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AN ABSTRACT OF THE THESIS OF Kerry Lewis for the Master of Science in Speech Communication: With an Emphasis in Speech Pathology/Audiology presented June 2, 1977.

Title: The Maximum Duration of Phonation of /a/ in Children.

APPROVED BY MEMBERS OF THE THESIS COMMITTEE:

Robert L. Casteel, Chairman

Mary E. Gordon

Joan McMahon

Measurement of maximum duration of phonation has been suggested by several voice experts as a clinical tool for assessing vocal function (Arnold, 1955; Irwin, 1965; Yanagihara, Koike and von Leden, 1966; and Boone, 1971). Most of the investigations of maximum phonation time have been conducted using adult populations. Exceptions to this can be found in the studies by Launer (1971) and Coombs (1976). An apparent need, therefore, existed to investigate maximum phonation time in children.

The present study was designed to investigate the affects of age, sex, height, weight and vital capacity on the maximum duration of phonation of sustained /a/ in children eight and ten years of age when controlling for pitch and intensity. The essential questions were:

What is the relationship of the variables age, sex, vital capacity, height and weight to the duration of sustained /a/?

Given twenty trials, does the maximum duration of sustained /a/ occur beyond the third trial?

The results indicated: 1) the five variables age, sex, vital capacity, height and weight collectively affect maximum duration of sustained /a/; 2) there is a significant correlation between vital capacity and phonation time; 3) sex is a statistically significant factor affecting phonation time, with male subjects tending to phonate longer than female subjects; 4) the variables age, height and weight were not statistically significant factors affecting phonation time; 5) thirty-six of the forty subjects failed to reach the mean for maximally sustained /a/ for their subgroup within the first three trials.

Analysis of the variance indicated approximately 46 percent of the variance among subjects' phonations of /a/ could be attributed to the variables of age, sex, vital capacity, height and weight. Approximately 54 percent of

the variance in phonation time, thus, could not be explained by the controlled variables in the present study. This would suggest other variables such as phonation volume, air flow rate and motivation need to be investigated in addition to further study of the controlled variables in the present investigation.

It was found that only two percent of the total population produced a maximum phonation time within the first three trials. Additionally, it was not until the fourteenth trial that fifty percent of the population had reached maximum phonation times and not until the twentieth trial that all forty of the subjects had produced maximum durations of sustained /a/.

THE MAXIMUM DURATION OF PHONATION
OF /a/ IN CHILDREN

by

KERRY LEWIS

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

MASTER OF SCIENCE IN SPEECH COMMUNICATION:
with an emphasis in
SPEECH PATHOLOGY/AUDIOLOGY

Portland State University
1977

TO THE OFFICE OF GRADUATE STUDIES AND RESEARCH:

The members of the Committee approve the thesis of
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CHAPTER I

INTRODUCTION AND STATEMENT OF PURPOSE

INTRODUCTION

Measurement of maximum duration of phonation has been suggested by several voice experts as a clinical tool for assessing vocal function. Boone (1971) stated that measurement of the maximum duration of phonation of a vowel, such as /a/, provides information about the efficiency of the respiratory system for phonation. Yanagihara, Koike and von Leden (1966) suggested using measurement of maximum duration as a tool for assessing overall vocal function. Similarly, Arnold (1955) and Irwin (1965) have recommended measurement of maximum duration time as a tool for assessing vocal quality.

Several researchers in the area of voice disorders have suggested "norms" for maximum duration of phonation (Van Riper, 1954; Arnold, 1955; Fairbanks, 1960; Yanagihara et al., 1966; and Boone, 1971). Researchers, however, do not concur on the length of maximum phonation time. Van Riper (1954) suggested normal individuals should be able to sustain the vowels /i/, /a/, and /u/ for at least fifteen seconds. Sawashima, reported in Isshiki et al. (1967), suggested that the mean values of maximum phonation times for males and females with normal voice were thirty seconds and twenty seconds respec-

tively, and that values below fifteen seconds for males and ten seconds for females could be regarded as pathological.

The suggested norms, from fifteen to thirty seconds for normal individuals, represent a considerable range for normality. This lack of agreement among voice experts has led researchers to investigate variables which may be affecting the maximum duration of phonation. Variables investigated include: vital capacity and air flow rate (Yanagihara et al., 1966; Isshiki et al., 1967; Yanagihara and von Leden, 1967; and Beckett, 1971), vocal pitch and intensity (Ptacek and Sanders, 1966; Yanagihara et al., 1966; and Yanagihara and Koike, 1967), phonation volume (Yanagihara et al., 1966; and Yanagihara and Koike, 1967), sex (Ptacek and Sanders, 1963; Yanagihara et al., 1966; Yanagihara and Koike, 1967; and von Leden, 1967), age (Launer, 1971; and Coombs, 1976) and height and weight (Launer, 1971).

Several investigators have specified the number of trials used to obtain maximum duration of phonation. Most of the studies have been based on three trials (Yanagihara et al., 1966; Yanagihara and Koike, 1967; Yanagihara and von Leden, 1967; Launer, 1971 and Coombs, 1967). A notable exception to using three trials to obtain maximum phonation times can be found in the pilot work of Stone (1976). Using a population of 21 adults, Stone found that given fifteen trials, it was not until the ninth trial that even 50 percent of his subjects had produced their maximum phonation times.

These findings would suggest the need for further investigation of the number of trials used to obtain maximum phonation times.

Several researchers (Ptacek and Sanders, 1963; Isshiki et al., 1967; Yanagihara and Koike, 1967; and Yanagihara and von Leden, 1967) have investigated maximum duration of phonation with adult populations. Few studies have been conducted using children as subjects; exceptions to this can be found in the studies of Launer (1971) and Coombs (1976). An apparent need, therefore, exists to investigate maximum duration of phonation in children.

STATEMENT OF PURPOSE

The present study was designed to investigate the affects of age, sex, height, weight and vital capacity on the maximum duration of phonation of sustained /a/ in children eight and ten years of age when controlling for pitch and intensity. The essential questions were:

What is the relationship of the variables age, sex, vital capacity, height and weight to the duration of sustained /a/?

Given twenty trials, does the maximum duration of sustained /a/ occur beyond the third trial?

CHAPTER II

REVIEW OF THE LITERATURE

MAXIMUM PHONATION

A Diagnostic Clinical Instrument

The measurement of maximum duration of phonation time has been suggested as a clinical test for evaluation of vocal function. Arnold (1955) stated "a good criterion for the general quality of the voice is immediately available by determining the phonation time." Similarly, Yanagihara, Koike, and von Leden (1966) wrote that the "efficiency" of the vocal function could be demonstrated by evaluating the maximum duration of phonation. Fairbanks (1960) suggested "time is a good indicator of efficiency of phonation because vital capacity is reasonably constant." Boone (1971) wrote that measures of sustained phonation of vowels, such as /a/, can provide information about an individual's efficiency in using the respiratory system for phonation.

Even though Isshiki, Okamura, and Morimoto (1967) suggested that measures of flow rate may provide more information regarding voice function than do measures of maximum duration of phonation, they concluded that maximum phonation measures are of clinical value, when no instrumentation is available to measure flow rate, especially in cases in which

there is incomplete closure of the glottis.

Several voice experts have indicated shorter phonation times accompany dysphonia. Ptacek and Sanders (1963) stated that an inability to sustain phonation for a reasonable duration is often found in association with such problems as excessive breathiness, inadequate intensity or incomplete word grouping. Similarly, Van Riper (1963) suggested using a test of maximum duration of phonation for individuals with weak or breathy voices. Based on clinical observations, Yanagihara, Koike and von Leden (1966) indicated that a substantial decrease in phonation time is often observed in association with severe organic or functional dysphonias. Isshiki, Okamura and Morimoto (1967) wrote that maximum phonation time has been used widely for evaluating vocal function, particularly in the case of vocal cord paralysis. Döhne, reported in Isshiki et al. (1967), stated that in all cases he tested of unilateral recurrent nerve paralysis with dysphonia, maximum phonation time was reduced. Döhne further stated the improvement of voice was accompanied by an increase in phonation time. Arnold (1955) suggested the clinical usefulness of measures of phonation duration in assessing the vocal ability of individuals with paralytic dysphonia.

Norms for Maximum Duration of Phonation

Several researchers have suggested "norms" for maximum duration of phonation. Van Riper (1963) wrote that normal individuals should be able to sustain a front, middle and

back vowel for at least fifteen seconds without difficulty. Isshiki et al. (1967) reported that Sawashima suggested the maximum phonation time for males and females was thirty seconds and twenty seconds respectively, and values below fifteen seconds for males and below ten seconds for females may be regarded as pathological. Fairbanks suggested a "par" of twenty to twenty-five seconds for maximum duration of vowel sounds. Similarly, Arnold (1955) stated: "In general, phonation time varies between twenty and thirty seconds within the median speaking range." Westlake reported in Ptacek and Sanders (1963), suggested that a child with cerebral palsy should be able to sustain a sound for a minimum of ten seconds. Westlake and Rutherford (1961) maintained that a child with a normal voice should easily sustain a tone for twenty seconds or longer after a few trials. Boone (1971) suggested a pre-pubescent child should be able to maintain a voiceless sound for ten seconds. He also wrote that an individual with a normal voice should sustain the unvoiced /s/ and the voiced /z/ for approximately the same length of time, but an individual with vocal pathology will sustain /s/ twice as long as /z/ due to the difficulty in producing the voicing feature of the /z/ sound.

The norms for maximum duration of phonation suggested by the above cited researchers range from ten to thirty seconds for a normal voiced individual. This wide range of variability has led several researchers to further investi-

gate the area.

Previous Research on Maximum Phonation

Many researchers have investigated the effect of vital capacity on the maximum duration of phonation (Yanagihara et al., 1966; Isshiki et al., 1967; Yanagihara and von Leden, 1967; and Beckett, 1971). Vital capacity has been defined as the total volume of air which an individual can expel from his lungs after maximum inspiration (Steer and Hanley in Travis, 1957). Yanagihara and Koike (1967) reported that Scalori in 1932 and Hulse in 1936 found little relation between vital capacity and sustained phonation. Also reported was a previous investigation by Gutzmann, in 1928, in which Gutzmann noted that air volume used during phonation was evidently smaller than vital capacity. Several other studies have been conducted in which the results have supported Gutzmann's findings. Representative of these studies was the investigation by Isshiki et al. (1967). This study was conducted with twenty normal-voiced adults, ten male and ten female, ranging in age from twenty to thirty-seven years. Measures of air volume used for phonation and vital capacity were taken using a respirometer and a pneumotachograph. The results indicated the whole quantity of vital capacity is never utilized for the longest phonation. The percentage of air volume expired during the longest phonation to vital capacity ranged from 68.7 percent to 94.5 percent. Yanagihara and Koike (1967) obtained similar findings, with the percent-

ages ranging from 50 to 80 percent for males and 45 to 75 percent for females. However, they further concluded "There is a significant correlation between the phonation volume (the total volume of air consumed in maximally sustained phonation) and vital capacity." Additionally, they suggested that longer phonation time is generally related to larger phonation volume. Yanagihara et al. (1966) suggested that maximum duration of phonation may be limited by phonation volume; and may vary with the change in air flow rate during phonation. They further suggested the air flow rate during phonation may relate to changes in vocal pitch, intensity and quality. The results of their investigation of these variables indicated there is a significant correlation between phonation volume and vital capacity and that phonation duration varies with the amount of flow rate, phonation volume and vital capacity. Additionally, the results indicated that mean flow rate during phonation has no specific relation to the fundamental frequency and intensity of the phonation. It appears researchers have not yet fully determined the relationship between vital capacity and phonation time.

Several other researchers have investigated air flow rate as it relates to maximum phonation duration (Yanagihara et al., 1966; Isshiki et al., 1967; Yanagihara and von Leden, 1967; and Beckett, 1971). In each case air flow rate was measured using a pneumotachograph. Isshiki et al. (1967) suggested that in assessing the laryngeal condition on the

basis of mean air flow rate it was necessary for subjects to control the expiratory air force. In their study, using ten adult subjects, they found that control of this expiratory force was impractical, and compromised by instructing the subjects to produce only an "easy" maximum phonation. They concluded that the great variability in maximum phonation time was partly due to this uncontrolled expiratory force. Isshiki et al. further concluded that the glottal condition is more directly reflected by air flow rate during phonation than by maximum phonation time. However, they stated the complexity and cost of the instrument to measure air flow rate, a pneumotachograph, limits clinical application of the technique.

Several investigations have been conducted to determine the effect of vocal pitch and intensity on maximum duration of phonation (Ptacek and Sanders, 1966; Yanagihara et al., 1966; and Yanagihara and Koike, 1967). Ptacek and Sanders (1963) sought to obtain maximum vowel duration measures under conditions of differing intensity and frequency levels. The subjects for their study were eighty adults, forty males ranging in age from seventeen to forty-one years, and forty females ranging in age from eighteen to forty-one years. A total of twelve maximum duration phonations was required of each subject as follows: (a) two phonations uncontrolled for either frequency or intensity; (b) three uncontrolled frequency phonations at soft, moderate and loud intensity levels; (c)

six frequency-intensity controlled phonations i.e., soft, moderate and loud phonations at low and high frequencies; and (d) one final phonation, again uncontrolled for frequency or intensity. Ptacek and Sanders concluded that measures of maximum vowel duration appeared to be a function of both frequency and intensity. Yet the results of the study indicated that the group mean duration differences were not significantly affected by intensity for the low frequency phonations or for phonations where frequency was uncontrolled. Additionally, the results of this study indicated no practice or fatigue effect could be inferred from a comparison of the first phonatory task and the twelfth or final task. Yanagihara and Koike (1967) in studying twenty-two adults found that phonation time decreased significantly with a rise in pitch from medium to high, but this difference was not found between the duration time of a medium pitched phonation and that of low pitched phonation.

Ptacek and Sanders (1963) and Sawashima (in Isshiki et al., 1967) presented separate suggested norms for maximum duration of phonation in males and females. Several researchers (Ptacek and Sanders, 1963; Yanagihara et al., 1966; Yanagihara and Koike, 1967; and Yanagihara and von Leden, 1967) investigated the maximum duration of phonation in both male and female subjects. Representative of the findings of these studies regarding sex differences in phonation time are the findings of Ptacek and Sanders (1963). The results of this

study indicated that male subjects, in general, tended to sustain phonation longer than female subjects. Yanagihara and Koike (1967) suggested that the sex linked difference in maximum phonation time is mainly attributable to the differences in vital capacity between male and female subjects.

All of the investigations cited in the previous paragraphs have dealt with adult subjects. Few studies have been conducted on maximum duration of phonation using a population of children. Launer (1971) investigated maximum phonation time in 206 normal voiced boys and girls ranging in age from seven to eighteen years. She controlled for pitch and loudness levels and investigated the relationship of age, sex and body size to maximum duration of phonation of the vowels /a/, /i/, and /u/. The results of her study indicated there was no significant difference among the phonation times of the three vowels. Launer also found the male subjects sustained phonation longer than the female subjects, and that phonation time increased as age increased. She concluded that age, sex, height and weight were overlapping predictors, such that ". . . given height and weight, age and sex add no independent information, or, given age and sex, height and weight give no additional information."

Coombs (1976) investigated the maximum duration of phonation of /a/ produced by children with normal and hoarse voices. The 190 subjects in her study ranged in age from six to ten years. The results indicated that degree of hoarseness,

sex and age collectively affected duration of phonation of /a/. Further statistical analysis of the results indicated that sex was not a statistically significant factor affecting length of phonation; as age increased, phonation time also increased; and as hoarseness increased, the duration of phonation of /a/ decreased. An analysis of variance showed that only 27.31 percent of the variance among the subjects' phonation times could be explained by the variables of age, sex and degree of hoarseness. Coombs concluded that other factors affecting the variance might have included lung capacity, height, weight, motivation, fatigue, and intensity and frequency of the vocal tone.

Several investigators have specified the number of trials used to obtain maximum duration of phonation. Most of the investigations have used three trials to obtain maximum phonation of /a/ (Yanagihara et al., 1966; Yanagihara and Koike, 1967; Yanagihara and von Leden, 1967; Launer, 1971; and Coombs, 1976). Ptacek and Sanders (1966) presented a study in which a total of twelve maximum phonations was required of each subject as follows: (a) two phonations uncontrolled for either frequency or intensity; (b) three uncontrolled frequency phonations at soft, moderate and loud intensity levels; (c) six frequency-intensity controlled phonations i.e. soft, moderate and loud phonations at low and high frequencies; and (d) one final phonation, again uncontrolled for frequency or intensity. They concluded no

consistent fatigue or practice effect could be inferred from a comparison of the first phonation and the twelfth, or final, phonation. Of the studies cited above, only that of Yanagihara and Koike (1967) included a rationale for the number of trials used. They reported discarding the first phonation time because unfamiliarity with the examination often affected the first sustained phonation. Additionally, it was reported that the difference in phonation time between the second and third trials was small enough to permit using a mean value of these trials as a representative measure of maximum phonation time.

The investigations cited in the above paragraphs summarize the research that has been presented in the area of maximum phonation. With the exception of the Coombs (1976) and Launer (1971) studies, each of the cited investigations has dealt with adult populations. Further research is needed in the area of maximum phonation time in children.

CHAPTER III

METHODS

Subjects

The sample for this investigation consisted of forty children; twenty at each of two age levels, eight years plus or minus six months with a mean age of 93.55 months and a median age of 92.50 months, and ten years plus or minus six months with a mean and median age of 122.25 months and 122.50 months, respectively. Each of these two age groups was further divided into ten male and ten female subjects. The children were all students at East Gresham Elementary School in Gresham, Oregon. Each subject's voice was rated as normal based upon a screening using the Jewish Hospital Voice Profile (Wilson, 1971). Additionally, none of the children had colds or were unable to comply with the instructions for eliciting maximum phonation of /a/ (presented in Appendix A) and vital capacity (presented in Appendix B).

Instrumentation

Each subject's maximum phonations of /a/ were recorded on a Sony tape recorder in conjunction with Memorex brand magnetic tapes. A Breitling stopwatch was used to measure the duration times. A wet spirometer was used to measure each subject's vital capacity in cubic inches. Measures of

height and weight were recorded. Each child was weighed on a scale checked for accuracy with a standard weight at the beginning of each day of data collection.

The Jewish Hospital Voice Profile, presented in Appendix A, was used to rate each subject's voice quality. The profile has rating scales for judging the following parameters of voice production: pitch, degree of openness of the vocal folds, nasal resonance, vocal range, rate and intensity. Severity is rated on a scale from "1" to "7" with "1" indicating a barely perceptible problem and "7" representing a significant problem which interferes with communication.

According to Wilson (1971), scale "A" on the profile is used to rate the open and closed positions of the vocal folds. A rating of "-4" on this scale represents the condition when the folds are totally open and there is little if any friction produced while communicating, "-3" represents whispered phonation, "-2" represents breathiness, "1" indicates normal voice, "+2" represents a voice accompanied by much tension and strained production and "+3" indicates extreme tension with random closure, characteristic of the voice of individuals with spastic dysphonia. A rating of "+2/-2" indicates a voice which is tense, strained and breathy which is commonly referred to as a hoarse voice quality. Scale "B" is used to rate "Laryngeal Capacity" or pitch. On this scale a rating of "+3" and "-3" respectively indicate the speaker's voice is either too high or too low for a listener to determine

sexual identification on the basis of voice. A "+2" or "-2" rating indicates pitch deviations noticeable only to the critical listener. A rating of "1" indicates normal pitch. Scale "C" represents "Resonating Cavity" or nasality. A rating of "-2" represents hyponasality, "1" represents normal nasal resonance, "+2" indicates assimilation nasality, "+3" represents nasalization of vowels with a slight nasalization of consonants, and "+4" indicates nasalization of both vowel and consonant sounds. A normal voice, based on the ratings of the Jewish Hospital Voice Profile, was defined as a rating of "1.5" or less on the severity scale for any rating on scales A, B, or C. Rate and intensity were not evaluated in the screening.

Data Collection

Each child was seen one at a time in an unoccupied regular classroom. The setting was private and relatively quiet. A conversational speech sample was obtained from each child to screen for normal voice. A normal voice was defined as one rated "1.5" or below on the severity scale for ratings on scales A, B, or C of the profile. Measures of each child's height and weight were recorded. Three vital capacity measures were recorded in cubic inches and converted to cubic centimeters. Instructions for eliciting maximum expulsion of air are presented in Appendix B.

A tape recording of twenty maximum phonations of /a/ was obtained with each subject standing. This investigator

held the microphone approximately four to six inches from the subjects' mouth. Each subject phonated at a pitch approximately one fourth from the bottom of his frequency range. This was determined for each individual child as follows: each child was instructed to phonate /a/ in his lowest voice, this frequency was identified on a pitch pipe and a frequency three notes above that lowest frequency was modeled by the examiner as the pitch the subject was to use in phonating /a/. Intensity was modeled and shaped by the examiner to represent an intensity level in the lower half of the conversational range. Instructions for eliciting maximum phonations of /a/ are present in Appendix C.

Data Measurement

The voice samples were analyzed at the time the samples were taken, by this examiner who was trained to use the Jewish Hospital Voice Profile by Robert L. Casteel, Ph.D., and Mary E. Gordon, M.S., voice clinic supervisors at Portland State University.

A training session for the profile was held using the Jewish Hospital Voice Profile training tapes and previous Portland State University research tapings of 190 voice samples. It was the goal of the training session to reach interjudge reliability of 100 percent for two consecutive sets of ten undiscussed samples. Agreement among judges was defined as ratings within a range of one point on the "severity scale" and in complete agreement on the other scales of

the Jewish Hospital Voice Profile. Initially, discussion was allowed after each set of ten samples. The goal of 100 percent interjudge agreement was met on the fourth and fifth sets of ten consecutive samples; there was no discussion among the judges during or between the presentation of these two sets of samples.

The twenty recorded samples used for determining interjudge reliability were rated by this researcher ten days after the original training session and an intrajudge reliability of 100 percent was achieved.

The greatest vital capacity reading of the three trials was recorded as that subject's vital capacity measure. The twenty phonations of /a/ for each subject were measured from the tape recording. The durations of the phonations were measured to the nearest one tenth second using a stop watch. The longest phonation time produced during the twenty trials was considered to be that subject's maximum duration of sustained /a/.

Data Analysis

The F test was used to determine the significance of the relationship of the variables of age, sex, vital capacity, height and weight, collectively, to the duration of sustained /a/. The data were analyzed using multiple regression techniques. The significance of the relationship of each of the variables individually to duration of sustained /a/ was determined by using the computed normal deviate for r_{xy} .

The percentage of the total population reaching maximum phonation times on each of the twenty trials was determined by inspection from a graphic representation.

CHAPTER IV

RESULTS AND DISCUSSION

RESULTS

The purpose of this investigation was to determine the relationship of the variables age, sex, vital capacity, height and weight to the duration of sustained /a/. Additionally, this investigator sought to determine if the maximum duration of sustained /a/ occurred beyond the third trial given twenty trials of sustained /a/ for each subject.

The first question posed was:

What is the relationship of the variables age, sex, vital capacity, height and weight to the duration of sustained /a/?

To answer this question, the data were analyzed using multiple regression techniques. The summary of the statistical analysis appears in Tables I and II. The F ratio (Table I) demonstrates that the relationship of the variables of age, sex, vital capacity, height and weight to duration of sustained /a/ is statistically significant at the .01 probability level with 34 degrees of freedom.

The multiple correlation value (Table II) indicates that 46.06 percent of the variance between subject's maximum

TABLE I
ANALYSIS OF VARIANCE FOR THE REGRESSION

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Value*
Attributable to regression	5	520.81819	104.16364	5.80864
Deviation from regression	34	609.70581	17.93252	
Total	39	1130.52400		

*.01 Probability Level.

TABLE II
DATA ANALYSIS OF THE INDIVIDUAL VARIABLES OF AGE,
SEX, VITAL CAPACITY, HEIGHT, AND WEIGHT

Variance	Mean	Standard Deviation	Correlation X vs Y	Regression Coefficient	Standard Error of Regression Coefficient	Computed t Value (Regr. Coef. Est)	Normal Deviate for r_{xy}
Age	107.90000	14.87693	.14857	.02782	.07085	.39270	.92782
Sex	.50000	.50637	.41570	2.70214	1.40384	1.92482	2.59605*
Vital Capacity	1745.37500	326.73566	.54814	.01137	.00297	3.82871	3.42313*
Height	52.64375	3.29524	.20156	.87513	.45891	1.90699	1.25874
Weight	69.32500	15.68992	.26707	.09433	.06292	1.49929	1.66785
Dependent	20.28000	5.38403					
Intercept		35.61553					
Multiple Correlat- ion		.67874					
Standard Error of Estimate		4.23468					

*.01 Probability Level.

phonations of /a/ can be attributed to the variables age, sex, vital capacity, height and weight.

The r^2 value for the correlation X vs Y indicated the variable sex represented over 17 percent of the shared variance and the variable vital capacity represented approximately 30 percent of the shared variance. The percent of shared variance for the variables weight, height and age were 7 percent, 4 percent and 2 percent respectively. Using the computed normal deviate for r_{xy} , vital capacity was shown to be a significant factor relative to length of phonation at the .01 probability level; as vital capacity increased, length of /a/ also increased. The ranges of vital capacity, height and weight measures for each of the four subgroups are shown in Figures 1, 2 and 3 respectively.

Sex was also shown to be a significant factor in relation to length of phonation at the .01 probability level. Male subjects tended to phonate longer than female subjects. Maximum phonation times for males ranged from 11.5 seconds to 39.0 seconds, with a mean of 24.41 seconds. The range of maximum phonation times for female subjects was 11.9 seconds to 23.0 seconds, with a mean of 19.19 seconds.

The relationships of the variables height and weight to phonation time were not found to be statistically significant. Age was not found to be a significant factor in relation to phonation time. However, Figure 4 indicates among male subjects those ten years old tended to phonate longer

Figure 1. Range of vital capacity.

Figure 2. Range of height.

Figure 3. Range of weight.

Figure 4. Range of maximum phonation times produced in twenty trials.

than those eight years old with a means of 24.93 and 20.05 respectively. Among the females, however, the eight year old subjects tended to phonate longer with a mean of 19.19 seconds, than the ten year old subjects with a mean of 16.98 seconds.

The second question posed was:

Given twenty trials, does the maximum duration of sustained /a/ occur beyond the third trial?

The percentage of the total population reaching maximum phonation times on each of the twenty trials was determined by inspection from a graphic representation (Figure 5). The results indicated only two percent of the total population produced a maximum duration of phonation within the first three trials. It was not until the fourteenth trial that fifty percent of the subjects had reached maximum phonation times, and not until the twentieth trial that all forty of the subjects produced maximum phonations.

DISCUSSION

The results of this investigation indicated there is a significant relationship between vital capacity and duration of phonation. These results are not supported by the findings of Hulse (1936) and Scalori (1932) who found little relation between vital capacity and sustained phonation. Several researchers have indicated that the entire volume of vital capacity is not used for maximally sustained phonation.

Figure 5. Percentage of N reaching maximum phonation times for each of twenty trials.

Yanagihara and Koike (1967) reported that Gutzmann in 1928 suggested the air volume used during phonation was evidently smaller than vital capacity. Isshiki et al. (1967), suggested the whole quantity of vital capacity is never utilized for maximum phonation. The percentage of air volume expired during maximum phonation ranged from 68.7 to 94.5 percent. Yanagihara and Koike (1967) obtained similar findings reporting percentages ranging from 50 to 80 percent for males and 45 to 75 percent for females.

Several researchers (Yanagihara et al. 1966; Isshiki et al. 1967; and Yanagihara and Koike, 1967) have suggested that the proportion of vital capacity used in maximally sustained phonation varies greatly. This variance might be partially explained by the fact the above cited researchers based their findings on three trials to obtain maximum phonation time, and further neutralized the results by taking a mean of the three trials rather than reporting actual maximum phonation times.

Results of the present investigation might suggest that given twenty trials, maximum phonation times could reflect utilization of a higher percentage of vital capacity. This assumption represents a possible explanation for the significant correlation between vital capacity and maximum phonation time found in the present study.

The relationship of sex to maximum phonation time also was found to be statistically significant. It was found that

male subjects tended to phonate longer than female subjects. This is consistent with the findings of several researchers (Ptacek and Sanders, 1963; Yanagihara et al., 1966; Yanagihara and Koike, 1967; Yanagihara and von Leden, 1967; and Launer, 1971). The results of a study by Coombs (1976) indicated no statistically significant correlation between sex and phonation time, although there was a consistent trend for male subjects to phonate longer than female subjects. Of the 190 subjects in her study only 38 exhibited normal voices, the remaining 152 subjects exhibited voices of varying degrees of hoarseness. The difference in voice quality of the subjects in the Coombs study, (disordered), and the voice quality of the subjects in the present investigation, (normal), could account for the discrepancy in findings.

Age was not found to be a significant factor in relation to length of phonation. These findings are not consistent with the findings of Launer (1971) and Coombs (1976). The results of these previous investigations indicated a significant relationship between age and phonation time, as age increased, maximum phonation time also increased. The children included in the Launer study ranged in age from seven to eighteen years, while the population included in the study by Coombs ranged in age from six to ten years. The population for the present investigation consisted of children eight and ten years of age plus or minus six months at each of the two age levels. This relatively narrow range between

age groups may have contributed to the lack of a statistically significant relationship between age and phonation time in the present investigation. It should also be noted that ten-year-old males tended to phonate longer than eight-year-old males, while, among the female subjects the reverse was true. A possible explanation may be that motivation was a contributing factor to the lack of a statistically significant relationship between age and phonation time.

The relationship of the variables height and weight to phonation time were not found to be statistically significant. Launer (1971) concluded that age, sex, height and weight were overlapping predictors, such that height plus weight equals age plus sex as a reliable predictor for duration of phonation.

In this investigation only 2 percent (one subject) of the total population produced a maximum duration of phonation within the first three trials. It was not until the fourteenth trial that 50 percent of the population had reached maximum phonation times. These results are shown in Figure 5. Previous researchers (Yanagihara et al., 1966; Yanagihara and Koike, 1967; Yanagihara and von Leden, 1967; Launer, 1971; and Coombs, 1976) have based their results on three trials of sustained phonation. The results of the present study strongly suggest that maximum duration of sustained /a/ probably would not be attained within the first three trials by a population of children.

Figure 6 illustrates the longest phonation times obtained within the first three trials and the maximum phonation times obtained in twenty trials for each of the four subject groups. Comparisons of maximum phonation times obtained in three trials and twenty trials for each of the four subgroups are shown in Tables III, IV, V and VI. These results show that none of the female subjects reached the mean of maximally sustained phonation obtained by their age group within the first three trials. Only two eight-year-old male subjects reached the mean for maximally sustained phonation obtained by their age group within the first three trials. Within the ten-year-old male group two subjects reached the mean for maximally sustained phonation obtained by their age group within the first three trials. Therefore, thirty-six of forty subjects in this investigation failed to reach the mean for maximally sustained phonation obtained by their subgroup within the first three trials.

Researchers have suggested a normal-voiced individual should be able to sustain a vowel for from fifteen (Van Riper, 1963) to twenty or thirty seconds (Arnold, 1955). Fifty percent of the forty subjects in this investigation failed to reach the suggested norm of fifteen seconds in the first three trials. Five of the forty subjects (12.5 percent) failed to reach this norm within twenty trials. Westlake and Rutherford (1961) presented the only norms for maximally sustained phonation in children. They suggested a child with

Figure 6. Range of maximum phonations produced within the first three trials and range of maximum phonation obtained in twenty trials.

TABLE III

COMPARISON OF MAXIMUM PHONATION TIMES OBTAINED IN
3 TRIALS AND 20 TRIALS AMONG 8 YEAR OLD
MALE SUBJECTS

	Best of 3	Best of 20	Gain
SUBJECTS	1. 8.0	20.1	12.1
	2. 8.1	20.5	12.4
	3. 9.5	11.5	2.0
	4. 10.2	15.8	5.6
	5. 10.7	23.6	12.9
	6. 16.1	16.8	.7
	7. 17.4	24.1	6.7
	8. 18.1	19.1	1.0
	9. 21.7	24.5	2.8
	10. 24.5	24.5	.0
Group Average	13.83	20.05	5.62

TABLE IV

COMPARISON OF MAXIMUM PHONATION TIMES OBTAINED IN
3 TRIALS AND 20 TRIALS AMONG 8 YEAR OLD
FEMALE SUBJECTS

	Best of 3	Best of 20	Gain
SUBJECTS	1. 8.2	11.9	3.7
	2. 10.4	12.4	2.0
	3. 14.0	21.1	7.1
	4. 14.8	21.5	6.7
	5. 15.0	18.1	3.1
	6. 15.0	23.0	8.0
	7. 15.1	21.1	6.0
	8. 15.4	22.0	6.6
	9. 15.9	19.1	3.2
	10. 17.1	21.4	4.3
Group Average	14.09	19.1	5.07

TABLE V

COMPARISON OF MAXIMUM PHONATION TIMES OBTAINED IN
3 TRIALS AND 20 TRIALS AMONG 10 YEAR OLD
MALE SUBJECTS

	Best of 3	Best of 20	Gain
1.	13.5	15.9	2.4
2.	15.6	24.5	8.9
3.	16.4	19.8	3.4
4.	16.8	23.6	6.8
5.	17.2	20.5	3.3
6.	19.4	21.7	2.3
7.	20.5	32.0	11.5
8.	20.7	22.2	1.5
9.	25.5	30.1	4.6
10.	34.4	39.0	4.6
Group Average	20.0	24.9	4.93

TABLE VI

COMPARISON OF MAXIMUM PHONATION TIMES OBTAINED IN
3 TRIALS AND 20 TRIALS AMONG 10 YEAR OLD
FEMALE SUBJECTS

	Best of 3	Best of 20	Gain
1.	8.2	12.0	8.8
2.	9.9	13.0	3.1
3.	11.0	16.0	5.0
4.	12.9	15.6	2.7
5.	13.0	17.4	4.4
6.	13.1	14.0	.9
7.	13.1	19.4	6.3
8.	14.1	18.2	4.1
9.	14.5	21.8	7.3
10.	14.6	17.4	2.8
Group Average	12.4	16.5	4.54

a normal voice should easily sustain a tone for twenty seconds or longer. The results of this investigation indicated thirty-four of forty subjects (85 percent) failed to reach this suggested minimum for children within the first three trials. Given twenty trials, nineteen of the forty subjects (47.5 percent) failed to reach this suggested norm.

These findings might also suggest that obtaining three trials of maximum phonation is of limited clinical usefulness. Researchers who have suggested norms for maximum phonation time (Van Riper, 1954; Arnold, 1955; Fairbanks, 1960; Yanagihara et al., 1966; and Boone, 1971) have not indicated the number of trials used to obtain these results, however, in reviewing the literature it seems clear most researchers used from one to three trials. The present investigation suggests it is not known how many trials are needed to produce maximum phonation time and this limits the diagnostic value of measuring duration of sustained /a/ and comparing these measurements to current norms.

A substantial variation in the subjects' ability to sustain /a/ was noted; for example, one ten-year-old boy sustained /a/ for 15.9 seconds, while another ten-year-old boy phonated for 39.0 seconds. Several other examples could be found. Launer (1971) and Coombs (1976) also found a considerable range among their subjects' abilities to sustain /a/. These results indicate a wide range in duration times among normal-voiced subjects exists and as such, suggests that

measuring maximum duration of phonation time in and of itself, may be of limited diagnostic value.

The results of this investigation indicated approximately 46 percent of the variance in the subjects' phonations of /a/ could be attributed to the variables age, sex, vital capacity, height and weight. The results of a previous study by Coombs (1976) indicated approximately 27 percent of the variance between her subjects' phonations of /a/ could be explained by the three variables, degree of hoarseness, sex, and age.

Approximately 54 percent of the variance in phonation time could not be explained by the controlled variables in the present study. Additionally, the variable of age was not found to be statistically significant in the present study, while Launer (1971) found the relationship of age to phonation time to be significant. This would suggest other variables such as phonation volume, air flow rate and motivation need to be investigated in addition to further study of the controlled variables in the present investigation.

CHAPTER V

SUMMARY AND IMPLICATIONS

SUMMARY

Measurement of maximum duration of phonation has been suggested by several voice experts as a clinical tool for assessing vocal function (Arnold, 1955; Irwin, 1965; Yanagihara, Koike and von Leden, 1966; and Boone, 1971). Most of the investigations of maximum phonation time have been conducted using adult populations. Exceptions to this can be found in the studies by Launer (1971) and Coombs (1976). An apparent need, therefore, existed to investigate maximum phonation time in children.

The present study was designed to investigate the affects of age, sex, height, weight and vital capacity on the maximum duration of phonation of sustained /a/ in children eight and ten years of age when controlling for pitch and intensity. The essential questions were:

What is the relationship of the variables age, sex, vital capacity, height and weight to the duration of sustained /a/?

Given twenty trials, does the maximum duration of sustained /a/ occur beyond the third trial?

The results indicated: 1) the five variables age, sex, vital capacity, height and weight collectively affect maximum duration of sustained /a/; 2) there is a significant correlation between vital capacity and phonation time; 3) sex is a statistically significant factor affecting phonation time, with male subjects tending to phonate longer than female subjects; 4) the variables age, height and weight were not statistically significant factors affecting phonation time; 5) thirty-six of the forty subjects failed to reach the mean for maximally sustained /a/ for their subgroup within the first three trials.

Analysis of the variance indicated approximately 46 percent of the variance among subjects' phonations of /a/ could be attributed to the variables of age, sex, vital capacity, height and weight. Approximately 54 percent of the variance in phonation time, thus, could not be explained by the controlled variables in the present study. This would suggest other variables such as phonation volume, air flow rate and motivation need to be investigated in addition to further study of the controlled variables in the present investigation.

It was found that only two percent of the total population produced a maximum phonation time within the first three trials. Additionally, it was not until the fourteenth trial that fifty percent of the population had reached maximum phonation times and not until the twentieth trial that all

forty of the subjects had produced maximum durations of sustained /a/.

IMPLICATIONS

Clinical

The results of this investigation revealed a wide variance among the subjects' ability to phonate /a/. Similar results were found in the studies of Launer (1971) and Coombs (1976). The wide range of phonation times produced by normal-voiced children would tend to suggest measures of maximum phonation time are of limited diagnostic value. Additionally, it was found that within the first three trials, thirty-seven of forty subjects failed to reach the mean for sustained /a/, obtained in twenty trials, for their subgroup. These findings strongly suggest that maximum phonation of sustained /a/ might not be attained within the first three trials by a population of children. These results suggest it is not known how many trials are needed to obtain maximally sustained phonation and as such, limit the diagnostic value of measuring phonation time and comparing these measurements to current norms.

Research

Further research is needed to investigate the relationship of these variables to phonation time with a population of children.

Sex was shown to be a significant factor affecting

phonation time. These findings were not supported by Coombs (1976). Further investigation of the relationship of sex to phonation time in children is warranted.

The relationship of age to phonation time was not found to be statistically significant in the present study conducted on children eight and ten years of age. The studies of Launer (1971) and Coombs (1976) do not support these findings. Further investigation of the relationship of age to phonation time in young children is needed.

The results of this study strongly suggested three trials might not be sufficient to obtain maximum phonation times. The number of trials needed to obtain maximum phonation times and the relationship of vital capacity, phonation volume and number of trials used to obtain maximum phonation time needs further investigation.

The variables of age, sex, vital capacity, height and weight accounted for 46 percent of the variance in phonation time in the present study. Future studies might investigate the relationship of phonation volume, air flow rate and motivation, as well as the variables investigated in the present study, to phonation time.

In addition, further investigation of the relationship of phonation volume to vital capacity with a population of children might provide valuable information, as previous investigators of this relationship have used only adult populations in their studies.

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APPENDIX A

JEWISH HOSPITAL VOICE PROFILE

NAME _____ AGE _____ B.D. _____ GRADE _____ SEX _____

How long has the problem existed?

Voice Severity: 1 2 3 4 5 6 7

In what situations is the voice better or worse?

Articulation Disorder: Yes _____ No _____

Length of sustained "ah" _____

LARYNGEAL CAVITY		RESONATING CAVITY	
PITCH		NASALITY	
HIGH		HYPERNASAL	
B		C	
+3		+4	
+2		+3	
A open	-4 -3 -2 1 +2 +3 closed	+2	
	-2	1	
	-3	-2	
LOW		HYPONASAL	
Constant _____	Rate	Intensity	Vocal Range
Variable _____	-2 1 +2	-2 1 +2	-2 1 +2
	Slow Fast	Soft Loud	Monotone Variable Pitch

Comments: _____

Examiner _____

Date _____

APPENDIX B

INSTRUCTIONS FOR ELICITING MAXIMUM EXPULSION OF AIR (VITAL CAPACITY)

"I want to find out how long people can blow air, and I'd like you to help me. Now, I want you to take a deep breath and blow into this tube as long as you can, like this."
(Examiner models an easy maximum expulsion of air into the spirometer tube.)

"See, as I blew into the tube this needle moved up to here." (Examiner points to the reading on the spirometer.)

"Okay, now you do it, use just one breath."

"Good you moved the needle to here." (Examiner reinstructs.)

"Now do it again."

"Good, this time you moved the needle up to here."
(Examiner points to the reading on the spirometer.)

"This time I'm going to write down how far you moved the needle. Ready, take a deep breath, go."

"Good, do it again."

"Good, do it once more."

APPENDIX C

INSTRUCTIONS FOR ELICITING /a/

"I want to find out how long people can say /a/, and I'd like you to help me. I want you to say /a/ into this microphone, like this." (Examiner models an "easy" maximum phonation of /a/.)

"Now, you say /a/ in your lowest voice." (Examiner identifies the subject's lowest pitch on a pitch pipe, and determines a pitch three notes above the lowest pitch.)

"Good, now say /a/ higher, like this." (Examiner models the higher pitch determined on the pitch pipe.)

"Good, now use that same voice and say /a/ for as long as you can. Ready, go."

"Good, that time you said /a/ for ____ seconds.
(Examiner shows the subject how many seconds were recorded on the stop watch. The examiner reinstructs and again times the subject's phonation time.)*

"Good, you said /a/ for ____ seconds."

"This time I'm going to record you. Ready, go."

"Good, do it again." (Examiner continues until twenty maximum phonations of /a/ have been obtained from each subject.)

*Each subject was allowed to view the stop watch while phonating.