EFFECTS OF PHYSIOLOGICAL AGING ON SPEAKING AND READING RATES IN TWO GROUPS OF ELDERLY FEMALES 65-91 YEARS

By

MANDIE L. ECK HARRIS

Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1994

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF ARTS
July, 1996

OKLAHOMA STATE UNIVERSITY

EFFECTS OF PHYSIOLOGICAL AGING ON SPEAKING AND READING RATES IN TWO GROUPS OF ELDERLY FEMALES 65-91 YEARS

Thesis Approved:

Nancy E. Monroe
Thesis Adviser

Arthur L Peavy

Ben Jacobson

Thomas C. Collins
Dean of the Graduate College

PREFACE

The following investigation focuses on the effects of physiological aging on speaking and reading rates in 37 elderly females.

I would like to express my sincere appreciation to the members of my committee, Dr. Nancy Monroe, Dr. Arthur Pentz, and Dr. Bert Jacobson, whose guidance, assistance, and encouragement were invaluable to the development and completion of this study. A special thanks goes to Dr. Monroe for chairing the committee and providing continued support and constructive guidance throughout this project.

I also wish to express my appreciation to colleagues, Boo Collier, Vicki Brazeal, and Melissa Bingham, for giving of their own time and energy to assist with my research. I wish to thank the Department of Communication Sciences and Disorders for supporting me during these two years of study.

Finally, a very special expression of gratitude goes to my parents, James and Peggy Eck, my sister, Roxanne Warlick, my husband, Chris Harris, and other family and friends who have continued to support me throughout my education and career development.

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

CHAPTER I

INTRODUCTION

The population profile of today's society is in the midst of rapid changes. Dramatic demographic shifts are predicted that will alter the overall makeup of the American population. In 1990, the U.S. population was comprised of more than 12% of individuals who were over the age of 65. That population continues to grow rapidly and may reach 22% of the population by the year 2040, with the largest increases among the oldest old (Statistical Abstracts of the United States, 1992). The "oldest old," those 85 and older, is the fastest growing segment of the population, by both numbers and by percentages. It is predicted that they will represent 3.7% of the population by 2040 (Brock, Guralnik, & Brody, 1990). Such abrupt changes in the number of older adults will create a demand for services from health care providers.

Those population trends should be of concern for those working with older, communicatively impaired adults. Current figures indicate approximately 20% of communicatively impaired individuals are over the age of sixty-five. It is estimated that by the year 2050, 39% of those individuals will be elderly (Fein, 1983). Anticipation of a population comprised of more elderly implies an urgent need for more studies in the area of normal aging processes, and how these processes produce changes in communication behaviors.

A dimension of the oral speech process which has received considerable research attention is rate of speaking. Several studies have shown that rate of speaking decreases with age (Mysak, 1959; Mysak & Hanley, 1959; Ryan, 1972; Ryan & Capadano, 1972; Hartman & Danhauer, 1976). The Mysak & Hanley (1959) study compared older males to younger males on several vocal variables including speech rate. The sample was composed of three groups of twelve men ages 30-62 (mean age of 47.9 years), ages 65-79 (mean age of 73.3 years), and ages 80-92 (mean age of 85.0 years). Speech samples were obtained through oral reading and impromptu or conversational speaking tasks. The first paragraph of the "Rainbow Passage" (Fairbanks, 1960) was used to provide an oral reading sample, and the topic "What I Like To Do Most in the Summertime" was used for the impromptu speaking task. Each task was tape recorded, and the number of words per minute was calculated.

Oral reading results revealed a gradual slowing in rate as group mean age increased. The younger males (x=47.9 years) had a mean speaking rate of 172.2 words per minute (wpm), followed by 138.3 and 123.8 wpm respectively for the two elderly groups. Impromptu speaking rates were slower overall, with the younger males averaging 122.4 wpm, and the elder groups averaging 136.9 and 128.5 respectively. There appears to exist a reverse relationship within the eldest group in which the average words per minute for oral reading was slightly slower than the impromptu speaking rate. The researchers attribute the reversal to reading and attention problems that may have occurred as a result of advancing age (Mysak & Hanley, 1959). Mysak & Hanley (1959) view the findings of a general reduction in rate with age from a physiological standpoint attributing progressive decline to neuromuscular "slowing" whereby fewer

words are produced per minute and pausal lengths are increased (Mysak & Hanley, 1959).

Ryan (1972) studied speaking rate in four groups of twenty males each ranging in age from 40 to 80 years (40-49, 50-59, 60-69, 70-79). The first paragraph of Fairbanks' (1960) "Rainbow Passage" was used to measure oral reading rates. Impromptu or conversational speaking was sampled from a 30 second segment on a topic of the subject's choice. For each group, the mean and standard deviation of average words per minute and words per minute per sentence were calculated. Although Ryan's (1972) results seemed to reveal a decrease in impromptu speaking rates with age, results were not found to be statistically significant. Oral reading rates compared across the groups were generally found to decrease as a function of age. Significantly slower rates were found in the group of oldest-aged subjects (70-79 years) when compared to the other three groups of subjects on both tasks, while the 60-69 year group was only significantly slower than the 40-49 year group

Oyer & Deal (1985) studied oral reading rates in twenty-four subjects ranging in age from 44 years to 82 years to determine if age or gender was a significant factor. Subjects were instructed to read the 132-word paragraph "My Grandfather". Total reading times in seconds revealed significant differences between the older group (subjects over age 61 years) and the younger group. No significant differences were found which related to gender (Oyer & Deal, 1985).

Duchin & Mysak (1987) investigated rate differences among young adult, middle-aged, and older groups of males ages 21-91 on three separate speech tasks. Five groups containing 15 male subjects each comprised the sample with mean ages of 25

(21-30 years), 49 (45-54 years), 60 (55-64 years), 68 (65-74 years), and 80 (75-91 years), respectively. The first paragraph of the "Rainbow Passage" (Fairbanks, 1960) was used to measure oral reading rates. Speech samples for the picture description task were elicited using three Norman Rockwell pictures, and conversational speech was sampled by the researcher asking the subject to talk about some of his favorite summertime activities or about his occupation, prior job, or family to obtain at least a ten minute sample. Speaking samples were recorded, and both syllables per second and words per minute were calculated for each group on each speaking task.

Results revealed significant differences in speaking rate for all tasks (oral reading, conversation, and picture description) as well as between age groups. Younger subjects generally spoke faster than older, and middle-aged subjects spoke faster than older subjects. Regardless of age, speaking rate decreased significantly with the oral reading task eliciting the fastest rates followed by conversation then picture description (Duchin & Mysak, 1987).

A study by Shewan and Henderson (1988) investigated elder speaking rates on a picture description task. Subjects in the study included four groups of adults ages 40-79 years (40-49, 50-59, 60-69, and 70-79). Spontaneous language samples were elicited for each subject using the stimulus picture from the Minnesota Test for Differential Diagnosis of Aphasia. Speaking samples were recorded, and rate in syllables per minute was calculated.

Speaking rate was found to decrease with age, but the differences between age groups were not found to be statistically significant. The disagreement between these findings and other general findings concerning elder speaking rates led the authors to

conclude that the different speaking tasks used in various studies may be the reason for varying results. Picture description was thought to be "more resistant to rate alterations" than the other tasks (Shewan & Henderson, 1988).

Ramig (1983) attempted to relate the effects of physiological condition to adult reading and speaking rates. Forty-eight male subjects representing two levels of physiological condition ("good" and "poor") were grouped into three chronological age groups (25-35, 45-55, and 65-75 years). Oral reading rate was assessed by having each subject read the "Rainbow Passage" (Fairbanks, 1960), and conversational speech was assessed by measuring 30 seconds of spontaneous speech in response to a picture stimulus. Speaking samples were recorded and rated in syllables per second was calculated with and without intersentence pause time.

The results supported previous suggestions of a decline in speaking and reading rates with advancing chronological age. Ramig (1983) found that the older subjects had significantly slower speaking and reading rates than the younger subjects. No statistically significant differences were found between physiological condition and either rate measure, although the differences between the groups were visually apparent when comparing the means. A greater decrease in rate was observed in those subjects in "poor" physiological condition (Ramig, 1983). The findings of the study suggest that more than just chronological age should be considered in the analysis of speech characteristics. The data imply that although individuals may be chronologically 'old', physiologically they may appear to be younger; therefore, physiological condition may be reflected in speech characteristics.

Harvey (1990) investigated speaking and reading rates of elderly females during oral reading and impromptu speaking. Thirty-six females participated in the study, ranging in age from 50-96 years. Subjects were divided into three groups of 12 subjects each ranging in age from 50-61 years, with a mean age of 56.9 years (Group I), 65-75 years, with a mean age of 69.1 years (Group II), and 80-96 Years, with a mean age of 86.5 years (Group III). The "Rainbow Passage" (Fairbanks, 1960) was used for the oral reading task, and Norman Rockwell pictures were used to elicit impromptu speech. Speaking samples were recorded and words per minute including pause time and words per minute without pause time were calculated.

Significant differences were found for speech rate across the groups for age and task. Findings revealed a general slowing in rate with age during oral reading. The mean speaking rates during conversational speech for the three groups were unexpected. Group II (65-75) had the fastest rate, Group I (50-64) was next, and Group III (80-96) was the slowest. The author attributed the findings to subject selection criteria which may have resulted in a sample groups with above average health status and similar educational levels (Harvey, 1990).

In summary, research has reported that speaking and reading rates appear to be affected by the aging process. Although studies investigating rate of speaking and oral reading have utilized different speech tasks, the studies have been limited to samples of subjects who are male and who are below the age of 60. Predicted demographic changes provide a need for a normative database that includes older female subjects. Therefore, this study will attempt to supplement the present normative database by investigating the rate of speech in elderly females.

Research in the field of speech pathology has traditionally used chronological age as its index of aging for normative data. Because individuals do not age physiologically at the same rate and much intersubject variability can occur within chronological age groupings, alternative indices for measuring the aging process have been suggested. Indices such as biological age, physiological age, and physiological condition have been among those suggested to be more accurate than chronological age (Morgan, 1969; Bourliere, 1970; Timiras, 1972). Physiological condition will also be explored in the present study in order to strengthen the overall understanding of the influences of health and aging on speech.

Reading and speaking rates are known to be affected by the aging process, and rate changes are often characteristic of communication disorders that affect the elderly population. Further investigation of differential aging on the temporal characteristic of speech may provide data to aid in differentiating normal speech from abnormal neuromotor disorders in the older population. Data from this study coupled with data from other studies that have included the factor of physiological aging would provide a valid normative data base to make these diagnostic decisions. Thus, the purpose of this investigation was to attempt to determine the effects of physiological condition ("good" and "poor") to the speech rate of two groups of elderly females (65-75 and 80+ yrs) during oral reading and spontaneous speech. It was hypothesized that there would be no differences in speaking and reading rates in two groups of elderly females (65-75 and 80+ yrs) in good or poor physiological condition.

CHAPTER I I

METHODS

Subjects

Approximately forty volunteer subjects were initially sought from community organizations in Stillwater, Oklahoma. Females in the age ranges of 65-75 years and 80 years plus who were living independently participated in this study. Participants ranged in age from 65-75 years with a mean age of 70.2 years, and from 80-91 years with a mean age 83.5 years. Eighteen subjects comprised the Young-Old group and 17 subjects comprised the Old group.

All subjects met the following criteria: First subjects had to be living independently. Second, each demonstrated speech that was free of any observable disorder; had no formal voice or speech training; and had reported no previous or existing pathological condition known to be associated with speech disorders. Each subject passed a hearing screening, and each subject met the criterion of a pure tone three-frequency average of 45 dB (ANSI, 1969) or better in the better ear. Individuals fitted with amplification were included in the study, but were not administered the hearing screening. An interview was conducted with each participant to gather information regarding selection criteria as well as information regarding

educational level, residential setting, employment history, current medications, and alcohol and tobacco use (See Appendix A for interview questionnaire).

Procedure

Subjects were either assessed in their homes, the OSU Speech-Language-Hearing Clinic, or in a community center. Investigators were graduate students in speech-language pathology. Examiners measuring physiological condition were trained by a doctoral student in the area of health promotion. Each subject was orally briefed about the purpose of the study and were required to sign an informed consent document approved by the Oklahoma State University Institutional Review Board prior to any testing. Subjects were assessed individually, and attempts were made to eliminate any sources of extraneous noise.

After the examiner completed the interview, subjects who did not have hearing aids were administered a hearing screening using a GSI 17 portable audiometer. Five subjects with mono- or binaural hearing aids were included in this study. Hearing of those subjects fitted with amplification was screened during one-on-one conversation with the examiner. All were judged to have hearing within functional limits. General speech behavior was screened during spontaneous conversation with the subject (See Appendix A for sample data sheet).

After each subject rested for three minutes, the physiologic assessment procedures were initiated. Resting heart rate and systolic and diastolic blood pressure were measured by the examiner while the subject was seated. Resting heart rate was measured by the examiner placing two fingers on the inside of the subject's radial artery. Heart rate in

beats per minute (bpm) was calculated by counting the subject's pulse for ten seconds and multiplying that number by six (Hoeger & Hoeger, 1992).

Systolic and diastolic blood pressure were measured using a sphygmomanometer and a stethoscope. The subject was seated, with the forearm and manometer at the same level as the heart. The arm was slightly flexed and placed on a flat surface. The cuff was positioned approximately one inch above the natural crease of the elbow. The center of the cuff was aligned with the middle of the arm. The head of the stethoscope was placed over the brachial artery in the crease of the elbow (antecubital space). The examiner then inflated the cuff while feeling for the radial pulse until it measured 30 to 40 mmHg per second. Systolic blood pressure was determined from the point where the initial pulse sound was heard. Diastolic blood pressure was determined from the point where the sound disappeared (Hoeger & Hoeger, 1992).

Forced vital capacity was measured using a Propper compact spirometer. To allow maximum expansion of the respiratory system and to facilitate maximal capacity and output, this procedure was carried out with the subject in a standing position. Subjects were instructed to take in a deep breath then to exhale for as long and as hard as they could. This procedure was repeated three times with rests between, and the three trials were averaged.

Body composition (percent body fat) was determined from four separate skin-fold measurements. The anatomical sites included were the triceps (arm), suprailium (hip), midthigh, and umbilicus (abdomen). All measurements were taken on the right side of the body with the subject standing. Using Lange skinfold calipers, each site was measured by the examiner grasping a double thickness of skin firmly with the thumb and forefinger,

pulling the fold slightly away from the muscular tissue. The calipers were held in a perpendicular position to the fold, and the measurement was taken one-fourth inch below the finger hold. Measurements were repeated three times by the same examiner using the same calipers (Hoeger & Hoeger, 1992). The averages from each site were summed and converted to a percent body fat estimate (Golding, Myers, & Sinning, 1989).

Speaking Samples

Each subject was asked to orally read the "Rainbow Passage", and each speaker was asked to respond spontaneously to picture stimuli. Large print copies of Fairbanks' "Rainbow Passage" (1960) (see Appendix B for text of this passage) were provided to each subject. Each subject was then given the following oral instructions: "Read this passage silently and familiarize yourself with the words. I cannot help you with any words." After reviewing the passage, subjects were then instructed in the following manner: "When I say 'go', read the passage outloud at your normal speaking rate." The entire passage was used for rate analysis.

Story pictures similar to Norman Rockwell pictures were presented randomly to each subject to elicit at least a three minute sample of spontaneous speech. The subjects were instructed to "Look at the picture and tell me all you can about it. Tell me what you see and what you think is happening." The first two minutes of each sample were used for analysis. Tasks were randomly assigned to each subject. A Nagra reel to reel tape recorder, high quality reel-to-reel tapes, and an appropriate microphone were used to record each subject's speech samples.

Rate in Oral Reading

Two rate measures were calculated for each reading sample: (1) syllables per minute including intersentence pause time and (2) syllables per minute without intersentence pause time (Ramig, 1983). Syllables per minute with intersentence pause time was determined by the examiner timing the passage using a stopwatch. Syllables per minute with intersentence pause time was determined by dividing the total number of syllables in the passage, 331, by the total speaking time. Intersentence pause times were determined by displaying segments of the Rainbow Passage on a Kay CSL 4300 spectrum analyzer. Pauses were measured in seconds and recorded. The pause times were totaled, multiplied by 60, then subtracted from the subject's overall speaking rate. The number of syllables spoken was divided by this difference to determine syllables per minute without intersentence pause time.

Rate in Spontaneous Speech

Syllables per minute with intersentence pause time for the spontaneous speaking sample was determined by counting the number of syllables uttered in the first two minutes of the sample and dividing that number by two minutes.

The spectrum analyzer was also utilized to measure rate without intersentence pause time during the spontaneous speaking samples. The speaking time for every utterance in the first two minutes of the sample was measured in seconds. These measurements were totaled to determine total speaking time without intersentence pauses.

Syllables per minute without intersentence pause time was then calculated by dividing the number of syllables uttered by the total speaking time and multiplying by 60.

Physiological Condition Classification

Normative data for resting heart rate, resting systolic and diastolic blood pressure, forced vital capacity, and percent body fat were used to establish specific criteria to allow for categorization into good and poor health groups (Kory & Smith, 1960; Golding, Myers, & Sinning, 1989; Williams, 1993) (See Appendix C for criteria). If a subject exhibited two out of three health criteria (systolic and diastolic blood pressure combined, percent body fat, and vital capacity) at or below the established criterion levels, then the subject was placed in a "good" physiological condition group. If a subject exhibited two out of three health criteria at or above the established criterion levels, then the subject was placed in a "poor" physiological condition group. Resting heart rate was not found to differentiate between the groups; therefore, it was not used in the final determination of condition group. A summary of the health status of the subjects is presented in Table I.

Eighteen subjects comprised the 65-75 year Young-Old group, and 17 subjects comprised the 80+ Old group. The Young-Old, Good Condition group (YOGC) was comprised of ten subjects. Eight subjects were determined to be in poor physiological condition in the Young-Old age group (YOPC). In the Old age group, eight subjects were determined to be in good physiological condition (OGC), and nine were determined to be in poor physiological condition (OFC). It must be noted that the use of the terms "good" and "poor" in this study are relative terms.

Table 1

Mean Values and Associated Ranges of Measures of Physiological Condition

Groups		Age	Resting Heart Rate (bpm)	Systolic Blood Pressure (mmHg)	Diastolic Blood Pressure (mmHg)	% Body Fat	Forced Vital Capacity (cc)
Young-Old Good Condition (N=10)	Mean	69.3	78	126.4	76.1	30.8	1910.1
	Range	65-74	66-90	115-140	62-90	21.9-37.2	0-2767
Young-Old Poor Condition (N=8)	Mean	71.3	72	146.8	76.3	35.6	1754.1
	Range	67-75	66-78	130-160	66-86	26.4-45.4	0-2400
Old Good Condition (N=8)	Mean	82.9	70	133.0	74.0	30.0	1483.4
	Range	80-87	52-78	115-150	60-86	26.4-34.5	0-2433
Old Poor Condition (N=9)	Mean	84.0	62	147.4	73.2	31.1	505.4
	Range	80-91	48-72	130-160	58-85	13.0-38.0	0-1233

Reliability

Interjudge reliability in determining intersentence pause times for the oral reading sample was determined. An independent observer, who was a graduate student in speech-language pathology, repeated the analysis procedures for one tenth of the subjects. The Pearson product moment correlation coefficient was calculated using independent observer and examiner measures. The Pearson product moment correlation coefficient was .955 for intersentence pause times during oral reading.

Intrajudge reliability was determined by the examiner re-evaluating one tenth of the subjects. Pearson produce moment correlation coefficients were calculated with the examiner's initial measurements. The Pearson product moment correlation was .907 for intersentence pause times during oral reading.

Total reading time was also measured by the examiner and an independent observer for 10% of the subjects. The differences between the two judges ranged from 1.00 to 1.81 seconds. The differences between examiners were so small that a Pearson of 1.0 was obtained using the SYSTAT software package. The correlation results presented indicate that both inter- and intra-judge measures were highly reliable for task measurements.

Statistical Analysis

Group speaking rates were compared using three-way mixed analysis of variance procedures (ANOVA). The age group was an independent (grouping) variable with

two levels, younger and older. The health status was a second grouping variable with two levels. The spontaneous speaking and oral reading rates constituted two levels of a dependent, repeated measure.

CHAPTER I I I

RESULTS

Table 2 represents the results of analyses of variances (ANOVA) comparing oral reading and spontaneous speaking rate across physiological condition and age. There were no statistically significant differences for physiological condition and oral reading with or without intersentence pause time. Significance was not reached for physiological condition and spontaneous speaking including intersentence pause time ($F=.713$; $df=3$; $p>.05$) or without intersentence pause times ($F=.324$; $df=3$; $p>.05$).

Statistical significance was reached between oral reading rate including intersentence pause time and chronological age ($F=4.352$; $df=1$; $p<.05$). However, spontaneous speaking rates both with and without intersentence pause time, did not differ significantly between chronological age groups.

Oral reading and spontaneous speaking rates, with and without intersentence pause time, for individual subjects are presented by physiological condition group in Appendix D. Mean values and associated standard deviations for speaking and reading rates were calculated for each physiological condition group by task. The results are shown in Table 3.

Table 2

Analysis of Variance (ANOVA) for Oral Reading and Spontaneous Speaking Rate Measures by Physiological Condition and Age

Source	Sum of Squares	df	Mean Square	F	Probability
Oral Reading Rate Including Intersentence Pause Time					
1. Condition	1694.078	3	564.693	1.609	0.208
Error	10526.554	30	350.885		
2. Age	1463.069	1	1463.069	4.352	0.045
Error	10757.563	32	336.174		
Oral Reading Without Intersentence Pause Time					
1. Condition	1390.903	3	463.634	1.096	0.366
Error	12694.862	30	423.162		
Spontaneous Speaking Rate Including Intersentence Pause Time					
1. Condition	2026.128	3	675.376	0.713	0.552
Error	29354.343	31	946.914		
2. Age	1032.582	1	1032.582	1.123	0.297
Error	30347.890	33	919.633		
Spontaneous Speaking Rate Without Intersentence Pause Time					
1. Condition	.319	3	.106	0.324	0.808
Error	10.184	31	.329		
2. Age	1212.85	1	1212.85	3.015	0.092
Error	12872.915	32	402.279		

Table 3

Mean Values and Associated Standard Deviations of Rate in Syllables per Minute by Physiological Condition and Task

Groups		Oral Reading		Spontaneous Reading	
		Reading Rate Including Intersentence Pause Time	Reading Rate Without Intersentence Pause Time	Speaking Rate Including Intersentence Pause Time	Speaking Rate Without Intersentence Pause Time
Young-Old (65-75) Good Condition (N=10)	Mean	166.035	153.856	131.3	194.918
	SD	(15.918)	(17.250)	(30.815)	(28.460)
Young-Old Poor Condition (N=8)	Mean	160.479	148.411	139.063	206.108
	SD	(21.598)	(24.531)	(31.910)	(34.186)
Old (80+) Good Condition (N=8)	Mean	153.169	141.398	130.813	195.631
	SD	(14.615)	(15.997)	(32.694)	(39.553)
Old Poor Condition (N=9)	Mean	148.288	137.970	117.722	190.008
	SD	(21.504)	(23.100)	(27.834)	(35.779)

Rate in Oral Reading

The mean rate including intersentence pause time for the Young-Old Good Condition (YOGC) group was 166.0 syllables per minute; Young-Old Poor Condition (YOPC) group was 160.5. Old-Good Condition (OGC) group was 153.2; and the Old-Poor Condition (OPC) was 148.3 as shown in Table 3. The mean rate without intersentence pause time was 153.86 syllables per minute for the YOGC group; 148.41 for the YOPC group; 141.4 for the OGC; and 137.97 for the OPC group.

Rate in Spontaneous Speech

During spontaneous speech, the mean rates including intersentence pause time are as follows: YOGC, 131.3 syllables per minute; YOPC, 139.1; OGC, 130.8; and OPC, 117.7. The mean spontaneous speaking rates without intersentence pause times for the YOGC was 194.92 syllables per minute; YOPC group was 206.11; OGC group was 195.63; and OPC was 190.0.

CHAPTER I V

DISCUSSION

The purpose of the present study was to investigate the relationship between relative physiological condition ("good" and "poor") and reading and speaking rates of two groups of elderly females (65-75 and 80+) using two measures of rate as suggested by Ramig (1983). One measure included intersentence pause time, and one measure excluded intersentence pause time. The present results support previous findings of reductions in reading and speaking rates with advancing chronological age (Mysak & Hanley, 1959; Ryan, 1972; Duchin & Mysak, 1987; Harvey, 1990). Old subjects (80+) orally read significantly slower than their Young-Old (65-75 yrs) counterparts. A similar trend was found during the analysis of spontaneous speaking rate (including intersentence pause time) and chronological age, but not to a level of statistical significance.

With regards to the physiological condition of the subjects, the null hypothesis was not rejected. Significant differences were not found when comparing the two age groups on the basis of "good" or "poor" physiological condition. However, oral reading rates, both with and without intersentence pause time, showed a steady decline in relation to health status across the groups. Inspection of the standard deviations for both rate measures also revealed a difference in variability. Those subjects in poor

condition (YOPC, OPC) demonstrated a larger range than the subjects in good condition (see Table 3).

Spontaneous speaking rate comparisons between the two age groups in good physiological condition (YOGC and OGC) are roughly equal. However, these same comparisons between the groups in poor physiological condition (YOPC and OPC) demonstrate more visible differences, especially when intersentence pause time is included.

Previous research has provided support to the idea that intersentence pause time, the time between sentence segments, increases as the aging process progresses. Some researchers would expect that total pause time varies directly with the aging process (Ramig, 1983). A speaker could conceivably have a normal rate of speaking if intersentence pause time was excluded from the groups of utterances and have an abnormally slow rate if intersentence pause time was included in the overall sample length. The present study demonstrated that intersentence pause time may be a more significant factor for groups in poor physiological condition than for groups in good physiological condition.

The results of this investigation are in general agreement with the results of earlier rate studies in that rate of speaking does appear to decline with increasing age (Mysak & Hanley, 1959; Ryan, 1972; Duchin & Mysak, 1987; Harvey, 1990). In the present study, oral reading and spontaneous speaking rates showed a gradual decline overall regardless of health status. Spontaneous speaking rates including intersentence pause time were generally slower than oral reading rates regardless of age or health

status, which is a consistent finding with previous research (Mysak & Hanley, 1959; Ryan, 1972; Ramig, 1983; Duchin & Mysak, 1987; Harvey, 1990).

A significantly reduced spontaneous speaking rate between the age groups as reported by Ramig (1983), Duchin & Mysak (1987), and Harvey (1990) was not observed in the present study. However, other rate studies have found results similar to those of this study. Ryan (1972), Yorkston and Beukelman (1980), and Shewan and Henderson (1988) did not find significant differences between age and spontaneous speaking rate. The consistency of these findings support the possibility that picture description is less likely to be affected by changes in rate than other types of speaking tasks (Shewan & Henderson, 1988). Different findings by researchers might be due to variability in age distribution between the subject pools of the studies. Another implication here is that overall rate, in general, may not be a significant differentiator of the finer changes that occur with the aging process. The need for the development of more sensitive measures such as consonant and vowel durations and voice onset time are indicated and should be the focus of future research in this area.

The findings from the present study relative to health status is in general agreement with previous research as well. Ramig (1983) did not find significant differences for oral reading or spontaneous speaking rates (both with and without intersentence pause time) for chronological age by physiological condition interactions. In a different study, Ramig and Ringel (1983) did not find significant differences when investigating the relationship between relative health status and selected acoustic characteristics of voice. Ramig (1983, 1986) claims that her findings are sufficient evidence to support using differential physiological aging in addition to chronological

age for classifying normative data on aging. However, the consistency in the results from this study, and in addition to Ramig's own findings, suggest that health is not a factor in age-related rate changes, or that the health measures being utilized are not able to clearly differentiate the groups.

The failure to reject the null hypothesis in this study may be due in part to several variable factors. Subject selection procedures may have elicited subjects who were more homogeneous than heterogeneous. Groups of elderly women were asked to voluntarily participate; volunteers are inherently different from randomly selected subjects. The self-selected nature of the cohort may have produced a group of subjects in better health than is typical of the population. Eighty-six percent of the subjects in this sample had at least completed high school and had earned some college hours. Sixty percent had earned a college degree at some level. Because the majority of the sample in this study were educated beyond the high school level, this suggests that the socioeconomic status of the sample may have also been higher than the general population.

These factors lead to another particular problem in research with older adults. Studies of normal communicative behavior may be biased because of the use of volunteers who represent a more affluent, educated, and articulate subgroup of the elderly. As a result, these volunteers might have also been more concerned about their health status than an individual with less education or lower socioeconomic status and might take advantage of preventative health measures more than the typical population. The community from which the subjects of the present study were sampled was a college community, and 49% of the participants were retired faculty. Therefore, a potential bias

does exist with the data from this study due to subject selection procedures which may have restricted the sample to a relatively educated, healthy subgroup of the elderly population.

Limited measures of health status may have also contributed to a lack of significant differences. There were inherent shortcomings in the four health measures used in this study for predicting "good" or "poor" physiological condition, such as their unestablished validity and measurement error (Ramig & Ringel, 1983). For example, average resting heart rate of older adults does not differ significantly from those of young adults. With regard to blood pressure, at least 40% of the 65+ population are hypertensive (Spirduso, 1995). Blood pressure is also highly variable, depending upon the examiner, the time of the day it is measured, and the potential for "white coat" phenomenon. The reliability of body fat measurements is also dependent upon examiner training and experience and the type of body composition measurement employed. While these variables are included in most heath related screenings they may not represent the most definitive measures.

Additional physical fitness measures that are more discriminatory should be incorporated into the present battery of physical health measures. One such measure is maximal oxygen uptake (VO2max) during a graded exercise stress test. VO2max can be determined using an incremental bicycle ergometer protocol modified for elderly adults or by open-circuit spirometry (American College of Sports Medicine [ACSM], 1991; Stone, 1987). Although the risks of submaximal physical fitness testing are minimal, a pre-participating health screening using a self-administered questionnaire such as the *Physical Activity Readiness Questionnaire* (PAR-Q) could be utilized to screen potential

subjects prior to exercise testing (ACSM, 1991). However, the difficulty of performing submaximal physical fitness testing with the "older" elderly (80+) is of concern. Undertaking such measures would require the approval or presence of a physician or trained professionals who are authorized and qualified to deliver emergency care and advanced cardiac life support.

A larger number of subjects in each age group might have increased the probability of better representing the elderly population. A sample size of 7-10 subjects per condition group in the present study is considered small. As a result, the subjects in this study may not have accurately represented the upper and lower ranges of physical condition in the age groups investigated. A more randomized sample that incorporates the suggested fitness measures above, under the same test conditions, might result in a more heterogenous sample that is better representative of the health status of normal, older adults.

The present study added important information to our knowledge about speaking rate in older persons, particularly in the older age category (80+). The data contribute to the development of speech rate guide lines for older adults that can be used by the clinician during evaluations. Data from this study can be combined with data from previous rate studies to help the clinician determine whether discourse performance is "normal" or is a symptom of disordered communication. When including intersentence pause time, an expected range for rate of speaking during oral reading for 65-80 year olds is approximately 138-182 words or syllables per minute, and 123-167 words or syllables per minute for adults over the age of 80 years. When intersentence pause time is excluded, one might expect oral reading rate to range from 151-238 words or syllables

per minute for those 65-75 years of age. An expected range for adults over the age of 80 is 139-165 words or syllables per minute. Spontaneous speaking rate has not been found to vary significantly in older adults (Ryan, 1972; Yorkston & Beukelman, 1980; Shewan and Henderson, 1988); therefore, an expected range for rate during spontaneous speech for adults 65 years and older is approximately 115-135 words or syllables per minute. Without intersentence pause time, 165-202 words or syllables per minute can be expected for adults over 65 years. Clinical decisions must be made with caution, however, whenever applying normative data to the older population. Clinicians who deal with communication disorders must consider the fact that the "pool" of normative data on older adults is multifaceted and reflects the heterogeneity of the process of aging. Therefore, clinicians must probe patient performance over time to obtain a more accurate picture of a patient's communication characteristics.

In conclusion, the present study showed no significant differences in speaking rate for subjects 65-75 and 80 or older when subjects in good and poor physiological condition were compared. Differences were not significant in reading tasks or spontaneous speaking tasks. When the age factor alone was analyzed a significant difference in reading rate with intersentence pause time was observed between the young and old subjects (65 to 75) and old subjects (80 and older). Age comparisons on other tasks did not reach significance. However, reading rates decreased with age.

The present study has strengthened the current normative database regarding rate characteristics in the older population. There is still a need however for continued research on how aging effects communication in the oldest-old (80+). The findings of the present study also indicate a need for the development of more sensitive measures of

age- and health-related changes that are reflected in speech characteristics. It is only through continued research of the aging process that communication specialists will better be able to differentiate both normal aging and disease processes.

REFERENCES

American College of Sports Medicine. (1991). Guidelines for exercise testing and prescription. (4th ed). Philadelphia, PA: Lea and Febiger.

American National Standards Institute. (1969). Specifications for audiometers. S3. 6-1969. New York, NY: American National Standards Institute.

Bourliere, F. (1970). The assessment of biological age in man. Geneva: World Health Organization.

Brock, D. B., Guralnik, J. M., & Brody, J. A. (1990). Demography and epidemiology of aging in the United States. In E.L. Schneider & J.W. Rowe (Eds.). Handbook of the biology of aging. (3rd ed.). San Diego, CA: Academic Press.

Duchin, S. W., & Mysak, E. D. (1987). Disfluency and rate characteristics of young adult, middle-aged, and older males. Journal of Communication Disorders, 20, 245-257.

Fairbanks, G. (1960). Voice and articulation drillbook. (2nd ed.), New York, NY: Harpers & Brothers Publishers.

Fein, D. J. (1983). The prevalance of speech and language impairments. American Speech Language and Hearing Association, 25, 37.

Golding, L. A., Myers, C. R., & Sinning, W. E. (Eds.). (1989). Y's way to physical fitness. (3rd ed.). Champaign, IL: Human Kinetics Publishers.

Hartman, D., & Danhauer, J. (1976). Perceptual features of speech for males in four perceived age decades. Journal of the Acoustical Society of America, 59, 713-715.

Harvey, M. (1990). Analysis of speaking rate and disfluency measures in three groups of females 50-96 years. Unpublished Masters Thesis, Oklahoma State University.

Hoeger, W. & Hoeger, S. (1992). Lifetime physical fitness and wellness: A personalized program. (3rd Ed). Englewood Cliffs, NJ: Morton Publishing Company.

Kory & Smith. (1960). Clinical cardiopulmonary physiology. (2nd ed.). New York, NY: Grune & Stratton.

Morgan, R. (1969). Are you older than you think? Science Digest, 8, 20-21.

Mysak, E.D. (1959). Pitch and duration characteristics of older males. Journal of Speech and Hearing Research, 2, 46-54.

Mysak, E., & Hanley, T. (1959). Vocal aging. Geriatrics, 14, 652-656.

Oyer, A. J., & Deal, L.V. (1985). Temporal aspects of speech and the aging process. Folia Phoniatricia, 37, 109-112.

Ramig, L. A. (1983). Effects of physiological aging on speaking and reading rates. Journal of Communication Disorders, 16, 217-226.

Ramig, L. A. (1986). Aging speech: Physiological and sociological aspects. Language and Communication, 6, 25-34.

Ramig, L. A., & Ringel, R. (1983). Effect of physiological aging on select acoustic characteristics of voice. Journal of Speech and Hearing Research, 26, 22-50.

Ryan, W. J. (1972). Acoustic aspects of the aging voice. Journal of Gerontology, 27, 265-268.

Ryan, W., & Capadano, N. (1978). Age perceptions and evaluative reactions toward adult speakers. Journal of Gerontology, 33, 98-102.

Shewan, C. M. Henderson, V. L. (1988). Analysis of spontaneous language in the older normal population. Journal of Communication Disorders, 21, 139-154.

Spirduso, W. W. (1995). Physical dimensions of aging. Champaign, IL: Human Kinetics Publishers.

Statistical Abstract of the United States. (1992). Washington, DC: Department of Commerce.

Timiras, P. (1972). Developmental Physiology and Aging. New York, NY: Macmillan.

Williams, M. H. (1993). Lifetime fitness and wellness: A personal choice. Dubuque, IA: Brown and Benchmark.

Yorkston, K. M., & Beukelman, D. R. (1980). An analysis of connected speech samples of aphasic and normal speakers. Journal of Speech and Hearing Disorders, 45, 27-36.

APPENDIXES

APPENDIX A

INTERVIEW QUESTIONNAIRE

Subject #: _____
Date: _____
Site: _____

Interview Questionnaire

NAME_____ AGE_____ DATE OF BIRTH_____

EDUCATIONAL LEVEL_____

RESIDENTIAL SETTING_____

EMPLOYMENT HISTORY_____

CURRENT MEDICATIONS_____

_____

Check any of the following that apply:

Hearing Loss_____ Hearing Aids_____ Speech Problems_____

Emotional Problems_____ Convulsions or epilepsy_____

Cerebral Vascular Accident (Stroke)_____ Brain Tumor_____

Arteriosclerosis_____ Laryngeal Cancer_____
(Hardening of the arteries)

Chronic Laryngitis_____ Vocal Nodules_____ Heart disease_____
(Hoarseness)

Vocal Polyps_____ Brain Injury_____ Paralysis_____

Neurological Diseases (specify)_____
(ALS, Alzheimer's, Parkinson's, MS, etc.)

Cerebral Palsy_____ Seizures_____

Serious Childhood Diseases (Polio, rheumatic fever, etc.)_____

Cleft palate and/or cleft lip_____ Orthopedic Problems_____

Other_____

_____

Any formal voice or speech training? _____
Any previous speech therapy?_____

Subject #:_____
Date:_____
Site:_____

SCREENING MEASURES

Hearing Screening

	R	L
500 Hz	_____	_____
1000 Hz	_____	_____
2000 Hz	_____	_____
Three Frequency Ave.	_____	_____
45 dB or better in better ear	pass / fail	
HEARING AIDS?	Yes / No	

General Speech Behavior Rating

1 = Adequate/Within Normal Limits 2 = Deviation which D/N Hamper Cmmctn

3 = Deviation which Hampers Communication

Pitch: 1 2 3
-too high/low
-monotonous
-pitch breaks
-other

Loudness: 1 2 3
-too loud/soft
-monotonous
-loudness pattern
-other

Rate: 1 2 3
-too rapid/slow
-monotonous
-rate pattern
-other

Voice Quality: 1 2 3
-breathiness
-harshness
-hoarseness
-glottal attack
-hyper/hyponasal
-other

Fluency: 1 2 3
-disfluencies of any type (list)
-other

Articulation: 1 2 3
-general misarticulations (describe)
-other

OVERALL GENERAL ADEQUACY: 1 2 3

COMMENTS:_____

_____

Subject #:_____
Date:_____
Site:_____

Physiological Measures

A. Resting Heart Rate _____ (X 6) = _____bpm

B. Blood Pressure (Systolic/Diastolic) _____ mmHg

C. Forced Vital Capacity

Trial #1	_____
Trial #2	_____
Trial #3	_____
Average	_____

D. Percent Body Fat

	Trial #1	Trial #2	Trial #3	Average
Triceps	_____	_____	_____	_____
Hip	_____	_____	_____	_____
Abdomen	_____	_____	_____	_____
Thigh	_____	_____	_____	_____
TOTAL				_____

E. Height _____

COMMENTS _____

_____

_____

APPENDIX B

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 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.

Throughout the centuries men have explained the rainbow in various ways. Some have accepted it as a miracle without physical explanation. To the Hebrews it was a token that there would be no more universal floods. The Greeks used to imagine that it was a sign from the gods to foretell war or heavy rain. The Norseman considered the rainbow as a bridge over which the gods passed from earth to their home in the sky. Other men have tried to explain the phenomenon physically. Aristotle thought that the rainbow was caused by reflection of the sun's rays by the rain. Since then physicists have found that it is not reflection but refraction by the raindrops which caused the rainbow. Many complicated ideas about the rainbow have been formed. The difference in the rainbow depends considerably upon the size of the water drops, and the width of the colored band increases as the size of the drops increases. The actual primary rainbow observed is said to be the effect of superposition of a number of bows. If the red of the second bow falls upon the green of the first, the result is to give a bow with an abnormally wide yellow band, since red and green lights when mixed form yellow. This is a very common type of bow, one showing mainly red and yellow, with little or no green or blue.

APPENDIX C

CRITERION VALUES FOR MEASURES OF BODY PHYSIOLOGY

Criterion Values for Measures of Body Physiology

Physical Condition	Good Poor
Physiological Measures	
resting heart rate (bpm)	<72>
resting systolic blood pressure (mmHg)	<140>
resting diastolic blood pressure (mmHg)	<90>
forced vital capacity (cc)	<30%>
percent body fat	<35%>

The notation '<72>' is to be read as follows: subjects with resting heart rates below 72 beats per minute are considered in good physiological condition; subjects with resting heart rates above 72 beats per minute are considered in poor physiological condition.

APPENDIX D

INDIVIDUAL SUBJECT SCORES

Table 4

Individual Subject Scores for Reading and Speaking Rate by Task and Physiological Condition in Syllables per Minute

		Oral Reading		Spontaneous Speaking	
Age	Subject Number	Reading Rate Including Intersentence Pause Time	Reading Rate Without Intersentence Pause Time	Speaking Rate Including Intersentence Pause Time	Speaking Rate Without Intersentence Pause Time
Young-Old Good Condition					
65	1	153.95	140.432	123.0	167.16
66	2	156.13	145.440	147.0	185.17
66	20	185.96	176.446	177.5	237.12
68	22	178.92	167.657	185.5	242.92
70	21	172.40	160.929	114.0	166.32
70	12	155.40	142.192	108.0	195.78
70	13	189.14	178.568	144.0	179.64
72	8	148.43	130.424	107.5	214.92
72	19	174.21	160.833	106.0	195.12
74	2	145.81	135.641	100.5	165.12
Young-Old Poor Condition					
67	15	189.14	179.690	205.0	271.98
69	17	147.11	132.355	140.0	194.7
69	18	163.05	150.820	116.0	221.64
71	23	159.13	147.774	130.5	215.34
72	4	181.87	174.720	116.5	186.9

		Oral Reading		Spontaneous Speaking	
Age	Number	Reading Rate Including Intersentence Pause Time	Reading Rate Without Intersentence Pause Time	Speaking Rate Including Intersentence Pause Time	Speaking Rate Without Intersentence Pause Time
73	38	161.46	149.500	157.5	180.84
74	16	163.86	151.623	144.0	218.52
75	10	118.21	100.804	103.0	158.94
Old-Good Condition					
80	7	169.74	160.766	118.5	191.22
80	26	157.62	139.367	88.5	180.12
81	32	133.47	126.722	155.0	225.00
81	24	149.10	132.255	147.0	241.32
82	34	159.13	148.974	140.0	176.64
86	3	168.02	160.842	184.5	245.76
86	11	135.10	120.861	123.0	176.46
87	36			90.0	128.52
Old-Poor Condition					
80	5	165.5	155.440	124.0	211.80
81	9	163.05	157.916	168.0	207.96
82	27	183.89	175.106	156.5	230.94
83	25	110.33	99.539	93.5	131.40
83	30	136.78	128.801	85.0	159.54

		Oral Reading		Spontaneous Speaking	
Age	Subject Number	Reading Rate Including Intersentence Pause Time	Reading Rate Without Intersentence Pause Time	Speaking Rate Including Intersentence Pause Time	Speaking Rate Without Intersentence Pause Time
84	31	149.10	138.197	107.5	187.26
86	37	142.06	130.884	116.0	151.62
87	29	152.53	141.594	102.0	233.52
91	28	131.35	114.257	107.0	196.02

APPENDIX E

INSTITUTIONAL REVIEW BOARD

APPROVAL FORM

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS REVIEW

Date: 10-13-95 **IRB#:** AS-96-018

Proposal Title: EFFECTS OF PHYSIOLOGICAL AGING ON SPEAKING AND READING RATES IN TWO GROUPS OF ELDERLY FEMALES

Principal Investigator(s): Nancy Monroe, Mandie Harris

Reviewed and Processed as: Expedited

Approval Status Recommended by Reviewer(s): Approved

ALL APPROVALS MAY BE SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING.
APPROVAL STATUS PERIOD VALID FOR ONE CALENDAR YEAR AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL.
ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Reasons for Deferral or Disapproval are as follows:

Provisions received and approved.

Signature: _____ Date: November 13, 1995

Chair of Institutional Review Board

VITA

Mandie L. Eck Harris

Candidate for the Degree of

Master of Arts

Thesis: THE EFFECTS OF PHYSIOLOGICAL AGING ON SPEAKING AND READING RATES IN TWO GROUPS OF ELDERLY FEMALES 65-91 YEARS

Major Field: Speech

Biographical:

Personal Data: Born in Longview, Washington, February 28, 1972, the daughter of James and Peggy Eck. Married to R. Christopher Harris on October 16, 1993.

Education: Graduated from Fairview High School, Fairview, Oklahoma in May, 1990; received Bachelor of Science degree in Speech-Language Pathology from Oklahoma State University, Stillwater, Oklahoma in May, 1994, completed requirements for the Master of Arts degree, Oklahoma State University, Stillwater, Oklahoma in July, 1996.

Professional Experience: Graduate Assistant, Department of Communication Sciences and Disorders, Oklahoma State University, August, 1994 to May, 1996; internship at Integris Baptist Medical Center, Oklahoma City, Oklahoma from June, 1996 to July, 1996.

Professional Memberships: National Student Speech-Language-Hearing Association, Oklahoma Speech-Language-Hearing Association.