1-1-2009

Speech evaluation tasks : normative data in 19-24 year old women

Lesley A. Alexander

NORTHERN ILLINOIS UNIVERSITY

"Speech evaluation tasks: Normative data in 19-24 year old women"

A Thesis Submitted to the University Honors Program

In Partial Fulfillment of the

Requirements of the Baccalaureate Degree

With Upper Division Honors

Department of

Communicative Disorders

By

Lesley A. Alexander

Dekalb, Illinois

05/09/2009

University Honors Program

Capstone Approval Page

Capstone Title (print or type):

~ee(\'" ~ cn\0Q\-\0(\ \-as\;"S', Ncx1Y'O..-bve.. d~

\'0 V1-"dLj. \\eA,CD~ \0oxneo

Student Name (print or type): Lesley A. Alexander

Faculty Supervisor (print or type): be. ~'aerd\\12..

Faculty Approval Signature: ,~bAJJ. S: LkPkC4

Department of (print or type): Communicative Disorders

Date of Approval (print or type): Apn'1 3/2, ¢dO 2

HONORS THESIS ABSTRACT
THESIS SUBMISSION FORM

AUTHOR: LESLEY A. ALEXANDER

THESIS TITLE: "SPEECH EVALUATION TASKS: NORMATIVE DATA IN 19-24 YEAR OLD WOMEN"

ADVISOR: DR. SHERRILL R. MORRIS

ADVISOR DEPT: COMMUNICATIVE DISORDERS

DISCIPLINE: SPEECH-LANGUAGE PATHOLOGY YEAR: 2009

PAGE LENGTH: 8

BIBLIOGRAPHY: INCLUDED

ILLUSTRATED: NO

PUBLISHED: NO LIST PUBLICATION: *N/A*

COPIES AVAILABLE (HARD COPY, MICROFILM, DISKETTE): 1

ABSTRACT:

THE PURPOSE OF THIS STUDY WAS TO AUGMENT DATED NORMATIVE STUDIES OF TYPICAL VOICE EVALUATION TASKS. ONE HUNDRED WOMEN, AGED 10-24 YEARS COMPLETED SEVERAL SPEECH TASKS. THE FOLLOWING WERE CALCULATED USING THE SPEECH FILING SYSTEM SOFTWARE: S/Z RATIO, MAXIMUM PHONATION TIME (MPT), SUSTAINED PITCH (FO), AND DIADOKOKINETIC RATES (DDK). RESULTS INDICATED THE ONE HUNDRED FEMALE PARTICIPANTS WERE COMPARABLE TO PREVIOUSLY PUBLISHED STUDIES FOR DDK AND FO; HOWEVER, , THEY EXHIBITED SHORTER PHONEME DURATIONS.

Speech evaluation tasks: Normative data in 19-24 year old women

Lesley A. Alexander
Under the supervision of
Dr. Sherrill R. Morris

Northern Illinois University
Department of
Communicative Disorders
Honors Capstone Project
Spring 2009

Abstract

The purpose of this study was to augment dated normative studies of typical voice evaluation tasks. One hundred women aged 19-24 years completed several speech tasks. The following were calculated using the Speech Filing System software: *s/z* ratio, maximum phonation time (MPT), sustained pitch (fo), and diadokokinetic rates (DDK). Results indicated the one hundred female participants were comparable to previously published studies for DDK and Fo; however, they exhibited shorter phoneme durations.

Keywords: *voice analysis, slz ratio, maximum phonation time, sustained pitch,, fundamental frequency, diadokokinetic rates*

Introduction

This study determined normative values of four voice evaluation tasks: *s/z* ratio, maximum phonation time (MPT), sustained pitch (fo), and diadokokinetic (DDK) rates among 100 females between the ages of 19-24 years. The information derived from this study proves vital to the speech-language pathology field by defining normative values to help discriminate normal and pathological voice attributes, utilizing readily available acoustical analysis, and supplementing previously established values with a larger sample.

The chosen measures are common in voice evaluations, because each assesses a unique attribute of the speech mechanism. For example, the s/z ratio allows for a comparison between the respiratory and laryngeal components necessary for speech production. MPT provides an indication of an individual's respiratory support for speech,, while fo is helpful in analyzing vocal fold vibratory function. DDK measures an individual's ability to produce quick alterations of the articulators demonstrating it as a necessary component of speech. Comparing variations from average values can identify several problems including respiratory abnormalities or vocal dysfunctions. Considering results from these four evaluation tasks, clinicians can identify clients with vocal abnormalities.

The s/z ratio is calculated through a division of maximum duration of */si* by maximum duration of */z/*. Because the distinctive feature between */si* and */z/* is vocal fold vibration, the speech language pathologist can distinguish respiratory from laryngeal factors associated with a voice disorder.. A large ratio would demonstrate an individual's difficulty in sustaining the voiced */z/*. As such, vocal fold pathologies, such as an additive lesion along the glottal margin,, may be present.. Along with identification of pathology, *slz* ratio may also be used for monitoring progress of treatment effectiveness in a speech therapy program (Eckel & Boone, 1987).

Prior studies have demonstrated the importance of determining the maximum phonation time (MPT) in speakers. MPT is imperative to speech language pathologists because of its ability to indicate a vocal dysfunction. Maximum phonation time is the greatest duration over which phonation can be sustained, typically for a vowel sound. A significantly shorter phonation time than expected may identify laryngeal lesions and/or deviations in regulating the air stream in the speech mechanism (Eckel & Boone, 1987). Additionally, a deviated phonation time may be

indicative of poor respiratory support (Case, 2002). One's ability to prolong voicing for analysis also helps to assess the function and anatomy of the larynx (Felippe, Grillo, & Grechi, 2006).

Additionally, sustained pitch, also called sustained fundamental frequency, is the number of times the vocal folds vibrate per second during the production of a prolonged vowel. A fundamental frequency that is higher or lower than expected for one's age or gender may indicate pathologies. Additionally, variability in frequency between cycles of vocal fold vibration, also known as jitter, is used as a screening measure for inadequate lung pressure or deviations in vocal fold mass and tension (Ferrand, 2007).

Finally, diadokokinetic tasks provide a maximum repetition rate when speakers produce a series of sound combinations (typically pu-te-ka) as quickly and accurately as they can. Slow diadokokinetic rates can identify problems associated with a wide range of speech disorders, including neuropathologies and functional dyslalia. (Baken, 2000)

With the increased availability of inexpensive acoustical analysis programs, all speech-language pathologists can supplement perceptual judgments with acoustical measures. The use of acoustic analysis provides professionals an objective and noninvasive measurement of vocal function that can supplement perceptual measures. Although the stopwatch served a primitive function for the temporal analysis of speech, the user friendly and often free software available to speech-language pathologists provides a more accurate and inclusive tool. For example, the availability of programs, such as the Speech Filing System (Huckvale, 1987), allows speech-language pathologists to easily conduct acoustic analysis of speech. Although some programs require a specific operating system, freeware programs suitable for multiple operating systems are available.

To reliably utilize these acoustical analysis programs in clinical practice, it is pertinent to establish a large-scale normative sample of values. This study expanded smaller data sets and increased the generalizability of values by implementing the user friendly Speech Filing System. Many studies have briefly addressed normative values of women in the aforementioned speech analysis tasks, but not many have recently addressed a large sample within a small age range. Almost 40 years ago, Fitch and Holbrook conducted a study in which they sampled 200 male and female university students (100 of each) for modal vocal fundamental frequency. In this study they utilized the FLORIDA (frequency-lowering or raising intensity determining apparatus), however, normative data was only recorded for modal fundamental frequency (Fitch & Holbrook, 1970).

Determining values within a small age range is important for accurate comparisons of an individual client's voice with a normative sample. The process of aging may have significant impacts on phonatory function (Awan, 2008), thus research must examine these smaller age groups to appropriately administer therapy. Awan (2008) reiterated the need for narrow age ranges in normative data as she examined acoustic and respiratory changes over the lifespan. Unfortunately, Awan restricted her study to only 10 female participants in each age set, and not every age group was studied.

MethodslProcedure

Participants

Participants included one hundred women, whose ages fell between 19 and 24 years at the time of recording. After reading and signing an Institutional Review Board approved consent form, each woman was instructed to take a deep breath and produce an /si/, /zJ, and /O/ for as long as they could. The s/z ratio, maximum phonation time, and sustained pitch were determined from those recordings. They were also requested to say "pu-te-ka" (/pAtaka/) as quickly and accurately as possible for as long as they could (at least seven seconds) to determine repetition rate. Additionally, participants answered questions regarding their health history. Previous communication problems, current illnesses and prescriptions that could impact vocal fold function, hearing loss, vocal concerns, previous vocal training, classification as a professional singer, smoking history, exposure to second hand smoke and exposure to agricultural chemicals and toxins were addressed (See Appendix A for questionnaire). All responses were taken into consideration after data was collected by acoustical analysis.

Speech Analysis

Each sample was recorded in a quiet environment on a windows operating system using the Speech Filing System Program (SFS). Various samples were recorded with one of three different microphones of differing qualities.

Recorded samples were then analyzed using the Speech Filing System. The SFS program, developed at University College of London, was the solitary acoustic analysis program used to make these measurements. All quantitative data was compared to prior studies that discussed similar measurements on women close to the 19-24 age range.

To acquire data for the slz ratio, each subject produced /si/ for as long as possible on two occasions. Each subject then sustained the /zJ sound for as long as possible for two trials. The duration of each trial was calculated using a waveform and spectrogram produced by the SFS program and the average ratio for each trial was determined.

Maximum phonation time required the subject to sustain a vowel sound for as long as possible. Each subject was recorded twice producing the /O/ sound. Values were then determined using a waveform and spectrogram generated by the SFS program.

In regards to sustained pitch, the sample of each subjects' /O/ recording was used to determine the fundamental frequency. This task required no additional recordings by the subject. Each /O/ recording from the MPT analysis was used to evaluate the sustained pitch ofthe subjects. Values for this task were determined using a fundamental frequency track generated by the SFS program.

Finally, diadokokinetic tasks were calculated from two trials from each subject. Each subject produced /pAtaka/ as quickly and accurately as possible for at least seven seconds. The

repetition rate was determined as the number of complete /pAtaka/ productions within 5 seconds extracted from the middle of each sample.

Results

Two trials were obtained for each of the speech tasks. Each subject's scores for each task were averaged together providing a mean *lsi* duration,, *hi* duration,, *sIz* ratio, /O/ duration, fundamental frequency, and DDK rate.

Scores from the 100 women were averaged to find normative values. Table 1 shows the mean with standard deviation in parentheses of each of the measures. Table 2 indicates the ranges of average values.

Table 1: Mean and standard deviation of average values.

TIISk	MetI1I	SlIJndanJ Deviation
S duration	16.73 sec	(6.29)
Z duration	14.89 sec	(5.99)
slz ratio	1.20 sec	(0.34)
Maximum phonation duration	13.29 sec	(5.07)
Fundamental Frequency	207.14 Hz	(26.55)
DDK rate	10.39 repetitions/ 5 sec	(1.54)

Table 2: Ranges of average values displayed by minimum and maximum results.

TIISk	Minim."",n	MI1Xim"h
S duration	7.04 sec	34.87 sec
Z duration	5.28 sec	33.69 sec
slzratio	.45 sec	2.27 sec
Maximum phonation duration	4.50 sec	32.71 sec
Fundamental Frequency	58.74 Hz	271.85 Hz
DDK rate	7 repetitionsl 5 sec	14 repetitionsl 5 sec

The results of this study were compared to the results of previously published studies. Due to the lack of studies on women with the same age range of subjects, the current data was compared to studies that included women aged 19-24 years.

slz ratio

Trudeau and Forest (1997) found that 25 women between 19 and 75 years of age had an average *lsI* duration of 17.85 (5.88) seconds and average z duration of 15.55 (5.9) seconds. The *sIz* ratio average was 1.15 seconds. Although the *slz* ratio was similar to the current study results, the 1997 study participants had longer *lsI* and *Iz/* durations. However, these differences were not outside the expected range based on the standard deviations of each sample. The average *lsI* duration of the current study was 16.73 (6.29) seconds and the *Iz/* duration was 14.89 (5.99) seconds. The average *sIz* ratio was calculated at 1.20 (.34) seconds. Average ranges for *lsi* within

Alexander, L.A. 2009.

the current data fell between 7.04 and 34.87 seconds; average */z/* ranges fell within 5.28 to 33.69 seconds; and average ranges for s/z ratio were .45 and 2.27 seconds.

Maximum Phonation Duration

According to Rau and Beckett (1984), nine subjects between the ages of 19 and 28 years averaged 24.6 (5.45) seconds in a maximum phonation task. Similar to the shorter *lsi* and */z/* durations, participants of the current study sustained /O/ for a shorter duration than Rau and Beckett's subjects; averaging only 13.29 (5.07) seconds. Average maximum phonation ranges in the current study fell between 4.50 and 32.71 seconds. These results appear to be significantly shorter than those reported by Rau and Beckett. However, the small sample size from Rau and Beckett (only nine subjects) reduces generalizability of those scores to a larger population.

Fundamental Frequency

In regards to sustained fundamental frequency, the present study found very similar results as previous studies. According to Solberg, Hoag, and Beals (1994), 10 females had an average fundamental frequency of216.4 Hz. Additionally, DeFelippe, Grillo, & Grechi (2006) reported the foof females between 20 and 45 years old averaged 205.82 Hz. The fundamental frequency of current participants averaged 207.14 (26.55) Hz. During the current study, one sample dropped to an unexpected frequency of 58.74 Hz which was 5.59 standard deviations below the mean. This drop may have compromised the validity of the sample. The concluding average range for fundamental frequency was 58.74 to 271.85 Hz.

Diadokokinetic Rate

Finally, similar to the previous studies ofDDK rates, the current study resulted in nearly equivocal syllables per second. DDK rates in the current study were calculated by counting the number of complete / pxtaka / repetitions produced in the middle 5 seconds of the sample. Participants averaged 10.39 repetitions per 5 seconds with a standard deviation of 1.77. This resulted in 6.23 syllables per second. The average diadokokinetic rate range was calculated as 7 to 14 repetitions per 5 seconds. According to the study conducted by Ptacek, Sander, Maloney, and Jackson (1966),31 women between the ages of 18 and 38 years produced 6.3 (.9) syllables per second.

Health History

The low fundamental frequency may be correlated to the known detrimental effects of the participants' history. Eighteen subjects reported being exposed regularly to second hand smoke, four identified themselves as smokers, eighteen were ill at the time of the recording, and five were taking medication that could affect the quality of their voice,

Additionally, in regards to MPT, 24% of women who fell two standard deviations below the mean or more indicated they were either a smoker themselves or were consistently exposed to second hand smoke whereas, only 3% of women who scored within -11+1 standard deviations of

the mean responded as being exposed to second hand smoke regularly. To reiterate, no smokers were within -1/+ 1 standard deviations of the mean.

Conclusion

Discussion

Differences between the current findings and previous findings are likely the result of the restricted age range and increased sample size of the current study. Even though participants had shorter durations than previously reported, typically they were within the range of scores determined in past research. Similar to other research, the current participants were instructed to hold their productions as long as possible. They were even told it might be a very long time, as long as 30 seconds. This was done to encourage them to continue the production for as long as they could.

Analysis of the results in comparison to the quality of the microphones also yielded unremarkable findings. An analysis of the three microphones was conducted based on the fundamental frequency findings. A set of 3 samples of 10 randomly selected samples of fundamental frequency were averaged separately to compare the means. The fundamental frequency for the lowest quality microphone was only 7-8 Hz lower than the averages of the two better quality microphones. Considering the standard deviation of 26.55 of the 100 samples of this study, the results of the microphone evaluation test were unexceptional..

Summary

This study sampled one hundred women in a narrow age range, providing a large sample study for the use of clinicians to compare data and implement an objective measure to report therapeutic progress. The findings of this study have presented similar, but comprehensive and new data to be utilized in further research and practice. This study also reflects the accuracy of freeware acoustical analysis systems, such as the SFS system in the use of clinical practice. The comparable results of this study demonstrate the validity in implementing inexpensive software in the clinic and during research. Even with the use of different quality microphones, the sample tasks presented no significant difference. The results of this study may be expanded upon with a more vigorous investigation of the use of the SFS system in other respects, such as, jitter, shimmer, and formant analysis.

Appendix A

The following were questions asked to the participants before recording:

1. Have you ever been diagnosed with communication impairment?
2. Were you feeling ill at the time of the recording?
3. Were you taking any medication that could affect your voice at the time of the recording?
4. Have you ever been diagnosed with a hearing loss?
5. Do you have any concerns with your voice?
6. Have you ever had previous voice training?
7. Do you consider yourself a trained singer?
8. Are you a smoker?
9. Are exposed to second hand smoke regularly?
10. Havel Are you exposed to agricultural chemicals or pesticides regularly?

Works Cited

Baken, RJ. & Orlikoff, RF (2000). *Clinical Measurement of Speech & Voice second Edition.*. San Diego: Singular Thomson Learning.

Case, J.L.. (2002). *Clinical Management of Voice Disorders.* Fourth Edition. Austin:Pro-Ed

De Filippe, A.C.N, Grillo, M.H.M.M, & Grechi, T.H.. (2006) Standardization of acoustic measures for normal voice patterns. *Brazilian Journal 0/ Otorhinolaryngology,* 72, 659-664.

Eckel, F.e.. & Boone, D.R (1981). The s/z ratio as an indicator oflaryngeal pathology. *Journal of Speech and Hearing Disorder,* 46, 147-249.

Ferrand, e..T. (2007). *Speech Science: An Integrated Approach to Theory and Clinical Practice 2'd edition.* Boston: Pearson Education, Inc.

Fitch, J.L.. & Holbrook, A. (1970). Modal vocal fundamental frequency of young adults. *Archives of Otolaryngology,* 92,379-382

Gallagher, T., and Shriner, T. (1975). Articulatory inconsistencies in the speech of normal children. *Journals of Speech and Hearing Research,* 18, 168-175

Huckvale, M.A., Brookes, D.M., Dworkin,, L.T., Johnson, M.E., Pearce, D.J., and Whitaker, L.. (1987). "The SPAR Speech Filing System". *European Conference on Speech Technology.* Edinburgh

Ptacek, P.H., Sander, E.K.., Maloney, W. H., & Jackson e.c. R (1966). Phonatory and related changes with advanced age. *Journal of Speech and Hearing Research,,* 9,353-360.

Rau, D. & Beckett, R L.. (1984). Aerodynamic assessment of vocal function using hand-held spirometers. *American Journal of Speech-Language Pathology,* 49, 183-68.

Solberg, L.C., Hoag, L.A.. & Beals, L.. (1994). Clinical Measurement of Fundamental. Frequency in Normal and Dysphonic Voices Using Electronic Tuners. *American Journal of Speech-Language Pathology,* 3,96-104.

Trudeau, M.D. & Forrest L.. A.. (1997). The contributions of phonatory volume and transglottal. airflow to the s/z ratio. *American Journal of Speech-Language Pathology,* 6, 65-69