PERCEPTIONS OF VOICE PRODUCTION IN HEALTHY FEMALES IN REGARDS TO AGE AND PROFESSIONALISM: AS QUANTIFIED BY ACOUSTIC AND PERCEPTUAL MEASURES

By

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ABSTRACT

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PURPOSE: The production of voice varies in accordance with various factors. These variations often provide an insight into a listener's perceptions of a speaker's vocal characteristics and these perceptions may vary across settings.

METHODS: The first component of this study required college aged participants to rate perceptions of age and health in young and old female vocalists. The second section required college aged participants to rate professionalism in young and old female vocalists. Speech Professionals were asked to participate in the third component of this study, in which they rated speakers among the GRBAS scale. The last component required a quantification.

RESULTS: Strong positive correlations were found between estimated age and actual age, strong negative correlations were found between older women and professionalism; moderately positive correlations were found between younger women and professionalism; moderate to strong correlation was found between age and GRBAS; and moderate negative correlations were found between age and CPPS.

DISCUSSION: The following results were found: College-aged students were able to distinguish between the younger and older females. Older women were perceived as less professional. As age increases, GRBAS scores also increase. As age increases, CPPS ratings will decrease.

CONCLUSION: Further research may require completion of surveys in a controlled environment, and inclusion of pitch-related measures as they relate to the workplace.

This thesis is dedicated to my parents,
who instilled in me the drive to seek and share knowledge

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I: INTRODUCTION

A vocalist's overall health status, vocal health, and professionalism often provide insight into the distinctive characteristics that may be perceived by a listener. In a clinical setting, such perceptions may be used by clinicians to initiate evaluations of a client, perhaps unconsciously. The output of an individual's voice is often dependent on certain factors. Current literature indicates that the physiological and anatomical deviations that occur within the speech subsystems result in vocal production changes across a lifespan. These changes can contribute to the perception of a talker's age, health status, education level, among other things. The perception of the aging voice as it relates to professionalism plays a crucial role in the social understanding of methods in which listeners may categorize speakers. Existing studies have investigated how individuals often adhere certain vocal qualities to specific professional skills. The primary aim of this study is to examine the relation of the actual age regarding the typical female voice with perceived age, overall health, and professionality/quality of the voice, as judged by a listener. This study additionally aims to examine the methods in which clinicians assess voice and the listener's perception of voice.

Voice Production and Aging

The physiological and anatomical systems within a person change in direct response to their ongoing maturation process, and while some of these deviations are observable, many are not. To understand the way in which aging affects the voice, it is important to consider how the systems supporting voice, which work in tandem with each other to contribute to an individual's vocal characteristics, typically respond to the natural aging process.

Neuromuscular System

The articulators, which include the muscles of the larynx, throat, palate, jaw, and lips, require a precise coordination of movements to create typical speech output (Simpson and Woodson. 2003). The neuromuscular system regulates coordination in musculature and accuracy of movements relating to the articulators. An interference in this system contributes to variations in the accuracy of articulatory function, which leads to changes in vocal quality production (Simpson and Woodson. 2003). Any disruption at the level of the larynx, which houses the vocal folds, contributes to a variation in vocal ability (Simpson and Woodson, 2003). The advancement of age may alter laryngeal function as the vocal mechanism may experience a calcification of cartilages and atrophy of muscles (Martins et al., 2013).

As a result of these underlying neuromuscular issues, the size and control of vocal fold movements will reduce (Martins et al., 2013). These physiological variations may lead to the distinguishable vocal characteristics of elderly voice, such as tremor and a quality of instability, which are typical to the geriatric population (Martins et al., 2013). Presbyphonia is a laryngeal disorder of physiologic origin that occurs within the geriatric population, and may be caused by neurological factors (Martins et al., 2013). This disorder leads to qualities that can be observed perceptually, such as an increase in breathiness, a reduction in vocal intensity and speech rate, and a decrease in range of voice (Martins et al., 2013). While tremor can occur in individuals with presbyphonia, it also occurs due to typical aging effects (Martins et al., 2013). Additionally, at the laryngeal level, spasms may occur, which are disruptions in vocal fold movement that contribute to perceptions of strained or harsh voice (Simpson and Woodson, 2003).

Neuromuscular issues may also cause disruptions at the level of the velopharynx (Simpson and Woodson, 2003). An inadequacy of palatal movement contributes to perceptions

of hypernasality, in which there is a weakened closure of the velopharyngeal port (Simpson and Woodson, 2003), or hyponasality, in which an obstruction is blocking air from escaping through the nose (Woo, 2012). While a range of neurological issues may lead to complications regarding voice, these will not be discussed as they have little relevance to this study.

The Respiratory System

An essential support in an individual's capacity to speak with quality and sustain phonation is attached to their respiratory system's structural and functional composition (Vaca et al. 2015). Anatomical deviations or functional changes may have an impact on the pulmonary system's ability to provide adequate breath support (Lowery et al., 2013). It is not uncommon for elderly individuals to experience curvature in their spinal column, and, depending on the degree of the deviation, this decreases overall thoracic volume which directly hinders the ability in which an individual exhales sufficiently (Lowery et al., 2013). Additionally, the advancement of age may lead to inadequate clearance in the airway due to the decrease in the musculature's functionality, a decrease in strength of cough, and an increase of defections in mucociliary function (Lowery et al., 2013).

A decrease in pulmonary function may contribute to deviations in pitch. Mueller (1997) identifies a gradual pitch reduction in the aging adult as a result of laryngeal and respiratory changes. The collaboration of the respiratory and laryngeal systems contributes to an individual's ability to speak with loudness. Subglottic pressure is the aspect that supports loudness and it requires sufficient functioning from the laryngeal valve and the supply of air within the pulmonary system (Mueller, 1997).

The Laryngeal System

The vocal folds, a vibratory mechanism in which phonation occurs, reside within the laryngeal system (Rapoport et al., 2018). This system, as with all the systems of the body, is subject to the results of maturation. The wearing down of laryngeal joints and decrease in muscular function is prevalent amongst the aging population (Baken, 2005). This is evident in the laryngeal muscles, such as the thyroarytenoid, where a decrease in mobility may be noted (Baken, 2005). In an aging individual, the vocal folds may experience an effect in which the folds bow, and this leads to an insufficient glottal adduction or closure when phonating (Rapoport et al., 2018). The atrophic process or deterioration of the thyroarytenoid muscles may eventually lead to this bowing effect (Vaca et al., 2015). This atrophy may alternatively lead to dystrophy, a diminishing of function in the muscles or nerve cells, or edema (Hunter et al., 2016) in which an overabundance of fluid in the vocal fold's cover, also known as the epithelium, leads to swelling (Ura-Sabat et al., 2020).

It is typical of the geriatric population to experience an increase in vocal fatigue, a decrease in the ability to project, changes in pitch range, and changes in vocal quality (Rapoport et al., 2018). These changes in vocal quality that are typical to the elderly include an increase in breathiness and hoarseness (Rapoport et al., 2018). Vaca et al (2015) identifies that the contribution of the superficial lamina propria thinning has a relation to the interference of the vocal fold's vibratory capabilities. The ongoing aging process additionally contributes to the loss of elasticity or stiffening of the epithelial layer of the vocal fold, which decreases the vocal fold's efficiency in vibrating to appropriately phonate (Vaca et al, 2015). The aforementioned deviations in the physiological components supporting an individual's voice have a direct impact

on that individual's change in regards to the specific characteristics of their voice (Vaca et al, 2015).

The Articulatory System

As previously mentioned, the changes of the neuromuscular system often contribute to the deviations of articulatory control; For this reason, information in this section may overlap with information presented in the neuromuscular section. Appropriate production of speech occurs due to the precise and rapid coordination of an individual's articulators (Meyerson. 1976). Any variation to the articulators may contribute to a distortion in function of surrounding articulators and output of speech. The absence of adequate dentition is often noted in the aging adult and there is evidence that this edentulous nature has an effect on other articulators, such as the tongue. Meyerson (1976) identifies that the musculature of the tongue may adjust, by increasing in movement or exhibiting hypertrophy, to compensate for the deviations in oral anatomy (Meyerson, 1976). Jaw size decreases in a vertical means due to the loss or deformation in dentition (Meyerson, 1976). As previously stated, mucociliary function decreases with age and this function along with salivary ability provides the moisture required in producing speech that is smooth and reduced in friction (Meyerson, 1976). There is a specific quality and rapidity in the movement of articulators that decreases in age, and this, along with anatomical deviations, contributes to the decrease in precise articulatory ability.

Reflections in Voice Signals

Reflected in the voice are the various biological changes within a talker's vocal subsystems. Listeners are able to perceive these aging vocal signals as a result of whole-body changes or, more specifically, changes at the laryngeal level.

Listener Perception of the Aging Voice

A listener's perception varies depending on the individual characteristics of the voice they are examining. Lantinus and Berlin (2019) research how the individualistic characteristics of voice provide socially relevant information to a listener, and they additionally emphasize that a listener is capable of extracting visual information when provided solely with the auditory input of voice. This auditory input provides important inferences about certain physical attributes, such as the gender and age of an individual (Lantinus and Berlin, 2019). In regards to perceptions of aging voice, Baken (2005) emphasizes this point by stating that listeners are able to perceive the variations in voice to accurately estimate age. Certain literature finds this true to an extent, such as in the finding of Hunter et al. (2016), where researchers found that a listener's perception of age specifically seems to vary depending on the age of the vocalist. In a meta-analysis of various pieces of literature, researchers found that listeners may often perceive older individuals at an age younger than true, and in the perceptual analysis of young speakers, listeners rated individuals to be older than their true age (Hunter et al., 2016). These statements are in relation to younger listeners. Other variations, such as internal anatomical deviations, are less noticeable or invisible to untrained observers or listeners (Rapoport et al. 2018).

The changes that occur in response to the typical aging process can be perceived by a listener. The process of aging often contributes to increased perceptions of increased roughness, breathiness, variabilities in pitch, and decreased ability to project (Rapoport, 2018). In a study by Goy and Pichora-Fuller (2006), in which researchers analyzed the perceptions of young and older voices, it was found that young talkers, who were perceived to be older, were also perceived as having less pleasant voices. In the same study, it was also found that older takers, who were perceived as older, were also perceived as having rougher voices. These specific

perceptions were made by young listeners who also identified perceived older voices to be less healthy or unpleasant (Goy and Pichora-Fuller, 2006).

Professional Voice

Vocal characteristics play an important role in the way listeners may perceive another's professionalism. These characteristics of voice vary in relation to the changes within the speech subsystems. Bottalico et al. (2015) identifies that some of these variations are due to natural anatomical and physiological differences, while other variations occur from vocal training or occupational experience. Individuals may undergo specific vocal training for their occupation, often amongst the profession of singing, to obtain a preferred quality of voice (Bottalico et al., 2015). Vocal quality is commonly identified as a necessary skill in the pursuit of employment as it is able to translate a possible amount of interpersonal skills to a potential employer (Tylečková et al., 2017).

Watson (2019) analyzes the concept of professionalism as it is perceived through voice, with specific emphasis on the qualities of the female voice. In general, females tend to speak with a higher pitch. A higher pitch of voice does not resonate as loud as a lower pitch of voice does, and this may lead to assumptions of decreased experience and youthfulness in individuals (Watson, 2019). With the advancement of age, pitch will often deviate, and this will often lower in women (Rapoport et al, 2018). In a professional setting, employers will typically prefer a lower-pitched voice as a "leader" voice as it is perceived to be louder and more resonant (Watson, 2019). The lowest register of voice is known as vocal fry (Tylečková et al, 2017). Although vocal fry is when an individual decreases their pitch to their lowest capability, the contribution it has to perceived professionalism is in question. A study by Tylečková and colleagues (2017) concludes that listeners identified the use of creaky voice, also known as vocal

fry, in American women at the age of 24 to be a less professional or hirable trait. In certain professional settings, such as print media or finance, women who use vocal fry are perceived to be increasingly intelligent, serious, or motivated (Anderson, 2014). Contrarily, in general terms, the research team of Anderson and colleagues (2014) found that vocal fry is often perceived as a negative quality in the workplace.

Another vocal characteristic common in women is the presence of a softer quality in voice, which may be difficult to hear (Watson, 2019). Though it is not uncommon for individuals with soft voices to add more power to their voice, Watson (2019) reports that this may add the additional negative perception of sounding "shrill". An additional quality that is difficult to hear and is increasingly prevalent in females is breathiness (Watson, 2019). The quality of breathiness occurs as a result of inefficient vibration of the vocal folds, as the folds do not adduct completely. Due to the negative perception of these vocal qualities, individuals may feel the need to modify or adapt their voice to better suit the demands of certain settings. This may prove to have an adverse effect on perception as individuals risk the possibility of sounding less natural or inauthentic, which employers may consider in the hiring process (Watson, 2019).

Assessing Voice and Voice Production

The goal in evaluation of voice production is to provide insight into the areas of control and physiology of speech systems subsystems. These evaluations provide crucial insight into the control and physiologic state of the speech systems. As previously stated, these subsystems contribute to the quality of voice production that listeners may hear. For the purposes of this paper, there will be specific emphasis on the perception of voice and the acoustic assessments of voice.

Perceptual Evaluation of Voice

Perceptual assessments may be informal, in which the clinician notes areas of concern while conversing with a client, or formal, in which voice is measured utilizing a standard assessment, such as the CAPE-V or GRBAS. The Consensus Auditory Perception Evaluation of Voice (CAPE-V) (Kempster et al., 2009) is a formal perceptual assessment that primarily focuses on clinical descriptions pertaining to the auditory and perceptual severities of one's voice (Reghunathan and Bryson, 2019). The Grade Roughness Breathiness Asthenia Strain (GRBAS) (Hirano, 1981) assessment is viewed as the gold standard for measuring the perceptual characteristics of voice (Reghunathan and Bryson, 2019). Each component of the GRBAS assessment is rated on the basis of a four point scale, in which 0 equates to normal, 1 is mild, 2 is moderate and 3 is severe. Nemr et al. (2012) find that the GRBAS scale is a reliable objective assessment that is able to be quickly administered and scored in comparison to other perceptual assessments. GRBAS additionally allows an evaluator to assess any voice, both typical and disordered (Nemr et al., 2012). The roughness and breathiness components of the GRBAS scale are more typically present in the typical aging adult.

Acoustic evaluation of Voice

Acoustic evaluations are often utilized by clinicians to objectively quantify voice production. Such evaluations have been used to document voice changes in the geriatric population (Harnsberger et al., 2010). Acoustic evaluations often regard variations within voice that relate to pitch, loudness and quality variations (Mueller, 1997).

To appropriately estimate pitch, the acoustic measure of an individual's fundamental frequency is crucial (Baken, 2005). Fundamental frequency is controlled primarily by the length and thickness of the vocal folds, and the more elongated or stressed the vocal folds are, the

higher an individual's pitch will be (Hunter et al., 2011). Researchers have found that fundamental frequency, which typically drops and has less variety throughout a lifespan, will typically settle between a range of 100-110 Hz in adult biological men, and 200-210 Hz in adult biological females (Mueller, 1997). These pitch changes occur in response to normal anatomical and physiological changes within the speech subsystems among the aging population (Mueller, 1997). The next component of acoustic evaluation, loudness, corresponds to the efficiency of subglottal air pressure, and as previously mentioned, this pressure requires adequate pulmonary effort and laryngeal valve coordination (Mueller, 1997).

Quality of voice refers to the perceivable quality of tone produced by an individual, and can be perceived perceptually as well (Mueller, 1997). An evaluator may use the measures jitter and shimmer for perceptions of instability in voice (Baken, 2005). Jitter and shimmer are measures often utilized to analyze cycle to cycle deviations, with jitter concentrating on the small cycle deviations in the vibratory frequency of the vocal folds, and shimmer concentrating on the cycle perturbations in amplitude (Mueller, 1997). Both measures increase as an individual ages due to structural and functional changes typical with aging (Baken, 2005). Some attributes of vocal quality that are common in the aging population are breathiness, strain and hoarseness (Mueller, 1997). Abnormalities in vocal fold movement and structure play a role in a regular vibration or quality production (Mueller, 1997).

Cepstral Peak Prominence (CPP) is an acoustic measure that is reportedly utilized by researchers as it is sensitive to changes in vocal fold anatomy and vibration (Fraile and Llorente, 2014). The vocal qualities of breathiness and roughness correlate with measures of CPP (Fraile and Llorente, 2014). Measures of CPP are evidenced to be more dependable in comparison to measures of jitter and shimmer (Padke et al., 2020). A study by Murton et al. (2020) found that

CPP has adequate sensitivity for factors such as vocal quality, loudness, age, and sex. Padke et al., (2020) supplements this by affirming that perceptual qualities correlate with measures of CPP. In a study involving teachers, who self-reported as not having any underlying vocal issues, CPP was used to measure their ability to speak in a loud and comfortable voice (Padke et al., 2020). The results garnered by the research team found that there was a significant increase in CPP in regards to loud voice when compared to a comfortable voice. This measure correlated to the perceptual findings in which the use of a loud voice was found to have better vocal quality in comparison to the use of a comfortable voice (Padke et al., 2020).

Conclusion

Voice is often used as a mean to evaluate an individual both consciously and unconsciously. Assumptions based on voice may be utilized by professionals, such as doctors or employers, to evaluate aspects such as health or competence. These assumptions may increase or decrease an individual's quality of life. The aging effect of voice in individuals may hinder quality of life, as the ability to converse and build relationships is increasingly dependent on one's vocal ability (Rapoport, 2018). This decrease in life quality often leads to feelings of isolation and may cause an individual to withdraw socially (Rapoport, 2018). Geriatric voice is an area with both established and emerging research, while aspects such as professional voice as it is perceived in social settings, is a fairly recent area of research (Tylečková et al., 2017). As evidenced by literature, researchers have studied the perception of age, professionalism, and vocal quality separately, but rarely have these components been combined under the same vocalist. This study aims to combine these areas of voice to better understand the impact of aging voice on the perception of voice.

RESEARCH QUESTION AND HYPOTHESIS

The review and compilation of literature prompts the introduction of this study's proposed research areas of inquiry, which are listed below. Additionally, and as supported by the review of existing evidence, four hypotheses accompany the respective questions. It is important to restate the following points as they contribute to the formulation of the hypotheses. A speaker's vocal production can give listeners insight into the perceived characteristics of voice. As evidenced by the literature, the characteristics of aging can be distinguished by a listener as older women typically speak at a lower pitch. These lower pitches are often perceived as increased competence. Vocal fry, the lowest register, is a quality of voice most common in young females, and is typically perceived negatively in professional settings. In addition to the perception of pitch, typical aging effects, such as tremor or breathiness, are also perceivable in voice. The acoustic measure, CPP and its variants, corresponds to these changes in vocal quality. Regarding how age is reflected in voice production, using speech recordings from young adult and senior women:

1. How well can listeners estimate the age of the speakers?

   Hypothesis (1): Listeners are more likely to rate older women's ages accurately, clearly distinguishing the younger voices from older voices.

   Reasoning: The literary findings of age estimation support this and older women typically speak with distinctive perceived characteristics, such as using a lower pitch, which can be perceived by a listener.

2. How does the age of the speaker relate to the perceptual rating of "professionalism" in a voice using the perceptual rating of overall general health as a control for Q1?

Hypothesis (2): Listeners are more likely to rate older women as more professional sounding.

Reasoning: Lower pitches are often perceived as increased competence in a work setting but the quality of vocal fry, typical in young women, is often perceived negatively in women.

3. How does perceptual ratings of vocal quality/health (vocal health with GRBAS) relate to age of the speaker?

   Hypothesis (3): Raters would likely rate younger women with a higher quality voice.

   Reasoning: The qualities of an aging voice, such as tremor or breathiness, are perceivable to a listener.

4. How does acoustic estimates of vocal quality (CPPs) relate to the age of a speaker?

   Hypothesis (4): CPPs will be higher in younger voices, as CPPs correlates with vocal quality measures.

   Reasoning: As raters will likely rate young voices with better quality, CPP which correlates with vocal quality, will increase.

CHAPTER II: METHODS

The following areas of inquiry correspond with the research questions previously stated: listener perception of age in voice, the aging voice as it relates to professionalism, vocal quality, and acoustic estimates in voice. Three participant groups were enlisted to achieve this.

[1] Towards Q1, a group of college students asked to estimate age based on the recordings of female voices. This group was also asked to rate the overall health of the speaker as a comparison to the professionalism rating.

[2] Towards Q2, a second group of college students asked to rate professionalism conveyed in the same recordings. This group was also asked to estimate age for comparison to the previous group.

[3] Towards Q3, a third group of speech pathology professionals were asked to rate the degrees of vocal health in a speaker utilizing the GRBAS scale.

Finally, towards Q4, smoothed cepstral peak prominence (CPPS) and voice spectral information were estimated from the recordings for comparison to the actual age and the perceptual ratings of Q1, Q2 and Q3.

Female Recording Samples

To quantify an individual's perception of voice, surveyors were asked to respond to a series of voice samples from younger and older women. These samples were contrived by two former graduate students from their respective studies. Olivia Rae Sowa recorded the first set of vocal samples from 11 women of the ages 55-70 to research the relation between vocal fatigue and aging (Sowa, 2018). Rachel E. Burtka (2018) recorded the second set of vocal samples from 10 women of the ages of 18-22, for her study in assessing the impact of respiratory training on vocal fatigue (only the pre-training recordings were used). A total of 107 recordings for 9 of the

11 older females were available to be used while 67 recordings were available for 6 of the 10 younger females. From these two sets, five younger female recordings and five older female recordings were selected to be used in the current study. It is important to note that the participants of Sowa's and Burtka's studies reported having typical health, as this author intends to research typical, non-disordered, aging differences in voice.

Both aforementioned studies used the same protocol for eliciting voice production; in which the vocalists participated in various vocal loading tasks and recitation of passages. In summary of the protocol, voice production instructions were presented via computer to participants to elicit a series of vocal tasks, and this included initial training on tasks particularly on producing voice at a specified vocal loudness (in dB). Over a 36 minutes period, these participants repeated the same set of passages a total of eight times as a part of the pre-vocal tasks (1 time), vocal loading tasks (6 times in 2 styles for 12 total), and post-vocal tasks (1 time). Within the pre and post-task, participants were instructed to read the passages in a comfortable or normal voice as part of the pre-vocal and post-vocal tasks with no alterations in loudness. In the vocal loading task portion, participants were asked to read the passages while alternating between 72 dB and 76 dB for 6 minutes and repeated 6 times. The recordings pre-task, vocal loading tasks, and post tasks included a recitation of the rainbow passage produced multiple times under these varying conditions. Recordings were conducted in a sound isolation booth with the participants wearing a head mounted microphone (44.1 kHz, 16bit). For the purpose of this study, the second sentence of the passage is clipped from the recordings: *"The rainbow is a division of white light into many beautiful colors."* With each individual recording this sample 8 times, three were selected for a single speaker, allowing for a more realistic representation of the speaker's voice. In each case, the 2nd, the 6th, and the 10th rendition were chosen. These were all

from the 72 dB instruction set and would represent some variation within a person from repeated productions. In total, 30 audio clips of the sentence above were prepared (3 from the 5 younger individuals and 3 from the 5 older individuals).

Participants for Question 1 and 2

This study intended to recruit a total of 50 college students for Q1 and Q2, with 25 students in group 1 and 25 in group 2. To best garner a variety of results and to keep data collection/analysis manageable, the author of this study identified 25 participants to be sufficient. This number was based on a previous study by Kaleigh Susan Cammenga (2018) studied college-aged student's ratings of the presence of vocal fry, in which 26 participants produced results in four sections. This number of participants is additionally supported by a study from Hunter and Ferguson (2017), in which 25 college students were recruited to listen and estimate the age of a talker.

The final number of participants exceeded the initial intent of the researchers. A total of 158 participant responses were collected for Q1, while a total of 133 participant responses were collected for Q2. Responses were excluded from the data collection if the participant had completed the survey under 10 minutes, answered that they were in noisy environments, had an excess number of unanswered questions, or did not respond to the consent portion of the survey. Once responses were excluded, a total of 107 survey responses were used for Q1 and a total of 107 survey responses were used for Q2. Students were recruited through the SONA system, a system provided by Michigan State University's College of Communication Arts and Sciences that allows students to participate in surveys to gain extra credit in certain courses.

Participants for Question 3

Towards Q3, 6 participants were recruited to perform perception of voice quality ratings. In a study by Cantor-Cutiva et al. (2018), three professional voice raters were asked to perceive vocal fry, while, in a study by Rubin et al. (2018), six participants were asked to rate clinical vocal health. This present study takes into consideration the previous studies to justify the recruitment of 6 participants, three Master's students in MSU's SLP program and 3 trained speech language pathology professionals. The participants were asked to perceptually rate the provided vocal samples using the GRBAS scale (Hirano. 1981).

Protocol for Q1 and Q2

The survey was designed generally as follows: informed consent section, instructions sections, environment section, listening and ratings section, and participant demographic section. Appendix B displays these various sections and questions in detail. The listening and rating sections for Q1 and Q2 were designed to be nearly identical. Both would estimate age from the recordings; group 1 would also rate overall health while group 2 would rate professionalism. This allowed us to compare age estimations across the two groups to verify similarity. Additionally, the presentation of professionalism rating could then be directly compared to the control of overall health rating.

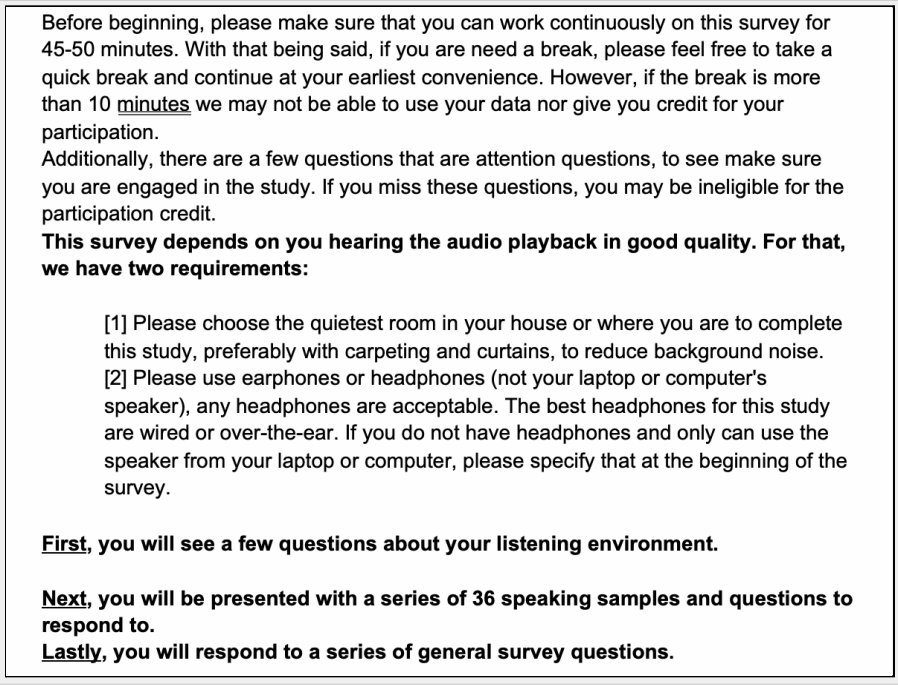
Survey Preparation and Testing

A preliminary survey with all of the sections but with only about 1/3 of the desired files to rate in the listening section was created in Qualtrics to test both the flow and the time to completion. Additionally, the survey ended with an option for feedback. These initial participants were able to complete the surveys in just less than 10 minutes. After gaining about 30 responses,

the instructions were revised per feedback and the full set of recordings were added with a goal of less than 30 minutes of participation time.

Survey Instruction Section

Prior to rating voice samples, participants were asked to read through an overview of the study, a consent, and general directions for the study. The general directions consisted of instructions regarding the ideal environment for completing this survey. These directions are presented in Figure 1. The instructions indicated that over the ear, wired headphones, and a quiet location was preferred. Listeners then had to respond about their environment and the headphones (or lack of headphones) they used (see Appendix C).


Before beginning, please make sure that you can work continuously on this survey for 45-50 minutes. With that being said, if you are need a break, please feel free to take a quick break and continue at your earliest convenience. However, if the break is more than 10 minutes we may not be able to use your data nor give you credit for your participation.
Additionally, there are a few questions that are attention questions, to see make sure you are engaged in the study. If you miss these questions, you may be ineligible for the participation credit.
This survey depends on you hearing the audio playback in good quality. For that, we have two requirements:

[1] Please choose the quietest room in your house or where you are to complete this study, preferably with carpeting and curtains, to reduce background noise.
[2] Please use earphones or headphones (not your laptop or computer's speaker), any headphones are acceptable. The best headphones for this study are wired or over-the-ear. If you do not have headphones and only can use the speaker from your laptop or computer, please specify that at the beginning of the survey.

First, you will see a few questions about your listening environment.

Next, you will be presented with a series of 36 speaking samples and questions to respond to.
Lastly, you will respond to a series of general survey questions.

Figure 1. Health and Professional Survey Requirements and Recommendations

Survey Questions

The uploaded surveys displayed identical formats in which participants were asked to complete general demographic and participant questions. These questions can be found in

Appendix G. Figure 2 displays the questions participants responded regarding age and the previously mentioned qualities for Q1 and Q2. The first group of college-aged participants were asked to rate age as it relates to health in voice samples. The second group, also made up of college-aged students, evaluated the voices as they relate to professionality. This population of participants will almost entirely be made up of individuals naive to the area of voice. The college participants, from the ages of 18-25, were asked whether or not they have typical hearing and are proficient in reception and expression of English.

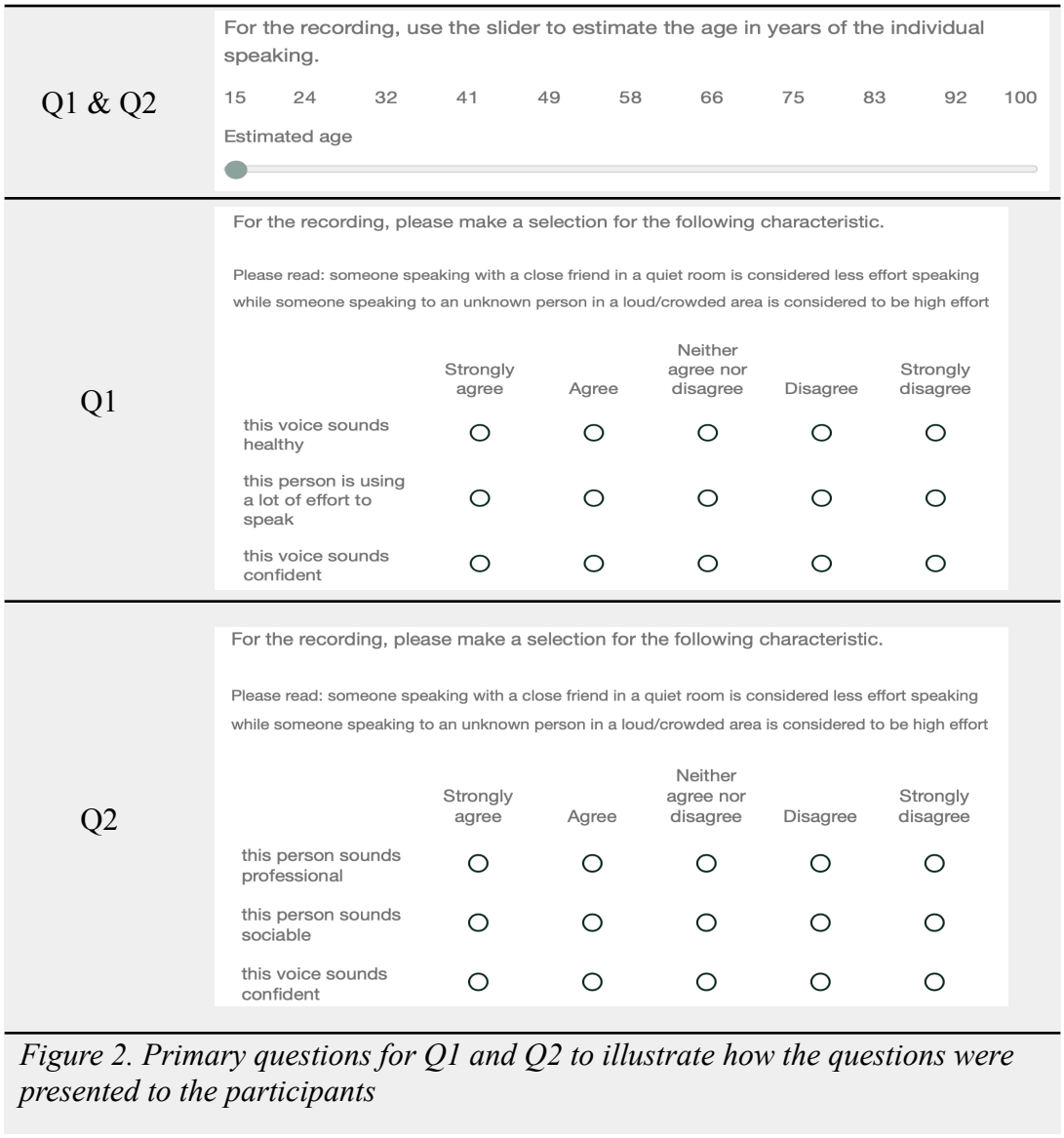


Figure 2. Primary questions for Q1 and Q2 to illustrate how the questions were presented to the participants

Q1 and Q2 participants were asked to respond to a series of questions in relation to the provided voice sample. The content of the voice-sample related questions varied depending on the group that the surveyors were in. Both groups were asked to estimate the age perceived in the voice samples.

The group of surveyors responding to Q1 were asked a series of questions related to perceptions of health in voice. These participants were asked questions pertaining to a speaker's age, speaker's health, effort and confidence reflected in the given voices. The group of surveyors responding to Q2 were asked questions relating to perceptions of professionalism in voice. These participants were asked questions pertaining to a speaker's age, speaker's professionalism, sociability and confidence reflected in the given voices.

The estimated age and confidence questions were included in both survey groups to compare the results of the two data sets. Questions for these surveys will be randomly presented with 15% of repeats to account for inter and intra-reliability. The use of inter and intra-reliability is crucial as inter-rater reliability identifies agreeance across raters, while intra-rater reliability identifies an individual's consistency in their own responses (Cohen et al., 2019).

Protocol for Q3

The protocol for Q3 participants required the perceptual measure of each voice sample presented in the survey. Six speech professionals (three Master students in SLP and three trained clinicians) were asked to complete GRBAS ratings on the voice samples presented in the surveys. These voice samples were randomly presented and participants were asked to complete their rating on an excel spreadsheet. The presented voice samples also contained 15% of repeated to account for inter and intra-reliability.

Protocol for Q4

Each sentence was analyzed using another set of custom MATLAB scripts, which preprocessed and managed the recorded samples. The custom MATLAB scripts (MathWorks, Natick, MA) used PRAAT 5.4.17 (Boersma & Weenik, 1996) to estimate CPPS using published routines (Maryn et al., 2010). As a check towards changes in style when it comes to professionalism, a second measure was estimated; previous studies (e.g., Smiljanic and Gilbert, 2017) have found a speech style effect in the mid-frequency range, energy of the spectral band 1 – 3.15 kHz. Using the same custom Matlab scripts, the long-term average spectrum (LTAS) was calculated between 50 and 8000 Hz using published spectral algorithms (Monson *et al.*, 2012). This was done by calculating first the overall energy (sum of all spectral components) and then the energy between 1 kHz and 3.15 kHz (sum of all spectral components between 1 kHz and 3.15 kHz). The energy difference in dB between these two was then calculated.

Q4 was completed after the completion of Q1, Q2 and Q3. Based on the results from the participants, the researcher of this study assessed the component of acoustics and speech patterns in individual vocal samples. The perceptions of vocal samples yielded a variety of responses. This required time dedicated to preparing files and analyzing these files to obtain a measure of fundamental frequencies and smooth cepstral peak prominence (CPPs). CPPs, an acoustic measure, has been identified to have appropriate sensitivity for factors such as vocal quality, loudness, age, and sex (Murton, 2020). Measures of CPPs will vary in correlation to those factors (Murton, 2020). As previously mentioned, younger and older women vary in vocal quality and loudness, therefore CPPs measures will be suitable in detecting acoustic variances.

Statistical Analysis

Statistical analysis was conducted with Microsoft Excel and the Data Analysis add-on. The analysis of Q1 and Q2 was similar. Inter-correlation and intra-correlation were conducted on responses to estimates in age and professionalism or overall health. Descriptive statistics was used to compare younger and older voices with student t-tests to indicate if there is a significant difference. Analysis of Q3 with GRBAS was approached in a similar fashion (descriptive statistics and t-tests) but with fewer raters. Likewise Q4 results of CPPs and mid-frequency energy were analyzed for descriptive statistics and t-tests for age differences. Finally, a correlation table between all of the above metrics was created to indicate the correlation between all questions.

CHAPTER III: RESULTS

Demographics

Question 1 – Health

A total of 107 respondents were analyzed for question 1 of the study, with the average age of participants being 20 years. The breakdown of this information is displayed on Table 3.1.

Table 3. 1. Participant numbers and demographics

Gender:	Females: 67
	Males: 39
	Non-Binary: 1
Race:	White or Caucasian: 69
	Asian: 19
	Black or African -American: 14
	American Indian/Alaskan Native: 1
	Mixed Ethnicities: 2
	Prefer not to Answer: 2

Question 2 – Professionalism

A total of 107 respondents were analyzed for question 2 of the study with the average age of participants being 20 years. The breakdown of this information is displayed on Table 3.2. These are very similar to those of Question 1.

Table 3. 2. Participant numbers and demographics

Gender:	Females: 64
	Males: 43
Race:	White or Caucasian: 78
	Asian: 15
	Black or African -American: 6
	Mixed Ethnicities: 1
	Prefer not to Answer: 4

Perception of Age

The younger voice sample set consisted of adult speakers ranging from the ages of 18 to 22. Table 3.3 presents the actual ages of the younger and older females, and the average estimated ages in relation to the health and professionalism responses. This data set found that college age listeners perceived the female's voices to range from 18 to 27 years of age. The listeners were able to perceive the ages of the younger voice samples to be within two years of the voice sample provider's actual age for a majority of the voices as evident on Table 3.3. While the average estimated age of the younger voices for the Q1 participants were slightly higher than Q1 participants, student t-test showed that this difference was not statistically different; additionally, the correlation between estimated age of Q1 and Q2 was high (0.96). Unlike the majority of the dataset, the voice samples for RBF01 and RBF09, were found to be consistently perceived as older than the actual age in both surveys.

Table 3. 3. *Younger Age Perceptions of age. Actual age and estimated ages from the two groups are shown*

Filename	Actual Age	Q1 - H Estimated Age	Q2 -P Estimated age
RBF0102	20	27.40	25.73
RBF0106	20	25.36	24.12
RBF0109	20	25.55	23.87
RBF0202	22	23.47	23.79
RBF0205	22	23.50	24.04
RBF0210	22	21.75	21.56
RBF0502	20	21.08	20.84
RBF0502-2nd	20	20.49	21.01
RBF0506	20	21.049	20.73
RBF0506-2nd	20	21.51	22.48
RBF0510	20	21.98	21.21
RBF0510-2nd	20	21.11	20.72
RBF0702	20	20.34	20.25
RBF0706	20	20.83	20.99
RBF0710	20	18.24	17.91
RBF0902	20	26.71	25.50
RBF0906	20	26.24	23.93
RBF0910	20	26.21	25.52
Average	**20.4**	**23.28**	**22.17**
St. Deviation	**0.83**	**2.82**	**2.29**

The older voice sample set consisted of adults ranging from the ages of 55-70. The combined health and professionalism survey results found that college students typically

perceived the older females voices to be from the ages of 35-76. It was noted that the college-aged listeners estimated the older female population to be younger than their actual age, as evident on Table 3.4. While the average estimated age of the younger voices for the Q1 participants' estimating ages was slightly higher than Q1 participants, student t-test showed that this difference was not statistically different; additionally, the correlation between estimated age of Q1 and Q2 was high (0.99). The voice samples provided in the OSF10 files were consistently estimated to be older than the individual's actual age. Two of the files provided for OSF13 (06 and 10) were also estimated as older. The perceptions that the college students had regarding the sample's actual age, and estimated age within the health and professionalism surveys are reflected on Table 3.4.

Table 3. 4. Older Age Perceptions of age. Actual age and estimated ages from the two groups are shown

Filename	Actual Age	Q1 - H Estimated Age	Q2 -P Estimated age
OSF0302	70	64.51	64.73
OSF0306	70	66.36	66.64
OSF0310	70	74.78	74.54
OSF0402	62	48.73	50.17
OSF0402-2nd	62	49.82	50.24
OSF0406	62	50.80	52.02
OSF0406-2nd	62	49.70	51.96
OSF0410	62	55.72	55.71
OSF0410-2nd	62	56.14	55.19
OSF0802	59	36.86	38.48
OSF0806	59	36.93	39.73
OSF0810	59	35.91	37.34
OSF1002	61	68.05	66.45
OSF1006	61	70.79	68.50
OSF1010	61	71.36	74.33
OSF1302	70	70.47	69.63
OSF1306	70	74.04	76.71
OSF1310	70	74	72.68
Average	**60.4**	**59.97**	**60.49**
St. Deviation	**4.83**	**14.56**	**13.87**

Q1 Age and Health Survey Results

Younger Vocal Sample Results

Table 3.5 reflects the averages of responses collected for each of the younger voice samples in relation to age, health, effort and confidence. The results of this study discovered a

moderate negative relation between age and health as evidenced by a correlation rate of -.53, a weak positive relation between age and effort as evidenced by a correlation rate of .20, and a moderate negative relation between age and confidence, as evidenced by a correlation rate of -.59. These outcomes suggest, as perceived age in female voice increases, perceived health and confidence in female voice decrease within the younger data set. The correlation generated for age and effort has little statistical significance.

Table 3. 5. Younger Estimated Age, Health, Effort and Confidence Survey Results

Filename	Est. Age	Health	Effort	Confidence
RBF0102	27	4.89	6.11	-0.79
RBF0106	25	4.52	-0.55	2.32
RBF0109	25	-1.34	-2.87	-6.72
RBF0202	23	1.03	0.24	-2.56
RBF0205	23	9.78	0.30	8.99
RBF0210	21	9.41	0.24	7.95
RBF0502	21	9.96	1.34	9.05
RBF0502-2nd	20	9.23	-0.48	6.17
RBF0506	21	9.29	-0.91	5.93
RBF0506-2nd	21	7.16	0.67	2.65
RBF0510	21	7.21	-0.85	2.56
RBF0510-2nd	21	8.61	0.06	5.99
RBF0702	20	8.44	-0.48	6.05
RBF0706	20	8.99	0.30	5.44
RBF0710	18	7.95	-0.61	5.93
RBF0902	26	7.76	-0.97	0.42
RBF0906	26	6.60	-0.61	4.70
RBF0910	26	5.99	-0.06	1.95
Average	**20.3**	**6.0**	**0.1**	**3.3**
St. Deviation	**2.8**	**4.4**	**1.9**	**4.3**

Older Vocal Sample Results

Table 3.6 reflects the averages of responses collected for each of the older voice samples in relation to age, health, effort and confidence. The results of this study indicate a strong negative correlation between age and health as evidenced by a correlation rate of -.74, a strong

positive relation between age and effort as evidenced by a correlation rate of .72, and a moderate negative between age and confidence, as evidenced by a correlation rate of -.53. These outcomes suggest that as perceived age in voice increases, perceived health and confidence decreases, while perceived effort increases in relation to the older female data set.

Table 3. 6. *Health survey results displaying the estimated age, health, effort and confidence perceived in the older voice set*

File	Est. Age	Health	Effort	Confidence
OSF0302	64	4.38	1.77	3.88
OSF0306	66	2.50	2.44	1.34
OSF0310	74	-2.20	5.19	-2.32
OSF0402	48	4.95	-0.06	-2.32
OSF0402-2nd	49	4.95	-0.06	3.79
OSF0406	50	4.89	0.43	3.91
OSF0406-2nd	49	5.74	-0.48	6.05
OSF0410	55	5.50	-0.85	6.48
OSF0410-2nd	56	2.38	1.16	3.18
OSF0802	36	2.65	2.16	4.07
OSF0806	36	8.62	-0.73	7.46
OSF0810	35	5.74	2.87	4.50
OSF1002	68	5.38	5.50	3.91
OSF1006	70	0.97	3.42	3.91
OSF1010	71	0.55	4.52	3.36
OSF1302	70	-0.30	4.89	2.69
OSF1306	74	-4.83	5.38	-1.22
OSF1310	74	-4.89	7.33	-0.85
Average	**60.4**	**2.2**	**3.0**	**2.8**
Standard Deviation	**4.8**	**4.0**	**2.5**	**2.7**

Comparing Health Results

The results of this study indicate that as age increases, the perception of health supplied in female voices decreases. This finding is apparent as both older and younger female voices have a moderate correlation between age and health. While the effort perceived in younger female voices has a weak statistical significance, surveyors found that the increased ages of older female voices portray an increased amount of effort, as evident by the strong correlation. When asked about their perceptions of confidence, surveyors found a moderate inverse relationship in older and younger females, which indicates as age increases, the perception of confidence in a voice decreases.

As observable in a summary Table 3.7 of the above results, the younger female voices were consistently judged to be slightly older in age, while the older female voices were judged to be slightly younger in age. The review of averages within the health survey's data set discovers that college students typically rate younger women to have an increased perception of health and slightly increased perception of confidence. Older women were perceived to display an increased perception of effort. In each of these cases, there was a clear perceptual difference between the perception of the younger and the older voices.

Table 3. 7. Health survey averages and standard deviations for both age groups

Voices	Age	Q1 Age	Q2 Age	Health	Effort	Confidence
Younger	20.4 sd 0.8	23.3 sd 2.8	22.7 sd 2.3	6.0 sd 4.4	0.1 sd 1.4	3.3 sd 4.3
Older	64.4 sd 4.8	60.0 sd 14.3	60.5 sd 13.9	2.2 sd 4.0	3.0 sd 2.5	2.8 sd 2.7

Professionalism Survey Results

Younger Vocal Sample Results

Table 3.8 displays the averages of responses collected for each of the younger voice samples in relation to age, professionalism, sociability and confidence. The results of this study indicate a moderate positive correlation between age and professionalism as evidenced by a correlation rate of .53, a weak negative between age and sociability as evidenced by a correlation rate of -.36 and a weak negative between age and confidence, as evidenced by a correlation rate of -.21. These results indicate that as perception of age in voice increases, the college students' perception of younger female's professionalism increases in a similar manner.

Table 3. 8. Professionalism survey results displaying the estimated age, professionalism, sociability and confidence perceived in the younger voice set

Filename	Est. Age	Professional	Sociable	Confidence
RBF0102	25.73	-1.07	2.45	0.51
RBF0106	24.12	-8.93	-4.46	-7.44
RBF0109	23.86	-4.59	-1.06	-3.49
RBF0202	23.79	5.65	7.29	8.82
RBF0205	24.03	5.03	7.49	8.33
RBF0210	21.55	3.64	7.67	7.38
RBF0502	20.83	1.50	4.96	4.06
RBF0502-2nd	21.01	0.25	5.66	5.20
RBF0506	20.73	-2.57	4.02	0.41
RBF0506-2nd	22.47	-2.26	4.02	0
RBF0510	21.21	-0.37	5.72	4.90
RBF0510-2nd	20.72	-0.56	5.78	4.52
RBF0702	20.24	-0.37	5.47	3.39
RBF0706	20.98	1.94	5.28	6.01
RBF0710	17.91	-9.20	0.12	-0.06
RBF0902	25.49	6.35	0.12	4.71
RBF0906	23.93	5.25	-0.05	1.83
RBF0910	25.52	0.17	-0.35	-3.054
Average	**22.7**	**0.1**	**3.0**	**2.4**
Standard Deviation	**2.3**	**4.9**	**3.7**	**4.7**

Older Vocal Sample Results

Table 3.9 displays the averages of responses collected for each of the older voice samples in relation to age, professionalism, sociability and confidence. The results of this study indicate a strong negative correlation between age and professionalism as evidenced by a correlation rate of -.74. , a strong negative between age and sociability as evidenced by a correlation rate of -.83 and a strong negative relation between age and confidence, as evidenced by a correlation rate of -.75. These results indicate that as perception of age increases, perceptions of professionalism, sociability and confidence contrastingly decrease.

Table 3. 9. Professionalism survey results displaying the estimated age, professionalism, sociability and confidence perceived in the older voice set

Filename	Est. Age	Professional	Sociable	Confidence
OSF0302	64.72	4.90	2.20	4.31
OSF0306	66.63	3.081	0.81	1.90
OSF0310	74.54	-2.76	-1.19	-3.83
OSF0402	50.16	6.41	3.27	5.91
OSF0402-2nd	50.24	6.16	2.76	4.84
OSF0406	52.01	6.54	4.08	6.35
OSF0406-2nd	51.96	7.10	4.84	6.91
OSF0410	55.71	4.27	2.20	4.21
OSF0410-2nd	55.18	3.27	1.84	4.33
OSF0802	38.47	8.05	6.16	7.61
OSF0806	39.73	3.83	5.09	5.03
OSF0810	37.33	1.82	3.20	3.55
OSF1002	66.44	2.51	1.69	3.74
OSF1006	68.50	1.76	1.82	3.58
OSF1010	74.32	-0.25	2.32	2.43
OSF1302	69.62	-1.44	0.18	-0.56
OSF1306	76.70	-1.82	0.37	-1.19
OSF1310	72.67	-1.57	0.88	0.44
Average	**60.4**	**2.3**	**2.2**	**2.9**
Standard Deviation	**13.9**	***3.4***	***2.0***	***3.1***

Comparing Professionalism Results

The quality of professionalism is the sole correlation coefficient that has significance within the younger age group, as the qualities of sociability and confidence have weak correlations with this age range. College-aged participants found that younger female voices portray increased professionalism, as apparent by the moderate positive correlation, whereas older females voices portrayed decreased professionalism as evident by the strong negative correlation coefficient. The qualities of sociability and confidence were perceived to decrease as age increased for the older female population, as apparent by the strong negative correlations mentioned above.

As observable on Table 3.10, the younger female voices were judged to be slightly older in age, while the older female voices were judged to be slightly younger in age. The review of averages within the health survey's data set discovers that college students typically rate younger women to have an increased perception of sociability. Older women were perceived to display a slight increased perception of professionalism and confidence.

Table 3. 10. Professionalism survey averages and standard deviations for both age groups

Voices	Age	Q1 Age	Q2 Age	Professionalism	Sociability	Confidence
Younger	20.35sd4.85	23.3sd2.69	22.7 sd 2.3	0.1 sd 4.9	3.0 sd 3.7	2.4 sd 4.7
Older	64.4 sd *4.8*	60.0 sd 14.3	60.5 sd 13.9	2.3 sd 3.4	2.2 sd 2.0	2.9 sd 3.1

GRBAS Ratings

Perceptions of health were additionally measured by three students in the Communication Sciences and Disorders Master's program and three certified speech-language pathology clinicians. These individuals were asked to complete GRBAS ratings on the combined older and

younger female voice samples. The averages of the GRBAS scores were then correlated with each of the categories in the table below. While many values are reflected in this table, this study will only discuss the values with statistical significance. The averages of results compiled from all six raters reveals that older women were perceived to have higher levels of Grade, Roughness, Breathiness, Asthenia, and Strain.

MA Student GRBAS Ratings

Of the three MA student raters, rater 2 was observed to have the highest rate of intra-rater reliability in completing GRBAS ratings, and these averages are reflected in Table 3.11. This rater perceived older women to have higher rating of overall grade, roughness, breathiness, asthenia and strain.

Table 3. 11. MA student (Rater 2) GRBAS ratings averages

Rater 2	G	R	B	A	S
Older	1.55	1.133	0.9	0.83	0.87
Younger	0.7	0.67	0.13	0	0.33

Clinician GRBAS Ratings

Of the three clinician raters, rater 7 was observed to have the highest rate of intra-rater reliability in completing GRBAS ratings, and these averages are reflected in Table 3.12. This rater perceived older women to have higher ratings of roughness, asthenia and strain. The overall grade and breathiness between the two groups were perceived to have an equal rating.

Table 3. 12. Clinician (Rater 7) GRBAS ratings averages

Rater 2	G	R	B	A	S
Older	0.7	0.81	0.17	0.35	0.34
Younger	0.7	0.7	0.17	0.2	0.06

Comparison of MA Student and GRBAS Ratings

Table 3.13 and 3.14 displays the averages of the GRBAS ratings compiled by the 6 raters, 3.13 represents the older talkers and 3.14 represents the younger talkers. On average, it was found that older women were conventionally perceived to have a slightly higher overall rating of grade, roughness, breathiness, asthenia, and strain as noticeable by the averages generated for the older and younger females.

Table 3. 13. Averages of GRBAS scores as rated by Speech-Language Pathology professionals [Older]

Older Files	G	R	B	A	S
OSF0302	0.67	0.83	0.33	0.5	0
OSF0306	0.75	0.33	0.5	0.67	0.25
OSF0310	1.33	0.67	0.83	1.16	0.83
OSF0402 avg	0.25	0.25	0	0.083	0.08
OSF0406 avg	0.25	0.33	0.25	0.083	0
OSF0410 avg	0.83	1	0.08	0.33	0.5
OSF0802	0.5	0.66	0	0.17	0
OSF0806	0.66	0.66	0.33	0.33	0.67
OSF0810	0.66	0.33	0.16	0.17	1
OSF1002	1.25	0.92	0.67	0.75	1
OSF1006	1.33	0.67	0.5	0.17	1.33
OSF1010	1.42	1.17	0.67	0.58	1.17
OSF1302	1.67	1.17	0.67	1.17	1.83
OSF1306	1.92	1.5	0.33	1.33	2.08
OSF1310	2	1.5	0.67	1.17	2.17
Average	**1.03**	**0.8**	**0.41**	**0.57**	**0.86**
St. Dev.	**0.57**	**0.41**	**0.27**	**0.44**	**0.75**

Table 3. 14. Averages of GRBAS scores as rated by Speech-Language Pathology professionals [Younger]

Younger Files	G	R	B	A	S
RBF0102	1	1	0.17	0.33	0.33
RBF0106	1.17	1.17	0.33	0.67	0.33
RBF0109	0.83	0.83	0.5	0.5	0.17
RBF0202	0	0	0	0	0

Table 3.14. (cont'd)

RBF0205	0.3	0.17	0.17	0.17	0
RBF0210	0.17	0	0	0.17	0.17
RBF0502 avg	0.5	0.67	0.17	0.17	0
RBF0506 avg	0.83	1	0	0.17	0.17
RBF0510 avg	0.67	0.83	0.33	0	0.5
RBF0702	0.67	1	0	0	0.17
RBF0706	0.5	0.5	0	0	0
RBF0710	0.5	0.67	0	0.17	0.17
RBF0902	0.58	0.58	0	0.083	0.08
RBF0906	0.67	0.67	0.25	0.083	0.08
RBF0910	0.83	0.83	0.5	0.33	0
Average	**0.62**	**0.66**	**0.16**	**0.19**	**0.14**
St. Dev.	**0.31**	**0.36**	**0.18**	**0.20**	**0.15**

CPPs Ratings

The results of the surveys gave an indication of correlations between a vocalist's estimated age and health, the degree of professionalism perceived, an estimate of vocal quality, and their acoustic CPPs. After the administration of surveys, the researchers of this study identified commonalities in the perception of voice by individuals of naïve and professional knowledge in the area of voice. This was done by using the acoustic measures of fundamental frequency and CPPs. To measure CPPs, a previous study by Rubin et al. (2018) calculated CPPs using the software, PRAAT, for the second sentence of the rainbow passage, much like this study has done.

Cepstral peak prominence ratings were generated for each vocal sample utilized in the SONA surveys. As reflected in the table above, the correlation coefficient between age and

CPPS is -.53, which indicates that there is a moderately significant correlation between the two datasets. These findings suggest that as age increases, CPPS ratings will decrease. In relation to the younger vocal samples, CPPS ratings averaged at -38.2 with a standard deviation of 1.6, while older vocal samples averaged at -39.9 with a standard deviation of 3.3.

Cross Comparisons

A large cross correlation table was done for all the metrics. Table 3.14 displays the various components measured in this study as they correlate with each other. Positive correlations are distinguished using the color blue while negative correlations are distinguished using the color tan.

Table 3. 15. Cross Correlation table of the primary metrics. The color blue indicates a stronger positive correlation between the metrics while tan indicates a strong negative correlation between the metrics

	Actual Age	H Est. Age	H Health	H Effort	H Confide	P Estimate	P Professio	P Sociable	P Confide	G	R
cpp__av ALL											
cpp__av CAT											
dB1kTo3 kN											
S											
A											
B											
R											1
G										1	0.84
P Confiden									1	-0.62	-0.62
P Sociable								1	0.87	-0.59	-0.53
P Professio							1	0.27	0.31	-0.02	-0.11
P Estimate						1	0.2	-0.32	-0.14	0.67	0.37
H Confiden					1	-0.25	-0.07	0.51	0.49	-0.36	-0.25
H Effort				1	-0.24	0.73	0.11	-0.18	-0.17	0.73	0.44
H Health			1	-0.69	0.77	-0.61	-0.08	0.44	0.43	-0.68	-0.49
H Est. Age		1	-0.62	0.73	-0.28	0.99	0.19	-0.34	-0.16	0.68	0.38
Actual Age	1	0.92	-0.48	0.62	-0.13	0.92	0.22	-0.17	0.01	0.48	0.21

Table 3.15. (cont'd)

	B	A	S	dB1kTo3kN	cpp_av CAT	cpp_av ALL
B	1					
A	0.75	1				
S	0.6	0.76	1			
dB1kTo3kN	-0.42	-0.31	-0.21	1		
cpp_av CAT	0.24	0.14	0.04	-0.39	1	
cpp_av ALL	0.38	0.3	0.28	-0.27	0.84	1
R	0.43	0.62	0.61	-0.21	0.32	0.41
G	0.72	0.85	0.88	-0.35	0.16	0.33
P Confiden	-0.51	-0.59	-0.31	0.24	-0.29	-0.26
P Sociable	-0.53	-0.57	-0.32	0.4	-0.27	-0.16
P Professio	0.11	-0.01	0.01	-0.12	-0.15	-0.017
P Estimate	0.69	0.73	0.71	-0.52	0.16	0.3
H Confiden	-0.36	-0.45	-0.24	0.38	0.04	-0.03
H Effort	0.57	0.69	0.75	-0.22	-0.14	0.06
H Health	-0.54	-0.69	-0.62	0.49	0.05	-0.13
H Est. Age	0.71	0.73	0.71	-0.53	0.15	0.28
Actual Age	0.53	0.59	0.6	-0.37	0.05	0.23

Age, Estimated Age, Health, and GRBAS Correlations

Table 3.14 displays the correlations between the various health survey results and GRBAS. In regard to estimated age as it relates to GRBAS, there was an apparent strong positive correlation for each severity, as quantified by the values of .68 for overall grade, .71 for breathiness, .73 for asthenia, and .71 for strain. The values of these correlation coefficients suggest that as age increases, the G, B, A, and S qualities perceived in the GRBAS scale increase in a similar manner.

The overall value of health has a moderate to strong negative correlation with all aspects of the GRBAS scale. This is evident by the Grade and health correlation coefficient of -.68

translating to a strong negative correlation. A correlation coefficient of -.49 was noted in regards to Roughness and health, which can be observed as a moderate negative correlation. In relation to Breathiness and health, the correlation coefficient of -.54, suggests a moderate negative correlation. As evident by the correlation coefficient of -.69, a strong negative correlation with asthenia was observed and as evident by the correlation coefficient of -.62, strong negative correlation with strain was observed. This indicates that the perception of the individual GRBAS qualities decrease as the perception of health increases.

The perception of effort in an individual, has a strong positive relation with Grade, as evident by the correlation coefficient of .73. A moderate positive correlation was observed with Roughness, as evident by the correlation coefficient of .44. A moderate positive correlation was observed with Breathiness, as evident by the correlation coefficient of .57. A moderate positive correlation was observed with asthenia, as evident by the correlation coefficient of .69, and a strong positive relation with strain was observed, as evident by the correlation coefficient of .75. This indicates that the perception of the individual GRBAS qualities increase as the perception of effort increases.

In regards to confidence, the value of asthenia is the sole quality with statistical significance, as evident by a correlation coefficient of -.45. This value suggests that there is a moderate, negative correlation between the perception of confidence and Asthenia. This indicates that the perception of asthenia decreases as the perception of confidence increases.

Q3. Age, Estimated Age, Professionalism, and GRBAS Correlations

Table 3.14 displays the various correlations between the professionalism results and GRBAS. In regard to estimated age as it relates to GRBAS, there was an apparent strong positive correlation for each quality in their relations with age.The values of .67 for overall Grade, .69 for

Breathiness, .73 for Asthenia, and .71 for Strain. These correlations are consistent with the health survey findings.

While the general quality of professionalism has weak statistical significance with the GRBAS score, the individual qualities of sociability and confidence portray moderate to strong negative correlations. The value of sociability has a moderate negative correlation with grade, as evident by the correlation coefficient of -.59. In relation to Roughness, a moderate negative correlation was observed, as evident by the correlation coefficient of -.53. A moderate negative correlation with Breathiness was observed, as evident by the correlation coefficient of -.53. In relation to Asthenia, a moderate negative correlation was found, as evident by the correlation coefficient of -.57. These values indicate that the G, R, B, and A values decrease moderately as the values within the perceptions of sociability increases.

The value of confidence has a moderate negative correlation with Grade, as evident by the correlation coefficient of -.62. a moderate negative correlation was observed with Roughness, as evident by the correlation coefficient of -.62. A moderate negative correlation was observed with breathiness, as evident by the correlation coefficient of -.51. In relation to Asthenia, a moderate negative correlation was observed, as evident by the correlation coefficient of -.59. These values indicate that the G, R, B, and A values decrease moderately as the values within the perceptions of confidence increases.

CHAPTER IV: DISCUSSION

The intent of this study was to discern the various perceptions college-students hold pertaining to health and professionalism within the female voice. The outcomes of this study provided a variety of correlation results, ranging from weak to strong correlations. To achieve this, the researchers utilized older and younger female voice samples, created two surveys for students in the SONA system to complete, recruited 6 individuals with training in speech language pathology to complete GRBAS ratings, and used CPPS as an acoustic measure.

Hypothesis (1): Listeners Are More Likely to Rate Older Women's Ages Accurately, Clearly Distinguishing the Younger Voices From Older Voices

The results accumulated from the surveys identify a strong positive correlation in relation to age and estimated age. This is apparent on Table 3.14 within the health and professionalism listener groups. These outcomes indicate a high accuracy in the college students ability to estimate the age of the individual voices provided. These results are consistent with the literary finding of Hunter et al. (2016) in which individuals were capable of judging the ages of listeners reasonably well, and that errors in estimation are usually to judge the ages of younger speakers to be slightly older than the actual age and to judge the ages of older speakers as to be lower. Overall, the listeners were easily able to distinguish the older voices from the younger voices.

Hypothesis (2): Listeners Are More Likely to Rate Older Women as more Professional Sounding

When comparing the overall results of younger and older females displayed on Table 3.14, statistical correlation was found to be weak for the qualities of professionalism, sociability and confidence. The separate correlations for younger and older females were found to hold

stronger correlations. The results of this study indicate that listeners perceive younger females to portray increased professionalism in their voices in comparison to older female voices. This refutes the initial hypothesis in which the researchers predicted older female voices to be perceived as more professional. It is important to note that the listeners were of college age and a majority of the group were young college students who identified themselves as females. To test this hypothesis further in the future, it may be necessary to recruit listeners from a variety of ages and backgrounds.

Hypothesis (3): Raters Would Likely Rate Younger Women with a Higher Quality of Voice

The researchers of this study hypothesized that younger females would likely be rated as having higher qualities of voice due to the older females having somewhat age compromised vocal systems. This is affirmed by the conducted study, as it was found that as age increases, GRBAS ratings increase as well. When comparing the averages of GRBAS ratings between the younger and older females, it was found that, overall, older females had higher GRBAS ratings. These ratings were most noticeable in the areas of overall Grade, Breathiness, Asthenia, and Strain.

Hypothesis (4): CPPs will be Higher in Younger Voices, as CPPs Correlates with Vocal Quality Measures

The voice measures generated for the provided voice samples indicate that younger female voices present with increased CPPs ratings. These findings are consistent with the formulated hypothesis in which the researchers predicted that younger females will present with higher CPPs ratings. CPP allows for measures relating to harmonic dominance in the population researched in this study, which consists of individuals with non-dysphonic voices using

connected speech (Antonetti et al., 2020; Awan et al., 2013; Murton et al., 2020). CPP also allows for a preferable measure of correlation with vocal intensity (Antonetti et al., 2020; Gaskill et al., 2017; Watts & Awan, 2011). CPPS, a variation of CPP, allows for an additional measure that slightly correlates higher with breathiness. The mid-frequency energy seemed to correlate more strongly to actual and estimated age than CPP. It also correlated strongly with perceived overall health.

Limitations

Although the researchers provided guidelines in regards to the ideal environment to complete the surveys, it is important to note that the environments in which the participants responded to vocal samples were uncontrolled. Additionally, it is possible that participants experienced some fatigue while completing the survey. Participants were informed that they were allowed to take quick breaks. Listeners may not have been able to distinguish the quality of professionalism in voices due to its subjectivity. In future studies, it may be necessary to conduct this research in a controlled environment with a training that includes definitions of the qualities researched

CONCLUSION

The accumulated results of this study identify the various perceptions college age students have regarding the female voice and utilized acoustic measures to quantify the voices. Further research in controlled settings may be required to decrease the variability in which individuals were completing the surveys. Additionally, it may be beneficial to include additional pitch-related measures for the professionalism study to better understand the way female pitch may contribute to workplace perception. The results of this study demonstrate that college age perception of female voices is highly accurate in regards to age, younger females are perceived as more professional in comparison to older females, younger females have an increased perceived healthy sounding voice, and that CPP measures are higher in younger females.

APPENDICES

APPENDIX A: Consent Form

Study Title: Perceptions of Voice Qualities

Research Participant Information and Consent

[to be presented at the beginning of the Qualtrics survey]

0. Summary of consent for survey

This study intends to analyze the perceptions of various voice qualities. As a participant, you will be presented with a variety of short recordings from a range of individuals. After hearing a recording, you will make some selections in a survey form indicating what was perceived in the recording.

This form also conveys the possible risks and benefits to best inform you on your participation in this survey. After reading the information below, continuing with the survey indicates that you voluntarily agree to participate.

1. Purpose of Research and what you will do

You are being asked to participate in a research study where we will ask for your insight on various qualities which may be perceived in the voice of a speaker. You must be at least 18 years old and of general good health to participate in this study. Your participation should take about an hour (usually less).

If you participate, you will be asked to use headphones in a quiet location to listen to several short recordings of a person talking. After each short recording, you will be asked to make some selections regarding qualities of the voice you heard such as "How old does this person sound?" You will be randomly presented with one of several sets of questions and your questions may be different than another person participating since we will have multiple different questions we are testing. We will also ask some general questions about you such as your primary spoken language, hearing ability, age, previous voice training, etc.

2. Your rights to participate, say no, or withdraw

Your participation is completely voluntary. You have the right to say no. Even after acknowledging your consent to participate, you may choose to withdraw participation at any time. You are also able to stop the survey at any point, if you change your mind. You may refuse to answer any question presented to you.

3. Costs and compensation for being in this study

There are no costs to participating in this study. For those enrolled in courses with a CAS SONA class credit option for participation, you may be eligible to receive credit for participation. For all others, no compensation or remuneration is offered or implied.

For those enrolled in courses that allow for CAS SONA credit, you may also find alternative assignments to earn extra credit if you choose not to participate in this specific project. The CAS SONA system awards 1 credit per 1 hour of research participation. Neither researchers nor individual instructors will know what studies participants are involved in. As an eligible student, your instructor may provide other forms of extra credit. To be eligible for the SONA Credit, a reasonable attempt at participation is required.

4. Privacy and confidentiality

Although we will make every effort to keep the data we collect from your participation confidential, there are certain times, such as a court order, where we may have to disclose your data.

Information about your participation will be kept confidential to the maximum extent allowable by law. The data collected from you will have a unique random identifier so neither the researchers nor anyone else should

be able to link data to you. Further, we only collect general information about or information that may impact how you would perceive speech from others (e.g. age, spoken language, hearing ability, personality).

Anonymous data collected from this study may be published or presented at professional meetings. The anonymous information gathered may be used for future research studies or distributed to another investigator for future research studies without additional informed consent from you.

The data collected will be stored in a secured location with limited access (locked cabinet in a locked room on campus or a password-protected computer in a locked room). Only trained researchers under the jurisdiction of this project and Human Research Protection Program will have access to the collected data. All data will be kept for at least 3 years after the study closes.

5. *Contact Information for Questions and Concerns:*

If you have concerns or questions about this study (e.g., to better understand scientific issues or how to do any part of it, to report an issue related to your participation), please contact the student researcher coordinating your participation or Eric Hunter, at ejhunter(at)msu.edu, College of Communication Arts and Sciences, Department of Communicative Sciences and Disorders, 1026 Red Cedar Road, East Lansing, MI 48824.

If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact (anonymously if you wish) the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb(at)msu.edu or at 4000 Collins Rd, Suite 136, Lansing, MI 48910.

6. *Documentation of Informed consent.*

By clicking "Yes, I agree to participate" you indicate that you voluntarily agree to participate and will be taken to the next part for participation.

APPENDIX B: Preliminary Survey Instructions and Information

Welcome!

Thank you for your inquiry into this graduate level research survey.

This study seeks to analyze how people may perceive and identify various personal traits relying only on the voice of a speaker. These traits may include such things as perceived professionalism, general health, and age. You will be asked to listen to a short audio clip of a person speaking and then answer some survey questions about what you heard.

This study will take approximately 45 minutes. *You will need a quiet place with an internet enabled computer/laptop with headphones (required)*.

All responses provided to this survey will be anonymous.

Please review the consent information on the next page. If you would like to participate, please select "**Yes, I agree to participate**" on the next page.

If you have any questions, comments, or concerns regarding the study, please feel free to email **nizamiha@msu.edu**

We appreciate your time,

Hafsaah Nizami (Grad Student)

Eric Hunter (Professor)

→

MICHIGAN STATE UNIVERSITY

Study Title: Perceptions of Voice Qualities

Research Participant Information and Consent

0. Summary of consent for survey

This study intends to analyze the perceptions of various voice qualities. As a participant, you will be presented with a variety of short recordings from a range of individuals. After hearing a recording, you will make some selections in a survey form indicating what was perceived in the recording.
This form also conveys the possible risks and benefits to best inform you on your participation in this survey. After reading the information below, continuing with the survey indicates that you voluntarily agree to participate.

1. Purpose of Research and what you will do

You are being asked to participate in a research study where we will ask for your insight on various qualities which may be perceived in the voice of a speaker. You must be at least 18 years old and of general good health to participate in this study. Your participation should take about an hour (usually less).
If you participate, you will be asked to use headphones in a quiet location to listen to several short recordings of a person talking. After each short recording, you will be asked to make some selections regarding qualities of the voice you heard such as “How old does this person sound?” You will be randomly presented with one of several sets of questions and your questions may be different than another person participating since we will have multiple different questions we are testing. We will also ask some general questions about you such as your primary spoken language, hearing ability, age, previous voice training, etc.

2. Your rights to participate, say no, or withdraw

Your participation is completely voluntary. You have the right to say no. Even after acknowledging your consent to participate, you may choose to withdraw participation at any time. You are also able to stop the survey at any point, if you change your mind. You may refuse to answer any question presented to you.

3. Costs and compensation for being in this study

There are no costs to participating in this study. For those enrolled in courses with a CAS SONA class credit option for participation, you may be eligible to receive credit for participation. For all others, no compensation or remuneration is offered or implied.
For those enrolled in courses that allow for CAS SONA credit, you may also find alternative assignments to earn extra credit if you choose not to participate in this specific project. The CAS SONA system awards 1 credit per 1 hour of research participation. Neither researchers nor individual instructors will know what studies participants are involved in. As an eligible student, your instructor may provide other forms of extra credit. To be eligible for the SONA Credit, a reasonable attempt at participation is required.

4. Privacy and confidentiality

Although we will make every effort to keep the data we collect from your participation confidential, there are certain times, such as a court order, where we may have to disclose your data.
Information about your participation will be kept confidential to the maximum extent allowable by law. The data collected from you will have a unique random identifier so neither the researchers nor anyone else should be able to link data to you. Further, we only collect general information about or information that may impact how you would perceive speech from others (e.g. age, spoken language, hearing ability, personality).
Anonymous data collected from this study may be published or presented at professional meetings. The anonymous information gathered may be used for future research studies or distributed to another investigator for future research studies without additional informed consent from you.
The data collected will be stored in a secured location with limited access (locked cabinet in a locked room on campus or a password-protected computer in a locked room). Only trained researchers under the jurisdiction of this project and Human Research Protection Program will have access to the collected data. All data will be kept for at least 3 years after the study closes.

5. Contact Information for Questions and Concerns:

If you have concerns or questions about this study (e.g., to better understand scientific issues or how to do any part of it, to report an issue related to your participation), please contact the student researcher coordinating your participation or Eric Hunter, at ejhunter(at)msu.edu, College of Communication Arts and Sciences, Department of Communicative Sciences and Disorders, 1026 Red Cedar Road, East Lansing, MI 48824.
If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact (anonymously if you wish) the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb(at)msu.edu or at 4000 Collins Rd, Suite 136, Lansing, MI 48910.

6. Documentation of Informed consent.

By clicking "Yes, I agree to participate" you indicate that you voluntarily agree to participate and will be taken to the next part for participation.

Do you agree to participate in this study?

Yes, I agree to participate	No, I do not agree to participate

→

Before beginning, please make sure that you can work continuously on this survey for 45-50 minutes. With that being said, if you are need a break, please feel free to take a quick break and continue at your earliest convenience. However, if the break is more than 10 minutes we may not be able to use your data nor give you credit for your participation.

Additionally, there are a few questions that are attention questions, to see make sure you are engaged in the study. If you miss these questions, you may be ineligible for the participation credit.

This survey depends on you hearing the audio playback in good quality. For that, we have two requirements:

> [1] Please choose the quietest room in your house or where you are to complete this study, preferably with carpeting and curtains, to reduce background noise.
>
> [2] Please use earphones or headphones (not your laptop or computer's speaker), any headphones are acceptable. The best headphones for this study are wired or over-the-ear. If you do not have headphones and only can use the speaker from your laptop or computer, please specify that at the beginning of the survey.

First, you will see a few questions about your listening environment.

Next, you will presented with a series of 36 speaking samples and questions to respond to.

Lastly, you will respond to a series of general survey questions.

What headphones are recommended for this study?

- Wireless Headphones
- Wired Headphones
- Computer audio

APPENDIX C: Preliminary Questionnaire

Select the setting that best describes the area in which you are taking this survey

- A quiet room by yourself
- A room with some noise (things/people moving or light chatter)
- A quiet room with other people (such as a library)
- A room with a lot of noise (such as a busy coffee shop)
- Outside

Are any of these sound reducing items in the room you are working in?

- Drapes/Curtains
- Tapestries
- Carpet
- Other
- Closed windows

What kind of headphone/earphones are you using?

- Wired
- Wireless
- None (listening from computer audio -- which was in the initial requirements to not do)

Could you describe what type of headphones are you using? (i.e. Apple AirPods, Apple wired headphone)
If you are unsure, briefly describe the device

APPENDIX D: Age and Health Survey Questions

Listen to this audio file as many times as needed for the next set of questions.

For the recording, use the slider to estimate the age in years of the individual speaking.

15 24 32 41 49 58 66 75 83 92 100

Estimated age

For the recording, please make a selection for the following characteristic.

Please read: someone speaking with a close friend in a quiet room is considered less effort speaking while someone speaking to an unknown person in a loud/crowded area is considered to be high effort

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
this voice sounds healthy	○	○	○	○	○
this person is using a lot of effort to speak	○	○	○	○	○
this voice sounds confident	○	○	○	○	○

APPENDIX E: Age and Professionalism Survey Questions

Listen to this audio file as many times as needed for the next set of questions.

For the recording, use the slider to estimate the age in years of the individual speaking.

15 24 32 41 49 58 66 75 83 92 100

Estimated age

For the recording, please make a selection for the following characteristic.

Please read: someone speaking with a close friend in a quiet room is considered less effort speaking while someone speaking to an unknown person in a loud/crowded area is considered to be high effort

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
this person sounds professional	○	○	○	○	○
this person sounds sociable	○	○	○	○	○
this voice sounds confident	○	○	○	○	○

APPENDIX F: Demographic Questions

Generic Demographic

Before you finish, could you tell us a little about yourself?

What is your Age?

18 26 34 43 51 59 67 75 84 92 100

Click to write Choice 1

What gender do you identify as?

- ○ Male
- ○ Female
- ○ [ ] Other
- ○ Prefer not to say

What is your Ethnicity?

- ○ Hispanic or Latino
- ○ Not Hispanic or Latino
- ○ Prefer not to answer

APPENDIX G: Participant Information

Generic Demographic

Before you finish, could you tell us a little about yourself?

What is your Age?

18 26 34 43 51 59 67 75 84 92 100

Click to write Choice 1

What gender do you identify as?

- ○ Male
- ○ Female
- ○ _____ Other
- ○ Prefer not to say

What is your Ethnicity?

- ○ Hispanic or Latino
- ○ Not Hispanic or Latino
- ○ Prefer not to answer

What is your race?

- ○ American Indian/ Alaskan Native
- ○ Asian
- ○ Native Hawaiian or Pacific Islander
- ○ Black or African American
- ○ White or Caucasian
- ○ _____ Other
- ○ Prefer not to answer

Sec 4 - Participant Information

Compared to a normal day, today I feel:

- ○ Much less stress
- ○ Less stress
- ○ The same stress
- ○ More Stress
- ○ Much more stress

Compared to a normal day, today I feel:

- ○ Much less tired
- ○ Less tired
- ○ The same tired
- ○ More tired
- ○ Much more tired

I would describe my PRIMARY workplace/learning environment as:

- ○ Very Quiet
- ○ Quiet
- ○ Neutral
- ○ Noisy
- ○ Very noisy

Do I commonly experience symptoms of reflux (heartburn)?

- ○ Yes
- ○ No

Am I experiencing reflux symptoms today?

- ○ Yes
- ○ No

Do I commonly experience allergy symptoms?

- ○ Yes
- ○ No

In the last two weeks, have you taken any herbal, over the counter or prescribed medication for symptoms of asthma, allergies, upper respiratory infections, heartburn/reflux, or anything which might affect your hearing, airway, or sinuses?

- ○ Yes
- ○ No

On average, I consume__ caffeinated beverages per day.

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4+

Are you a native speaker of American English?

- ○ Yes
- ○ No

Do you have a non-American accent?

- ○ Yes
- ○ No

If you have an accent, where did you grow up?

- ○ [ ] Enter area
- ○ Prefer not to say

Have you ever experienced a ringing sensation in your ear(s)?

Did you experience this ringing sensation in your ear(s) during the survey?

- ○ Yes
- ○ No

Do you have any history of voice training, hearing disorders, or speech/language therapy?

- ○ Yes
- ○ No

If yes to the previous question, What kind of training or treatment did you have?

- ○ _____ Please Specify

Have you or do you play a musical instrument or sing regularly?

- ○ Yes
- ○ No

How would you rate your musical experience?

- ○ Extremely incompetent
- ○ Somewhat incompetent
- ○ Neither competent nor incompetent
- ○ Somewhat competent
- ○ Extremely competent

To be eligible for SONA credit for your participation, enter your SONA pin.

How well do the following statements describe your personality? [BIG5]

	Disagree Strongly	Disagree a little	Neither disagree nor agree	Agree a little	Agree strongly
I see myself as someone who is reserved	○	○	○	○	○
I see myself as someone who is generally trusting	○	○	○	○	○
I see myself as someone who tends to be lazy	○	○	○	○	○
I see myself as someone who is relaxed; handles stress well	○	○	○	○	○
I see myself as someone who has few artistic interests	○	○	○	○	○
I see myself as someone who is outgoing and sociable	○	○	○	○	○
I see myself as someone who tends to find faults with others	○	○	○	○	○
I see myself as someone who does a thorough job	○	○	○	○	○
I see myself as someone who gets nervous easily	○	○	○	○	○
I see myself as someone who has an active imagination	○	○	○	○	○

How well do the following statements describe your experience? [VFIa]

	Never	Almost Never	Sometimes	Almost Always	Extremely well
My voice makes it difficult for people to hear me	○	○	○	○	○
I run out of air when I talk	○	○	○	○	○
People have difficulty understanding me in a noisy room	○	○	○	○	○
The sound of my voice varies throughout the day	○	○	○	○	○
My family has difficulty hearing me when I call them throughout the house	○	○	○	○	○
I use the phone less often than I would like to	○	○	○	○	○
I'm tense when talking to others because of my voice	○	○	○	○	○
I tend to avoid groups of people because of my voice	○	○	○	○	○
People seem irritated with my voice	○	○	○	○	○
People ask "what's wrong with your voice?"	○	○	○	○	○
I don't feel like talking after a period of voice use	○	○	○	○	○
My voice feels tired when I talk	○	○	○	○	○
I experience increased sense of effort with talking	○	○	○	○	○
My voice gets hoarse with use	○	○	○	○	○

It feels like work to use my voice	○	○	○	○	○

How well do the following statements describe your experience? [VFIb]

	Never	Almost Never	Sometimes	Almost Always	Extremely well
I tend to limit my talking after a period of voice use	○	○	○	○	○
I avoid social situations when I know I have to talk more	○	○	○	○	○
I feel I cannot talk to my family after a day of work or school	○	○	○	○	○
It is effortful to produce my voice after a period of voice use	○	○	○	○	○
I find it difficult to project my voice with voice use	○	○	○	○	○
I experience pain in my neck at the end of the day with voice use	○	○	○	○	○
I experience throat pain at the end of the day with voice use	○	○	○	○	○
My voice feels sore when I talk more	○	○	○	○	○
My throat aches with voice use	○	○	○	○	○
I experience discomfort in my neck with voice use	○	○	○	○	○
My voice feels better after I have rested	○	○	○	○	○
The effort to produce my voice decreases with rest	○	○	○	○	○
The hoarseness of my voice gets better with rest	○	○	○	○	○

APPENDIX H: Correspondence Letter

MICHIGAN STATE
UNIVERSITY

EXEMPT DETERMINATION
Revised Common Rule

September 15, 2021

To: Eric James Hunter

Re: **MSU Study ID:** STUDY00006439
Principal Investigator: Eric James Hunter
Category: Exempt 3iA
Exempt Determination Date: 9/15/2021
Limited IRB Review: Not Required.

Title: Perceptions of Voice Qualities

This study has been determined to be exempt under 45 CFR 46.104(d) 3iA.

Principal Investigator (PI) Responsibilities: The PI assumes the responsibilities for the protection of human subjects in this study as outlined in Human Research Protection Program (HRPP) Manual Section 8-1, Exemptions.

Continuing Review: Exempt studies do not need to be renewed.

Modifications: In general, investigators are not required to submit changes to the Michigan State University (MSU) Institutional Review Board (IRB) once a research study is designated as exempt as long as those changes do not affect the exempt category or criteria for exempt determination (changing from exempt status to expedited or full review, changing exempt category) or that may substantially change the focus of the research study such as a change in hypothesis or study design. See HRPP Manual Section 8-1, Exemptions, for examples. If the study is modified to add additional sites for the research, please note that you may not begin the research at those sites until you receive the appropriate approvals/permissions from the sites.

Please contact the HRPP office if you have any questions about whether a change must be submitted for IRB review and approval.

New Funding: If new external funding is obtained for an active study that had been determined exempt, a new initial IRB submission will be required, with limited exceptions. If you are unsure if a new initial IRB submission is required, contact the HRPP office. IRB review of the new submission must be completed before new funds can be spent on human research activities, as the new funding source may have additional or different requirements.

Reportable Events: If issues should arise during the conduct of the research, such as unanticipated problems that may involve risks to subjects or others, or any

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