rate, imprecise articulation, breathiness and long pauses.

In summary, examination of the most prominent features indicated by the male and female listeners as a group reveals that they may be classified according to "Pitch," "Quality," "Articulation" and "Rate of Speech." From the judgments of these listeners, it can be postulated that these four parameters of speech serve as the primary perceptual bases for describing the speech of males ranging in age from 25 to 66 years.

CHAPTER V

DISCUSSION

The main purposes of this investigation were to determine (1) if there was a significant difference in the judgments of untrained male and female listeners in identifying the age of male speakers from spontaneous conversation, (2) the perceptual features of speech that trained male and female listeners identified as being characteristic of a judged speaker's age, and (3) how trained male and female listeners ranked these perceptual features on the basis of similarity and frequency of occurrence.

This chapter presents a discussion and interpretation of the results reported in Chapter IV. Since individual summaries have been provided within Chapter IV regarding Part One and Part Two of the study, the present analysis will be devoted to a discussion of the compiled data. Experimental and theoretical information will be provided in light of the main purposes of the investigation.

Part One

The finding that there was a nonsignificant difference in the overall age judgments of untrained male and female listeners, and that female listeners were

consistently more accurate in judging age from conversational speech after the fifth decade, represent original observations. It could be postulated that within the design of the present investigation, male and female listeners use similar perceptual sets for judging age until after the fiftieth year. From this point to the beginning of the seventh decade, male perceptions of aging speech change, possibly because of egocentric involvement associated with aging. This premise is substantiated, in part, by studying those ages which reflected a significant difference in mean perceived age estimations. All were within or beyond the fifth decade and exemplified lower mean perceived age judgments on the part of the male listeners.

The trend for untrained listeners to underestimate the age of male speakers was congruent with earlier research (Shipp and Hollien, 1969). This phenomenon, which has been discussed by Shipp and Hollien, may be a reflection of the age of the listeners themselves. In both their studies, and in the present investigation, listeners did not exceed 30 years of age.

The above findings have important experimental implications for future research which utilizes untrained male listeners for making age judgments. First, in

order to either substantiate or negate the premise that listeners alter their perceptual sets when making an age judgment of someone their own sex, the present study should be replicated using female speakers. Second, listeners should be matched with speakers in terms of chronological age in order to determine if more accurate age estimations are possible when persons in both populations are the same number of years.

Part Two

For the 25 features of speech identified by trained male and female listeners as being characteristic of male speech across four perceived age decades, the finding that low pitch and hoarseness were the most reoccurring was not unexpected. Analysis of individual perceived ages reveals that 76% of the speakers were judged to be above 30 years. Examination of the third, fourth and fifth perceived age decades shows that low pitch and hoarseness initially appeared during the third decade, and were dominant features for the latter two decades.

Ptacek and Sander (1966) found through an a posteriori schema that some of the perceptual features characteristic of "old" speakers (67 to 87 years) were low pitch, hoarseness, reduced intensity, hesitancy, and less pitch variability. A comparison of these features

with those indicated in the present investigation reveals that low pitch, hoarseness, low volume (reduced intensity), dysfluency (hesitancy) and limited pitch variability (less pitch variability) were specified features for speakers whose chronological age ranged from 25 to 66 years. The majority of these speakers (86%) were below 60 years of age. Furthermore, low pitch and hoarseness, which tended to be good discriminators of speakers in the fourth and fifth perceived age decades, were identified for speakers who ranged in chronological age from 34 to 66 years ($\bar{X} = 53.71$ years). The implication is that the features indicated by Ptacek and Sander as being characteristic of "old" speakers may be, in reality, salient features of younger speakers alike.

In an investigation to determine characteristics of aging speech in males 40 to 80 years, Ryan (1972) found that men between 60 and 80 years displayed a significant decrease in reading rate when compared to those in the age range of 40 to 50 years. In terms of the present investigation, slow speaking rate was noted in the third and fourth perceived age decades, and was a prominent feature of the fifth decade. The chronological age range of the former two decades was 30 to 63 years ($\bar{X} = 45.72$ years). The chronological age range for the

fifth decade was 34 to 66 years ($\bar{X}$ = 56.16 years). Although lower ages were utilized in the present study, it would appear that the feature of slow rate is a characteristic of aging male speech for speakers younger than those used by Ryan.

Ryan and Burk (1974) observed that for reading, five perceptual features (air loss, laryngeal tension, voice tremor, imprecise consonants and slow rate of articulation) were effective predictors of perceived age of 80 male speakers 40 to 80 years of age. In the present investigation, breathiness (air loss), imprecise articulation (imprecise consonants) and slow rate (slow rate of articulation) were prominent features of the fifth perceived age decade. Laryngeal tension was indicated for all decades with the greatest incidence occurring during the fifth decade. Voice tremor was not specified as being a feature of speech for any of the speakers. It would appear that the majority of features found to be prevalent for male speakers 40 to 80 years by Ryan and Burk may also be salient for younger speakers.

The general trend to underestimate features of aging male speech in previous research may be a reflection of a number of different factors. First, Ptacek and Sander attempted to identify features in an informal manner.

This approach resulted in a compilation of perceived features, without respect to a hierarchical relationship to chronological age. Second, the three previous studies utilized speakers near or beyond the fiftieth year of life. This factor allowed for assumptions to be drawn for feature characteristics for a limited age range. Third, earlier studies used a reading stimulus rather than conversational speech for the perceptual task. This factor could have caused the observed features to be emphasized, thus dominating the perceptual reference sets of the listeners.

Although there appear to be discrepancies between the results of the present investigation and prior research, there are tangible similarities. In the present investigation, the most prominent features of speech indicated by male and female listeners were classified according to "Pitch," "Quality," "Articulation" and "Rate of Speech." Theoretically, the features specified in earlier research could also be classified according to these four parameters. The only feature which would not conform to this common classification system would be reduced intensity, identified in the study by Ptacek and Sander. In the present investigation, low volume (reduced intensity) was specified seven per cent of the

time by listeners, and was therefore not considered to be a primary feature of aging speech. In view of the fact that the majority of features identified in the present study, and those specified in earlier research can be similarly classified, the parameters of "Pitch," "Quality," "Articulation" and "Rate of Speech" could be considered the primary perceptual characteristics of aging speech.

Review of the total number of responses indicated as features by the trained listeners reveals that 101 responses ($\bar{X} = 25.25$), representing 31 overlapping features (features that occurred for more than one decade), were specified by males for the four perceived age decades. The total female responses were 87 ($\bar{X} = 21.75$), representing 26 overlapping features for the four decades. The observation that male listeners indicated more features than females, appears actually to be an illustration of greater overlap in terminology used by females rather than a difference in perceptual referents. This premise can be verified through examination of Table 12. Both male and female listeners considered rapid rate, high pitch, precise articulation and clear quality to be the most prominent features of speakers judged to be below 30 years. For speakers perceived to be between 30 and 40 years, low pitch,

precise articulation, clear quality and moderate pitch were judged by both groups to be the most salient features of speech. Both male and female listeners judged low pitch, hoarseness, imprecise articulation and moderate rate to be the dominant features for speakers perceived to be between 40 and 50 years. For speakers judged to be between 50 and 60 years of age, both groups of listeners considered low pitch, hoarseness, slow rate, imprecise articulation, breathiness and long pauses to be the most prominent features of speech.

Further substantiation of the fact that female listeners tended to group terms to a greater degree than males, can be observed through examination of two terms used by the latter group. The features oral tone focus and balanced resonance, both of which were specified by male listeners but not female listeners, may be reflecting the same concept. Cooper (1973) has described a dependent relationship between these two features; oral tone focus being contingent upon balanced resonance. It is possible, therefore, that male listeners were using two different terms to describe the same feature, that of equalized resonance between vocal tract cavities.

Discussion with male and female listeners following Part Two of the study revealed an interesting, if not

noteworthy phenomenon. Regardless of sex, listeners found that describing perceptual features of normal speech was an inordinately difficult task. The most reoccurring comment was that they had not been sufficiently trained in the normal features of speech. This finding would appear relevant for speech pathology, in that it is basically a science in which perceptual deviancy is constantly compared to perceptual "normalcy." In order to overcome the apparent lack of training in describing the features of normal speech, it is proposed that a program similar to that reported by Wilson (1971) for deviant voice, be developed. Within an a posteriori paradigm, speech pathologists could identify, label and come to a consensus of opinion regarding the features of normal speech. Such a program could theoretically generate a standardized nomenclature system for describing features of speech.

The information gleaned from the present study, and a normal feature analysis program could be useful diagnostically in differentiating normalcy from speech deviancy. Darley, Aronson and Brown (1969) reported that perceptual characteristics of physiological alterations in the speaking mechanism can be used analytically to describe neurological impairments. Through a

standardized system for describing normal features of speech, persons with speech differences due to age, dialect and the like, could be differentiated from those who have actual speech disorders.

Summary and Conclusions

The main purposes of this study were to determine (1) if there was a significant difference in the judgments of untrained male and female listeners in identifying the age of male speakers from spontaneous conversation, (2) the perceptual features of speech that trained male and female listeners identify as being characteristic of a judged speakers age, and (3) how trained male and female listeners rank these perceptual features on the basis of similarity and frequency of occurrence.

Spontaneous conversation, elicited from 46 male speakers ranging in age from 25 to 70 years, was tape recorded in a controlled recording environment. Thirty seconds of continuous speech from each speaker was provided as listening stimuli for 20 untrained male and female listeners. The listening task was to determine the exact age of the speakers from the speech samples. Those speech samples which indicated statistical agreement between the two listening groups as to

perceived age, were provided as listening stimuli for 10 trained male and female listeners.

The 37 speech samples which met statistical criterion for the untrained listeners, were presented to the trained listeners who described, through an a posteriori schema, the salient features of speech judged as being characteristic of the speaker's perceived age. The responses of the trained listeners were arranged according to similarity and frequency of occurrence. The data were also qualitatively compared to the features of speech which have been identified in previous age recognition studies.

The results of this investigation make the following conclusions tenable:

- 1) Untrained male and female listeners use similar perceptual sets in judging the age of male speakers until after the fiftieth year of life. From this period to the beginning of the seventh decade, male perceptions of aging speech change, possibly because of egocentric involvement associated with aging.
- 2) Untrained male and female listeners tend to underestimate the age of male speakers. This phenomenon may be a reflection of the age of the listeners themselves.
- 3) Trained male and female listeners view low pitch and hoarseness as being the most salient features of speech for male speakers ranging in age from 25 to 66 years. However, there are prominent features for individual perceived age decades.
- 4) The most prominent features indicated by trained male and female listeners for male speakers

could be qualitatively classified according to "Pitch," "Quality," "Articulation" and "Rate of Speech."

- 5) Trained male listeners tend to use a greater number of features in describing male speech than do trained female listeners. However, this may be a reflection of greater overlap in terminology used by females, rather than a difference in perceptual referents between the two sexes.
- 6) Trained male and female listeners tend to agree on the characteristic features of speech for a given perceived age decade.

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