June 2018

Relationship Between Vocal Fatigue and Physical/Psychological Factors in Prospective Vocal Professionals

Camille C. Gray
University of South Florida, camillegray@mail.usf.edu

Relationship Between Vocal Fatigue and Physical/Psychological Factors in Prospective Vocal Professionals

by

Camille C. Gray

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science Speech-Language Pathology
Department of Communicative Sciences and Disorders
College of Behavioral and Community Sciences
University of South Florida

Major Professor: Supraja Anand, Ph.D.,
R. Michael Barker, Ph.D.,
Mary Pyfrom, M.A., CCC-SLP, MT-BC

Date of Approval:
June 15, 2018

Keywords: Vocal fatigue, Psychosocial factors, Speech pathology students, Vocal loading tasks

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Background: To date, research has primarily focused on the subjective and objective measurement of vocal fatigue in professional voice users such as teachers and singers. However, these studies have not examined the effects of psychosocial factors (*e.g.*, lack of sleep, emotional distress) leading to vocal fatigue in depth. Much like the professional voice users, students seeking to be professional voice users may face several psychosocial difficulties, may also experience similar vocal demands, and may develop vocal fatigue.

Goal: The purpose of this study is to identify the relationship between psychosocial factors and vocal fatigue in students majoring in Communication Sciences and Disorders.

Methods: During this study, graduate and undergraduate students completed a survey consisting of questions on employment, general health, vocal demands, and several standardized measures, (*e.g.*, Beck's Depression Inventory, Perceived Stress Scale, and the Vocal Fatigue Index). Vocal fatigue was induced using an adapted LingWAVES vocal loading task (~30-min duration) where participants had to meet a specific intensity goal as well as modify their pitch and voice quality. Recordings of phonation and passage reading were also made pre- and post-loading to evaluate the effects of vocal exertion. The VFI score and two objective measures (fundamental frequency and sound pressure level) were acquired and analyzed in addition to the scores from the surveys.

Results: Results revealed that all students were moderately stressed, while graduate students reported more depression. All students demonstrated vocal fatigue in both subjective and objective outcome measures. Moderate-high correlation between total psychosocial scores and VFI as well as phonation Sound Pressure Level (SPL) were observed.

CHAPTER ONE:

INTRODUCTION

"Severe or more permanent voice issues can lead to inability to work and psychosocial impacts that detract from a person's quality of life."

- *Searl and Bailey (2014)*

Vocal Demands on Professional Voice Users

Research indicates that between one-fourth and one-third of the United States workforce (*e.g.,* musicians, speech-language pathologists, and teachers) are classified as "vocal professionals" or "professional voice users" due to their reliance on a healthy voice to appropriately complete job duties (Cantor Cutiva, Vogel, & Burdorf, 2013; D'Haeseleer et al., 2017; Gottliebson, Lee, Weinrich, & Sanders, 2007; Titze, Lemke & Montequin, 1997; Vilkman, 2000). Although a standard definition of a healthy voice currently does not exist, healthy voice is often thought to be characterized by "natural phonation, smooth tone, clear articulation and speech in conformity with meaning" (Park & Park, 2015) and is an end product of a voice that has been well-maintained through adequate vocal hygiene and habits. The most effective strategies to support a healthy voice are to stay hydrated, maintain a healthy lifestyle and diet, and most importantly to use voice appropriately (National Institute of Deafness and Communication Disorders, 2014). However, many vocal professionals, do not maintain a healthy lifestyle (*e.g.,* not sleeping adequately, eating fast foods) as well as use voice appropriately (*e.g.,*

taking adequate amount of vocal rest, avoiding extreme vocal ranges) as reported by Martins, Pereira, Hidalgo & Tavares, 2014.

Due to the extreme amount of vocal demands placed on such professionals, they are at higher risk for developing phonotraumatic injuries leading to voice disorders more frequently than the general population. The American Speech-Language-Hearing Association (*ASHA*, 1993) defines a disordered voice as one characterized by "abnormal production and/or absences of vocal quality, pitch, loudness, resonance, and/or duration, which is inappropriate for an individual's age and/or sex." Further, voice disorders that are caused by poor vocal hygiene and vocal habits as seen in many vocal professionals, and occur in the absence of any structural pathology, are generally classified as "functional voice disorders." Within the realm of vocal professionals, *ASHA* (n.d.) further reports that voice problems are highest in teachers and singers, as these populations are the most likely to report functional voice disorders (Behlau & Oliveira, 2009; Van Houtte, Van Lierde, D'Haeseleer & Claeys, 2009). Additionally, teachers have been reported to exhibit more vocal symptoms (*e.g.*, throat clearing or coughing, strained or hoarse voice, vocal fatigue, globus sensation, etc.,) compared to non-vocal professional peers (Simberg, Sala, & Ronnemaa, 2004). However, according to the 2012 National Health Interview Survey, other populations may be under-represented in these statistics, as only 10% of vocal professionals seek medical intervention for their voice disorders (Bhattacharyya, 2014; Cantor Cutiva et al., 2013).

Furthermore, the increased risk of functional voice disorders in such vocal professionals can negatively impact wages, employability (Behlau & Oliveira, 2009; Solomon, 2008) and "quality or quantity of work" (Isetti & Meyer, 2014, p. 701). Because of the high prevalence of vocal professionals in the workforce, it is focal to understand how the symptoms of functional

voice disorders manifest, to better educate professionals on preventative vocal hygiene and vocal habits.

Students in Vocal Professions

Despite the incidence of voice disorders reported in teachers and professional singers, researchers have determined that future musicians and speech-language pathologists, or students majoring in these fields, are also at high risk for functional voice disorders due to poor vocal habits, which stem from poor vocal hygiene training prior to the transition into the occupational realm (Baylor, Yorkston, Eadie, Miller, & Amtmann, 2008; D'Haeseleer et al., 2017; Fairfield & Richards, 2007). Subsequently, due to poor vocal habits and hygiene, students experience increased vocal symptoms even prior to career acquisition (Behrman, Rutledge, Hembree, and Sheridan, 2008; Caraty and Montacié, 2014; Ferreira, Guerra, Loiola, and Ghirardi, 2012; Kostyk and Rochet, 1998; Welham and MacIagan, 2003). For example, Simberg, Laine, Sala, and Ronnemaa (2000) studied voice disorders in student teachers at the University of Turkey, where 34% of students (N =226) reported they had suffered from more than two vocal symptoms within the previous month, with the most prevalent symptoms being throat clearing, voice tiredness/fatigue, and sore throat. Of these students, 24% reported abnormal vocal quality and were referred to a laryngologist for further evaluation. Of the 47 participants who complied with this recommendation, 42 presented with undiagnosed organic voice disorders (*e.g.*, laryngitis, nodules, polyps), while only a small percentage (N=5) presented with functional voice disorders.

Prior research has also shown that students at the undergraduate and post-graduate level may be increasingly impacted by these vocal symptoms compared to their professional counterparts, as they tend to be younger and participate in more demanding speech situations

both occupationally and socially (Baylor et al., 2008; D'haeseleer, et al., 2017; Gottliebson et al., 2006). With regards to vocal use and exertion, it is further important to not only consider the vocal exertion of students, but also to consider the level of educational acquisition as this may impact the pursuit of employment and overall quality of life.

Level of Education. In the vast majority of prior research, voice symptoms have been primarily reported in undergraduate students rather than graduate students. This focus stems from the increased emphasis on volunteering at different community positions for undergraduate students in order to improve skills for either career acquisition or application into graduate programs. Astin and Sax (1998) reported that an estimated 70% of students participate in collegiate-sponsored activities. Further, they reported that undergraduates who are involved in structured activities, including religious events, tutoring, and teaching, have a higher occurrence of participating in the community. These factors, in conjunction with the requirement to actively participate in academic roles, contribute to an increased vocal load in undergraduate students compared to their professional counterparts. In contrast, graduate students across professions, especially those who work as teaching assistants, may be required to teach and mentor undergraduate students, which involves increased vocal exertion, in addition to the increased workload required to prepare and deliver lessons (Park, 2002). Further, as with professional teachers, 'voice' is used as the standard tool for delivering these lessons, and as such, is expected to be healthy (Laukkanen, Ilomaki, Leppanen, & Vilkman, 2008). For graduate students completing clinical work, such as speech-language pathology students, clinical work can cause not only increased vocal use, but significant stress and anxiety as these students manage classes in conjunction with clinical placement (Beck, Verticchio, Seeman, Milliken, and Schaab, 2017).

Level of Stress. Many college students are under immense levels of stress, as they are forced to juggle multiple roles (student, employee, etc.) in order to live independently and appropriately take care of their personal needs. In a comparison study between the stress levels of undergraduate and graduate speech-language pathology students, Beck et al. (2017) found that while stress levels were increased in speech pathology majors when compared to peers in different majors, there was little difference in stress level between graduate and undergraduate speech pathology majors. For both levels of students in speech pathology programs, quality of life can be greatly impacted by the vocal load required and the symptoms that may present themselves throughout the workday.

Quality of Life

Voice disorders can significantly affect quality of life, which includes concepts of "life satisfaction, well-being, happiness, meaning, and economic[s]" (Bagwell, D.K., 2013). Measurements to understand these concepts are, to date, subjective, reflecting the feelings of an individual based on their health and life participation. Researchers have attempted to quantify the extent to which quality of life is diminished specifically in individuals with voice disorders, using measures that address health-related quality of life ("perceptions of the impact of disease and treatment in…physical, psychological, and social function;" Zraick & Risner, 2008, p. 188) in conjunction with voice-disordered quality of life ("disease-specific construct that assesses activity limitations and participation restrictions;" Zraick & Risner, 2008, p. 188). Two such scales include the Voice-Related Quality of Life (V-RQOL) and Voice Activity and Participation Profile (VAPP). Cantor Cutiva and Burdorf (2014) found that overall life satisfaction was 23%

higher among teachers without voice complaints compared to those with voice complaints. Another study by Merrill et al (2013) found that 29% of the students who reported a history of voice disorders had poorer quality of life. While such scales review the communication aspect of quality of life appropriately, they poorly encompass a holistic understanding of quality of life categories such as work/occupational and/or social factors. Indeed, Smith et al (1996) classifies quality of life into "work, social, physiological, physical, and communication" categories.

Occupational Success. Across professions and levels of experience, first impressions are vital in an occupational interview. In a study focused on a voice disorder known as adductor spasmodic dysphonia (ADSD), Isetti, Baylor, Burns and Eadie (2017) found that employers make incorrect assumptions about potential employees based on the severity of symptoms related to voice disorders and may choose to hire or dismiss individuals based on this perception. Allard and Williams (2008) further reviewed disordered articulation (*e.g.,* sound errors), fluency (*e.g.,* stuttering), language (*e.g.,* Wernicke's aphasia), and voice (*e.g,* moderate hoarseness) as they relate to personality stereotypes. These stereotypes were classified into nine personality traits, which included "intelligence, self-esteem, decisiveness, reliability, emotional stability, social adjustment, stress levels, employability, and ambitiousness" – areas that are pivotal to occupational acquisition and success. They found that individuals with voice disorders are viewed to have increased stress and low ambition, and overall were rated less desirably in the aforementioned areas than individuals with no disorders. Another study by Scherer (1978) inferred personality traits based on an individual's voice. They found that specific desirable traits, including emotional stability and extraversion, were perceived based upon voice alone.

Factors and judgements such as these may lead to reduced job opportunities and consequently reduced quality of life.

For students who work in addition to being in college, negative vocal symptoms such as weak voice can have severe implications. According to Hunter and Titze (2010), negative vocal symptoms can lead to missed work days and performances, with resulting lost revenue. In more severe cases, voice disorders can cause the need for rehabilitation, changes in profession, or moving to an administrative job which would mean a decrease in work pleasure for many individuals (Martins et al., 2014). Similarly, Roy, Merrill, Gray, and Smith (2005) conducted a study to understand the impact of voice disorders on occupation. Of the 1,192 participants who reported that they have been employed in the last year, 7.2% reported voice-related work absence for one or more days, 2% reported voice-related absence for more than 4 days, and 4.3% reported that they were unable to do certain job tasks due to their voice.

Social Success. According to the aforementioned study by Merrill et al (2013), about 18% of students reported that they became depressed because of their voice, while 15% of students reported that they became less outgoing socially due to their voice. For university students, it is especially important to participate in social interaction for mental well-being (Kawachi & Berkman, 2001). The social interaction with peers, family, and co-workers is pivotal to development and can serve as a "stress buffer," or decrease the physiological response to stressful events and help individuals cope (Cohen & Wills, 1985). Considering this philosophy, students in highly demanding majors are encouraged by their school to participate in outings, study groups, community events, and service learning projects (Fenzel & Peyrot, 2005; Baylor et al., 2008). This vocal load has been studied in teachers in a study by Hunter and Titze (2010)

who found that the vocal load expected during non-occupational use (14.4% voicing) was about half of that in occupation voice use (29.9% voicing). With this in consideration, and the increased pressure on students to use their voice, there are serious implications of vocal use in and out of the occupational realm, as excessive vocal use in both settings collectively can lead to vocal misuse which can paradoxically cause vocal symptoms. These vocal symptoms can, in turn, cause individuals to withdraw from social participation causing a cycle of poor life participation and socialization (Ilomäki, Kankare, Tyrmi, Kleemola, and Geneid, 2017). If these vocal symptoms are prolonged, they can cause vocal fatigue – a common functional voice disorder (Rammage, Nichol, & Morrison, 1987) – which can further impact quality of life on a day-to-day basis.

Vocal Fatigue

In relation to functional voice disorders, vocal fatigue is of particular interest, as it is most poorly defined and, to date, delineated only by self-perception of symptoms related to the ability to produce, project, and sustain the voice (Caraty & Montacié, 2014; Fujiki & Sivasankar, 2017; Welham & Maclagan, 2003; Yiu & Chan, 2003). Vocal fatigue is most commonly characterized as "tiredness of the voice after its prolonged [use]" among other symptoms (Guzmán, Malebrán, Zavala, Saldívar, & Muñoz, 2013, p. 176). Throughout the literature, researchers have utilized questionnaires including the Vocal Handicap Index (VHI) and Vocal Fatigue Index (VFI), to quantify self-perceived symptoms of vocal fatigue (Jacobson et al., 1997; Nanjundeswaran, Jacobson, Gartner-Schmidt, & Abbott, 2015). A detailed description of these questionnaires can be found in the ***Subjective Measures of Voice*** section below.

According to prior research, vocal fatigue presents with at least one of the following symptoms: 1) altered vocal quality, 2) aphonia, 3) pain, tension, or discomfort 4) dyspnea, 5) decreased vocal projection, 6) increased vocal effort throughout the day, 7) reduced pitch maintenance or range, 8) xerostomia, or 9) improvement after resting (Behrman et al., 2008; Caraty and Montacié, 2014; D'Haeseleer et al., 2017; Ferreira et al., 2012; Gottliebson et al., 2007; Kostyk and Rochet, 1998). Fatigue is a universal symptom of normal body function, caused by prolonged use of the body system both physically and intellectually (Caraty & Montacié, 2014). As such, it is expected that these symptoms typically occur post high vocal demand (Aaronson et al., 1999). Research has further hypothesized that there are several underlying processes that may increase the occurrence or risk of vocal fatigue, and impact quality of life. The purpose of the current study is to examine a) psychosocial and b) physiological factors, as these factors have been found to be more impactful on voice problems than environment and vocal load itself (Schloneger & Hunter, 2017).

Psychosocial Factors. Psychosocial factors and overall stress on the human body have been shown to increase the risk and symptoms of vocal fatigue (Seifert & Kollbrunner, 2005). These factors can affect the voice in two ways: first, psychosocial factors may involuntarily impact motivation, emotional levels (*e.g.,* mood disturbances), sleepiness, and cognition. These factors are most notably simulated when professional actors display emotions on set by yelling, screaming, or crying (D'Haeseleer et al., 2017); however, they are also present when individuals experience emotional overload or psychological distress, such as a heated argument or traumatic event. Comparatively, an individual's ability to cope with stress, depression, and anxiety can manifest itself through the voice (Aaronson et al., 1999; Fairfield & Richards, 2007). These

variations in the untrained and trained voice can result in vocal fatigue (Titze, Lemke, & Montequin, 1997). In a study examining sleep patterns in singers, Ragan (2016) reported that the lack of sleep had a negative effect on psychosocial factors and resulted in an increase in vocal fatigue. Another study by Pilcher, Ginter, and Sadowsky (1997) investigated the alterations of sleep patterns in college students and the effects on psychosocial factors. According to their study, an average of 7-8 hours of sleep a night positively influences mental-health and wellbeing; however, most college students do not achieve this requirement. Additionally, Pilcher et al. (1997) and Bulbotz Jr, Brown, and Soper (2001) found that poor sleep quality further causes an increased feeling of "tension, depression, anger, fatigue, and confusion" which, as previously discussed, are psychosocial factors that can impact an individual's voice.

Throughout prior literature of psychosocial factors and their impact on the body, a philosophy of "the mind-body connection" has developed. This philosophy essentially encompasses the paradigm that psychosocial factors impact the body and cause somatic symptoms (Ziadni et al., 2018). The second way that psychosocial factors affect the voice is by causing physiological changes within the muscles of the body when emotions are heightened. As an example, emotional factors are shown to increase muscular tension within the larynx, causing less vocal cord flexibility and increased effort to produce and sustain the voice (Lopez, Catena, Montes, & Castillo, 2017). As such, research has shown that individuals with a lower emotional threshold or those who are experiencing increased psychological distress are more likely to experience vocal fatigue (Van Houtte, Claeys, Wuyts, & Van Lierde, 2011).

Subjective Measures. Across factors, it has been difficult to objectively measure the severity of emotional disturbances. Much like the quality of life questionnaires, subjective

questionnaires have been used for patients and research participants to self-rate their perceived symptoms.

Subjective Measures of Voice. Researchers have attempted to incorporate the study of psychosocial factors and their influence on vocal fatigue by applying psychoemotional and self-perception scales, including Vocal Handicap Index (VHI; Jacobson et al., 1997), Vocal Fatigue Index (VFI; Nanjundeswaran et al., 2015), the V-RQOL, and the VAPP (Cantor Cutiva & Burdorf, 2014).

Briefly, VHI is one of the first gold-standard scales that attempted to "quantify psychosocial consequences of voice disorders" (Jacobson et al., 1997). Questions on the VHI focus on the self-perception of experience and participation of individuals with voice disorders, including *"People seem irritated with my voice"* and "*I find other people don't understand my voice problem."* However, Jacobson et al (1997) tested this scale on individuals with organic vocal disorders – which are caused by either structural or neurological causes (*ASHA,* n.d.) - including laryngectomy, musculoskeletal tension, and acute erythema of the vocal folds. For this reason, Nanjundeswaran et al (2015) developed a secondary scale, the VFI, specifically to obtain information on the symptoms of vocal fatigue. They studied 100 participants with a variety of vocal diagnoses, including atrophy (N = 20), membranous lesion (N = 22), and dysphonia (N = 15). In contrast to the VHI, questions on the VFI focus on perceived symptoms and the temporary nature of vocal fatigue (*e.g., "the hoarseness of my voice gets better with rest."*).

While the previously mentioned scales briefly look at the broad realm of psychosocial aspects directly associated with voice disorders, or discuss the after-effects of such, they do not relate the fundamental attributes of stress, depression, and sleep with vocal fatigue despite the obvious psychosocial implications. Therefore, for the purpose of this study, subjective measures

of these fundamental attributes have been comprehensively incorporated to study their effects on vocal fatigue.

Subjective Measures of Stress. As a major psychosocial factor, stress can have a lasting impact on the vocal mechanism (Ohlsson et al., 2016). Research conducted by Przysiezny and Przysiezny (2015), showed that the working conditions of both students and professionals impacted their voices significantly. These working conditions are characterized by extreme stress, which may include "long and overloaded days, excess activities and functions, excessive vocal demand, lack of breaks, and stressful working pace."

In an attempt to measure self-perception of stress, Cohen, Kamarck, and Mermelstein (1983) devised the Perceived Stress Scale (PSS). They characterized stress by three factors: 1) unpredictability, 2) uncontrollability, and 3) overloaded. High PSS scores are indicative of vulnerability to stressful events and depressive symptoms (see Appendix C). As previously discussed, individuals with heightened interpersonal sensitivity (*e.g.,* "people [who] misinterpret others' attitudes and behaviors;" Aydogdu, Celik, & Eksi, 2017, p. 39) are more likely to experience vocal fatigue (Van Houtte et al., 2011). However, to date there is little to no literature on the correlation between these two factors.

Subjective Measures of Depression. Depression, much like stress, can have a lasting impact on the voice. Mundt, Snyder, Cannizzaro, Chappie, and Geralts (2007) studied the perception of voice via telephone throughout the progress of depression treatment. For the purpose of their study, they utilized the Hamilton Depression Rating Scale (HDRS; Hamilton, 1960) to assess progress in vocal symptoms in response to treatment. The HDRS is a common clinical tool comprised of 21 questions regarding general symptoms of depression. This scale is to be administered by a health care professional and is based upon clinical observations, rather

than the patient's perception. Authors found that greater depression severity, marked by a higher score on the HDRS, was positively correlated with lower vocalization/pause ratio and slower speaking rates.

In another study by Alpert, Pouget, and Silva (2001) HDRS was used in conjunction with a self-perceived symptoms scale known as Beck's Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, and Erbaugh, 1961). Within the realm of self-perception of depression, the BDI encompasses symptoms including "mood, pessimism, sense of failure, self-dissatisfaction, guilt, punishment, self-dislike, self-accusation, suicidal ideas, crying, irritability, social withdrawal, indecisiveness, body image change, work difficulty, insomnia, fatigability, loss of appetite, weight loss, somatic preoccupation, and loss of libido" (Sajatovic, Chen, & Young, 2015). Many of these can be connected to the psychosocial symptoms that increase the prevalence of vocal fatigue, as previously described. Encompassing a comprehensive understanding of self-perception of symptoms regarding stress and depression may lead to an increased understanding of physiological factors.

P**hysiological Factors**. Boucher and Ayad (2010) discussed the physiological factors of vocal fatigue, stating that prior research indicates that the intrinsic laryngeal muscles are generally "non-fatigable" and that it is difficult to localize fatigue to one mechanism without the use of objective observation. They further found that during and post- vocal exertion tasks, that the vocal mechanism can show signs of temporary weakness, or tremor, visualized with the use of Electromyography (EMG). Additionally, several researchers found that vocal fatigue may cause temporarily reduced strength and speed of laryngeal contraction (Hunter & Titze, 2009; Kostyk & Rochet, 1998; Solomon, 2008; Welham & Maclagan, 2003). Their observations were

consistent with Remacle, Garnier, Gerber, David, and Petillon (2017) who defined vocal fatigue by the deeper neuromuscular symptoms that occur when the laryngeal muscles are stressed to the point that it is "difficult to maintain vocal fold tension and stability in laryngeal posture." This muscular-level phenomenon may in one sense cause the self-perceived symptoms of vocal fatigue, as seen with the VHI and VFI, but further cause fundamental frequency, (F0; measured in hertz) and sound pressure level (SPL; measured in decibels or dB) variations as noted by many professionals post-vocal loading (Boucher & Ayad, 2010; Gottliebson et al., 2007; Kostyk & Rochet, 1998; Merrill et al., 2013; Schloneger & Hunter, 2017; Solomon, 2008; Vilkman et al, 1999; Weekly, Carroll, Korovin, & Fleming, 2017). Some studies have also reported contradictory findings with no correlation between acoustic parameters and vocal fatigue symptoms (Laukkanen et al., 2008)

Objective/Acoustic Measures. In prior research, a variety of objective measures such as acoustic measures have been used to identify vocal fatigue by detecting subtle changes in the voice (Fujiki & Sivasankar, 2017; Park & Park, 2015; Vilkman, Lauri, Alku, Sala, & Sihvo, 1999). Two common measures that have been a focus of the vocal fatigue research inlclude F0 and SPL (Guzmán et al., 2013). In addition, variations of F0, including habitual F0 and mean F0, (Park & Park,2015) as well as measures of perturbation (*e.g.*, jitter and shimmer) and measures of noise (*e.g.*, harmonic-to-noise ratio) have been examined (Ramacle, Garnier, Gerber, David, and Petillon, 2018). Results of these studies have been inconsistent due to the discrete changes in the vocal mechanism and how they differ between individuals (Solomon, 2008). Further, methodological variations such as recording equipment and environment, vocal loading tasks that induce fatigue may have caused differences. For the current study, a German software called LingWAVES (WEVOSYS, 2014) was selected due to its advanced voice diagnostic and analytic

capabilities. LingWAVES consists of a range of modules, including voice protocol and vocal loading test (designed to induce vocal fatigue), which makes it multidimensional for many researchers and clinicians alike. LingWAVES further provides a sound level meter-microphone for precise vocal recording. These acoustic measurements and tools aim to provide increased consistency during speech tasks, to appropriately understand the effects of high vocal demand.

Vocal Loading Tasks

Vocal Loading Tasks – henceforth referred to as "VLTs" – have been used extensively to study vocal fatigue. VLTs are speech tasks that cause significant stress to the vocal mechanism, or larynx, which in turn causes physiological system changes (Fujiki & Sivasankar, 2017). These tasks can occur or be completed in both naturalistic and laboratory settings, with the outcome being a temporary change in the laryngeal mechanism as previously discussed. In a naturalistic setting, music students undergo extensive vocal loading through strict performance and practice (D'Haeseleer et al., 2017), while teachers may combat with a noisy classroom to deliver their lectures (Echternach, Nusseck, Dippold, Spahn, & Richter, 2014). In this sense of vocal loading, the task lasts an extended period of time and can range over multiple days. In a study by Laukkanen et al (2008), teachers were recorded pre- and post- vocal exertion during a typical day of teaching. Results revealed increased F0, SPL, and alpha ratio (*e.g.*, sound energy in specific frequency bands in a long-term average spectrum).

In a laboratory setting, researchers have simulated similar effects on the vocal mechanism in a relatively shorter and more clinically-functional period of time. Echternach et al (2014) compared the effects of a 10-minute vocal loading task and a 45-minute teaching lesson on the voice, by analyzing the vibration of vocal fold tissue in participants (Assad, Magalhaes, Santos,

& Gama, 2017). Generally, during VLTs, participants are asked to either read loudly or at a varied pitch to induce stress in their voice. In Echternach's study, participants were asked to read at greater than 80 dB SPL for a prolonged period of time. They found that there were only nominal differences between the 10 min and 45 min sessions, indicating the possibility for VLT to truly simulate naturalistic setting.

A comprehensive review of such vocal loading tasks was recently published by Fujiki and Sivasankar (2017) and the article recommended that due to the complexity of the vocal mechanism, it is necessary to vary multiple factors (*e.g.*, intensity and pitch) in order to stress the vocal mechanism and invoke vocal fatigue in a short period of time. Researchers have further attempted to find the most efficient VLT by varying task specificity, time, pitch, and voice quality. For example, Vilkman et al (1999) completed their study across 5 sessions, lasting 45 minutes each. During each session, participants were tasked with reading at variable intensity levels and a rate of approximately 1 word per second. On the other hand, Buekers (1998) asked participants to read with a variety of characteristics, including increased/decreased intensity, creaky voice, non-linguistic noises and coughing, and singing at a high pitch. Highlighted in Table 1.1 are a selection of studies that feature different vocal loading tasks in different participant populations along with the loading durations, outcome measures, and the findings.

Research Gap and Questions

While the majority of research related to vocal fatigue has been conducted in vocal professionals, and specifically teachers, it is important to look at the features that impact voice in students who are prospective vocal professionals and across educational levels, including undergraduate and graduate students. While prior research has focused on the relationship

between vocal fatigue and psychosocial factors, it has not examined effects of stress, sleep and depression adequately.

Further, as it relates to graduates and undergraduates, there is variation in workload, socialization, and participation. These factors could contribute to the psychosocial presentation across these populations. In order to address these gaps in the literature, this study aimed to answer the following questions:

1) Do psychosocial factors differ between:

a) graduate versus undergraduate students

b) employed students versus unemployed students

2) How do graduate and undergraduate students vary their Fundamental Frequency (F0) and Sound Pressure Level (SPL) during the VLT?

3) Does perceived vocal fatigue as measured by the Vocal Fatigue Index (VFI) change post-vocal exertion?

4) Do acoustic measures of F0 and SPL change pre- and post-vocal exertion?

5) Is there a correlation between psychosocial factors and perceived vocal fatigue?

6) Do psychosocial factors impact acoustic measurements pre- and post- vocal exertion?

Table 1.1 Review of Prior Articles Examining Vocal Loading Tasks (VLTs).

Author	Population	# of pts	Task Description	Measures	Relevant Results
Buekers, (1998)	Women registered in phoniatric outpatient clinic with a history of vocal fatigue	20	1. Voice intervals per page; reading loudly, whispering, in a low, creaky voice, or imitating a child 2. Making an array of noises 3. Singing in different pitches 4. Coughing	- F0 - SPL - Relative Average Perturbation (RAP) - Pitch Period Perturbation Quotient (PPQ) - Shimmer - Smooth Amplitude Perturbation Quotient (sAPQ) - Noise-to-Harmonic Ratio (NHR)	No significant acoustic changes were found.
Vilkman et al (1999)	Health subjects	80	45 min x5; variable loud reading	- F0 - SPL - Subglottal Pressure	Increase in all factors.
Laukkanen et al., (2004)	Females w/ variable vocal training.	24	Reading @ 70 dB for 45 minutes	- F0 - SPL - Alpha Ratio	F0 rose. Voices w/ more vocal training had a lower F0. SPL was variable.
Boucher and Ayad, (2010)	Paid volunteers w/o history of voice problems, variable occupations.	7	1. Reading out loud for 3 min every 12-15 minutes x50. 2. Vocalizations at normal pitch and slightly higher than normal pitch	- F0 - SPL (vocalization intensity) - Parameters of Vocal Tremor	F0 inconsistent across participants
Guzman et al (2013)	Broadcasters	8	Pre- and Post- Vocal Loading; phonation tasks at variable F0, reading 104 words for 1 min	- Cepstrum (acute, medium, low) - Noise-harmonic ratio - Soft Phonation Index	Decrease in cepstrum acute pre and post. Decreased noise-harmonic ratio Increased soft phonation index
Caraty & Montacié (2014)	Actors	4	3-hour reading	- Phoneme occurrence percentage - F0 - Intensity	Increased F0 and intensity only occurred in one participant
Echternach et al., (2014)	Senior student teachers	101	Standard text, 10 minutes at 80 dB; compared to normal teaching lesson.	- DSI - F0 - SPL - Phonation Time	Experiment produced higher results in the analyzed areas than normal teaching lesson.

*Note: pts refers to participants throughout this section.

CHAPTER 2:

METHODS

This study was approved by the University of South Florida Institutional Review Board. In order to address the research questions, all participants completed - 1) a questionnaire ranging from generic to specific questions relating to demographics, education, overall health, vocal use and health, stress, depression, and sleep through Qualtrics online portal, 2) a Vocal Loading Task (VLT) via an adapted LingWAVES vocal loading test protocol, and 3) pre and post-loading subjective (*e.g.*, self-perception of symptoms) and objective (*e.g.*, acoustic measurements) measures.

Research Participants

Undergraduate and post-graduate students majoring in speech-language pathology and music from the University of South Florida were recruited by posting flyers throughout the Communicative Disorders and Music buildings for participation in this study. This population was selected due to high reported prevalence of vocal fatigue and psychosocial disturbances in college students seeking vocal professions (Bulbotz Jr, et al., 2001; Gottliebson et al., 2007; Pilcher et al., 1997).

Inclusion and Exclusion Criteria. All students were expected to meet the following requirements: native speakers of American English, between 18 and 35 years of age, healthy

voice without history of co-morbid health conditions involving voice, respiration, and swallowing, and at least part-time enrollment at the University of South Florida, as this is a contributing factor to student workload. Exclusion criteria included students with history of smoking, chronic alcohol use, recent upper respiratory infections, asthma or other respiratory disorders, or self-reported reflux disease. Study participants were required to meet inclusion and exclusion criteria from the initial Qualtrics questionnaire.

Twenty-eight students from speech-language pathology and music majors completed the initial Qualtrics questionnaire. Of these, 82% (N=23) fit the inclusion criteria and were able to complete the questionnaire. However, only 17 of these students were able to complete the Vocal Loading Task (VLT). Of those who fit the inclusion criteria but did not participate in the VLT, one student did not provide contact information and thus was not able to be scheduled for the VLT, two students dropped out prior to VLT completion due to illness, and two participants were unable to participate due to scheduling conflicts. Finally, one student was unable to complete the VLT and thus was not included in data analysis.

Procedure

This study consisted of two portions: a questionnaire and a loading task. Below is a summary of purpose and procedure for each portion. The goal of participation was to assess academic status (*e.g.*, education level, clinical training, etc...,), overall psychosocial status (*e.g.*, depression, stress, etc...,), perception of voice and voice-related issues (*e.g.*, vocal fatigue), and the effects of vocal loading via subjective and objective measures.

Part 1: Questionnaire. The first part of this experiment involved completion of a questionnaire online using Qualtrics research software (See Appendix A) to assess accurate inclusion criteria (as discussed above), demographics, general health information, and symptoms of perceived vocal fatigue, depression, and stress. This questionnaire consisted of 103 questions grouped under five sections, as detailed below. Informed consent was obtained via positive response (e.g., "I consent") prior to beginning the questionnaires. Survey was automatically terminated if participants responded "yes" to key questions related to inclusion criteria, as follows:

- Have you had the flu, pneumonia, or throat infections in the last 2 weeks?
- Have you smoked (including cigarettes, recreational drugs, and hookah) in the past 5 years?
- Do you have acid reflux?

Participants who answered "yes" to current use of medications for sinuses, allergies, asthma or contraceptives were not excluded from this study, although this was noted. The following sections briefly describe each section of this questionnaire.

Section I: Personal Demographics and Employment. Personal demographics were acquired from each participant as a means to further classify individuals. Additionally, current employment status was collected in this section, as this could impact stress, vocal use, and sleep levels of participants.

Section II: Education and Health. The education and health section was devised with several purposes, including 1) to classify participation at the student level and ensure that all participants were in vocal professions, 2) to collect information on current clinical and voice training, and 3) to ensure inclusion criteria. As discussed in chapter 1, educational level can not

only impact stress levels due to increased participation and demands between undergraduate students and graduate students, but also vocal demand, which is important to differentiate. Additionally, an adapted portion of the works of Goldberg and Hillier (1979) and Kroenke, Spitzer, Williams, and Lowe (2010) was incorporated to briefly review mental and vocal health habits in order to gain a general impression of health quality of life.

This section further addressed sleep, including how many hours each participant sleeps per night. With regards to vocal health and habit, questions were designed to understand daily vocal use, and prior singing training (if applicable). Further, this section included questions on vocal hygiene (*e.g.,* daily water and caffeine intake) and provided a segway into the next section, the Vocal Fatigue Index (VFI), as it addressed common symptoms of fatigue, including pain, voice loss, and drying sensations in the throat and mouth.

Section III: Vocal Fatigue Index (VFI). This section included the Vocal Fatigue Index (VFI; Nanjundeshwaran et al., 2015), with two purposes: 1) to determine current perception of vocal fatigue in each participant, and 2) to compare pre- and post- perceptions of vocal fatigue when confronted with vocal loading. The purpose of the VFI is to identify factors of vocal fatigue, which include "tiredness and avoidance, physical discomfort, and symptom improvement (with rest)." The VFI is a standardized tool with strong test-retest reliability and validity that consists of 21 questions. Each question has a five-point Likert-type response scale from never to always. This was adapted to an online representation, where participants were to select radio buttons from "never" to "always", rather than circle responses from "0" to "4". The highest attainable score on the VFI is 84, with higher scores indicating more severe vocal symptoms.

Section IV: Perceived Stress Scale (PSS). The Perceived Stress Scale (PSS; Cohen et al., 1983), as discussed in chapter one, was used to analyze how much perceived stress participants were under and ordinally classify on a continuum of normal daily stresses to extreme stress with the goal to compare stress levels to vocal fatigue symptoms. This questionnaire consists of 10-questions and additionally uses a five-point Likert type scale. Much like the VFI, this scale was adapted to an online version, where participants selected responses, as opposed to circling numbers to indicate their response. However, scoring was consistent with the standard protocol, as it was completed by reversing responses for questions 4, 5, 7, and 8, and then adding scaled items to achieve a scaled score. The maximum score that can be achieved on this scale is 40, with higher scores indicated high perceived stress. To date, this scale has been widely used in a psychiatric setting and demonstrates excellent reliability and validity. Prior research on prevalence of psychosocial distress in patients presenting with voice concerns has used this scale due to its ability to assess stress independently from depression (Misono et al., 2014).

Section V: Beck's Depression Inventory (BDI). Beck's Depression Inventory (Beck et al., 1961), also discussed in chapter one, was used to assess depression and other mood disturbances in participants. This questionnaire contains 21-questions, each with four responses with scoring ranging from 0 to 3. Additionally, this was adapted to an online version with radio buttons for selection. The highest attainable score is 63, with higher scores indicating more severe depression. The BDI has been used in many different settings and has proven to be valid and reliable.

Upon completion, participants who fit inclusion criteria were contacted via preferred method (phone or e-mail) to schedule the VLT. Time between survey and questionnaire ranged from one day to two weeks, and occurred across the Spring 2018 and Summer 2018 semesters.

As such, there is a possibility that for participants who completed the VLT after the summer semester began, stress levels may have been reduced. Participants who did not fit experiment criteria were contacted via e-mail to notify them of the results.

Part 2: Vocal Loading Task

Participants were seen in the Communication Sciences and Disorders (CSD) building at the University of South Florida to complete the VLT. The VLT was devised to create high stress vocal situations in a short period of time and simulate the daily vocal load of student professionals in order to invoke vocal fatigue. Informed consent was reviewed again, and participants were allowed to ask questions prior to receiving a printed and signed hard copy. Time of day was recorded. Specific experimental protocol is highlighted in Figure 2.1 and described below.

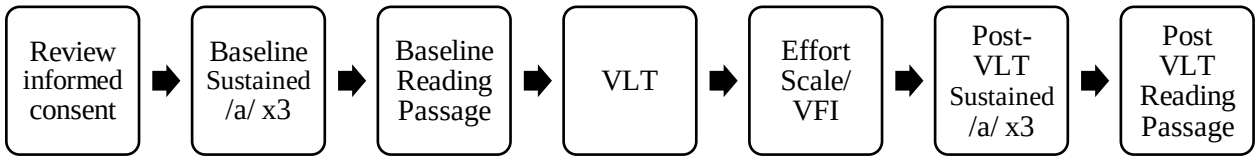

Figure 2.1 Diagram of Flow: Vocal Loading Task.

Booth Setup. Experiment was completed in a sound-treated booth, where participants were seated facing a laptop screen with the LingWAVES software and paper reading materials present on table. Primary investigator was seated on the left side of participant for the duration of this experiment, to provide instructions, and to direct them. LingWAVES was used with a certified sound level meter-microphone for reliability positioned 50 centimeters from the participant's mouth. As discussed by Vertigan, Kapela, Franke, and Gibson (2017),

LingWAVES voice analysis program consists of a *Windows* software program, used to analyze acoustic measurements, and recording hardware.

Pre-Post VLT Speech Tasks. Upon completion of the informed consent, participants were asked to complete a set of tasks pre- and post-VLT including:

- Sustained /a/ for five to six seconds, three times at a comfortable pitch and volume.
- Reading "The Rainbow Passage" (Fairbanks, 1960) which was provided on screen via the LingWAVES voice protocol module.

During each baseline measure, participants were given specific instructions to sit up straight, take a deep breath, and maintain a comfortable pitch and loudness until the primary investigator advised them to stop. Measures, including F0 and SPL during sustained phonation and reading task, were entered into a password-protected excel document for further analysis.

LingWAVES Vocal Loading Test. For the purpose of this experiment, participants completed an adapted version of the LingWAVES Vocal Loading Test protocol. The LingWAVES Vocal Loading Test is a specialized module on the LingWAVES voice analysis program, designed by WEVOSYS (2014). Within this module, researchers can select between sustained vocalizations or reading. For the purpose of this study, the reading task was selected because of its ecological validity. All participants were provided with a printed copy of Charlotte's Web by E.B. White (2012) in large font, congruent with the work of Gavigan (2017), due to "its popularity in classic fiction, elementary reading level and opportunity to use increased prosody when reading the text." (p. 20)

The vocal loading test required participants to alternate reading intensity between two pre-determined intensity levels – referred to as "low load" and "high load" within the software. The default setting for the protocol is equal to 70 dB for low loudness requirement (LLR), and 75

dB for high loudness requirement (HLR). Participants altered their voice production for a total of six intervals with each interval lasting for five minutes in duration resulting in a 30-minute loading task (Figure 2.2).

The LLR was modified to be consistent with the baseline reading SPL of each participant, while the HLR was set at an additional 15%, as displayed below:

$$HLR = LLR + (LLR \times .15) \quad \text{……Equation 1}$$

Participants were additionally asked to alter their pitch and vocal quality by mimicking the voices of famous cartoon characters of "Minnie Mouse" and "Mufasa" during LLR and HLR respectively. Participants were not told the length of the VLT prior to completion. Participants were advised to continue task until they felt discomfort or task fatigue, or until researcher indicated the experiment was complete. Participants were also notified that a large blue arrow would appear on the screen if their intensity fell below the dB goal. VLT instructions can be found in Appendix D.

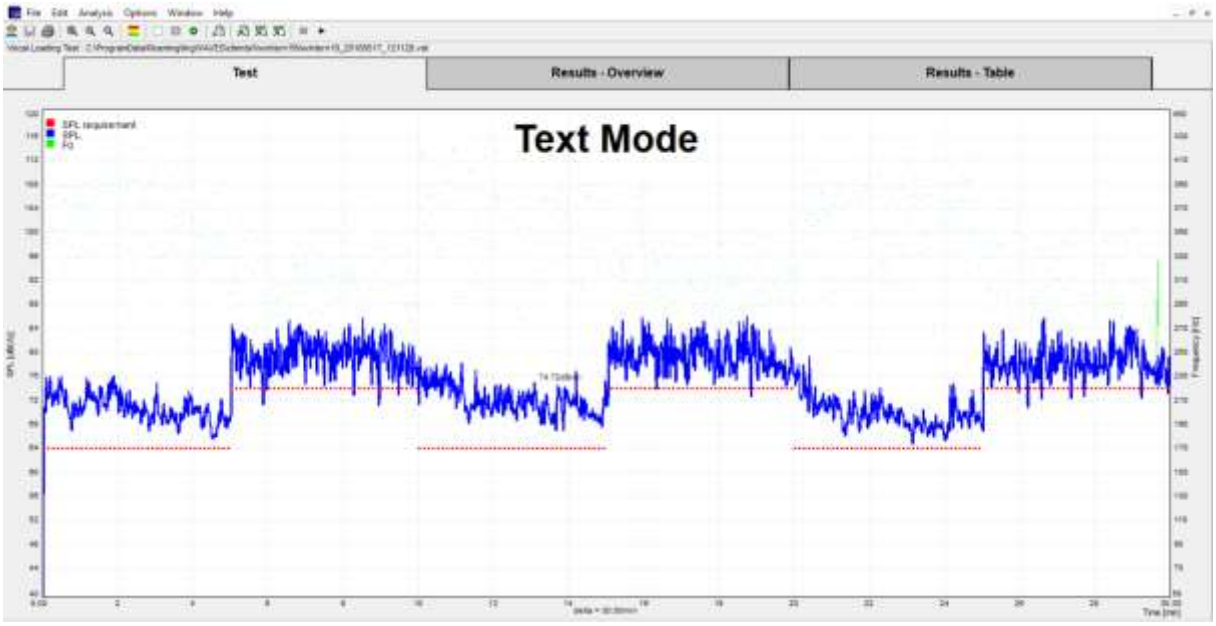

Figure 2.2 LingWAVES Vocal Loading Task.

Post-Measurements and Tasks

Upon completion of VLT, participants were given a five-minute break, in which they were directed to a secondary computer within the booth to complete a Qualtrics questionnaire, which consisted of the adapted Borg CR10 physical exertion scale (Van Leer & Van Merscbergen, 2017) and the Vocal Fatigue Index (Nanjundeswaran et al., 2015). After the break, post-loading speech tasks similar to the baseline were completed for comparison. At the end of the experiment, participants were provided with water, if desired, and were compensated for their participation.

CHAPTER THREE:

RESULTS

Using the aforementioned protocol, descriptive, visual, and inferential statistical analyses were completed. Descriptive analysis was used to discuss the results of the Qualtrics questionnaire. Additionally, raw data of the acoustic measures extracted during the vocal loading task was examined visually through Figures 3.2 to 3.6. Non-parametric statistical tests were used to analyze differences between graduate and undergraduate students as well as several pre- and post-loading outcome measures. Finally, regression analysis was used to understand the effects of psychosocial factors (including stress, depression, and sleep) on the difference scores of subjective outcome measure of Vocal Fatigue Index (VFI) as well as objective outcome measures of fundamental frequency (F0), and sound pressure level (SPL) outlined in the methods section.

Descriptive Analysis of Qualtrics Questionnaire

Descriptive statistics (*e.g.*, mean, minimum, maximum, range, and standard deviation) was completed for various Qualtrics questions. Results are organized based on content areas in the questionnaire. To reference each question, they are presented prior to results in the format of Appendix #, Section #, Question # (App. #, Sec. #, Q. #).

Personal Demographics

Of the 28 undergraduate and graduate students who attempted the questionnaire, 17 were included in data analysis, as they completed the experiment in its entirety (see **Chapter 2: Methods** for details). Demographic information compiled from Qualtrics questionnaire showed that, all participants were female, with mean ages of 22 and 24 years (App. B, Sec. I, Q. 3-4).

Employment and Enrollment Status

Students were asked to disclose their current employment status as it is associated with their enrollment status. With regards to employment, 47.1% of students were reportedly unemployed, while 47.1% reported working part-time, and 5.8% reported working full-time.

Students also provided their classification (*i.e.*, undergraduate vs. graduate) and current credit hours. All students who completed this experiment were enrolled full-time, characterized by 12 credits or more at the undergraduate level, and 6 credits or more at the graduate level. Of these students, 8 were undergraduate, and 9 were graduate (including 2 doctoral students; App. B, Sec. II, Q. 1-2).

Ninety-four percent of students were reportedly Communication Sciences and Disorders majors (*e.g.*, Audiology, speech-language pathology, or undecided; N = 16). Of the students enrolled in Communicative Disorders, 50% (N = 8) were graduates, while the remaining students were undergraduate (App. B, Sec. II, Q.5).

Psychosocial Symptoms

In addition to the questions on PSS, BDI and sleep, students were also required to report symptoms of heightened emotions such as worry (feelings of anxiety or uneasiness), strain

(feeling increased physical effort in day-to-day life), stress, nervousness along with feelings of edginess (inability to cope with situations), bad temper (feelings of anger and annoyance), and irrational fear or panic (App. B, Sec. II, Q. 19).

Students were allowed to select as many, or as few, as they preferred. Four students reported none of the listed symptoms. The remainder (N = 13) are presented in **Figure 3.1.** For each category, a total of 13 responses are possible, indicating that all students who responded selected that option (e.g., all students selected stress, as there are 13 responses). Edginess, bad temper, and irrational fear or panic were included in one category ("all other"), as they received fewer responses overall. Overall, all students responded that they felt stressed, while 53% reported feeling worried, and 38% reported nervousness, or other symptoms. Few students reported feelings of strain (23%).

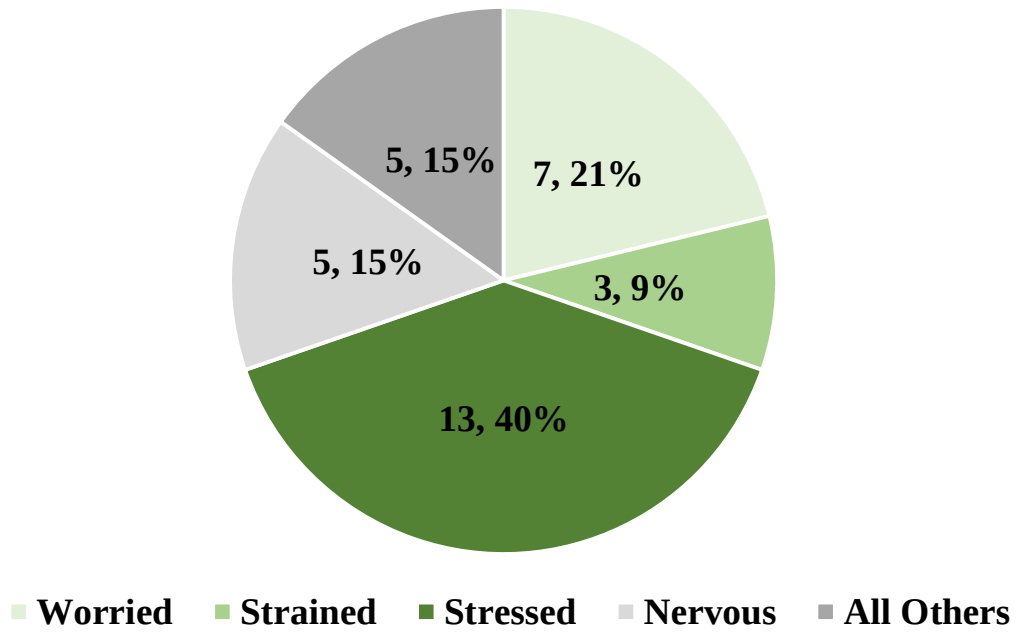

Figure 3.1 Reported Symptoms of Heightened Emotions.

This section addresses the research question 1) Do psychosocial factors differ between:

a) graduate versus undergraduate students

b) employed students versus unemployed students

Stress Symptoms. In Section IV, students completed the PSS. Note that the PSS was not used as a diagnostic tool in this experiment; rather, to quantify the level of stress in students through a reliable and valid tool. For all students, the overall mean ±standard deviation score was 20.3 ±2.3, with a minimum of 16, and a maximum of 25 (range = 9). These scores indicate that students have moderate amount of stress. While the undergraduates had a mean score of 19.5 ±1.6, the mean scores were slightly higher in graduates (21.1 ±2.7). These scores also varied by employment status where unemployed students received a score of 19.7 ±2.2 and employed students received a mean score of 21.1 ±2.4. Scores on PSS were not significantly different between education levels and employment status based on a Mann-Whitney test (U = 20.50*; p = 0.131* and U = 25.50; *; p = 0.307 respectively*)

Depression Symptoms. Prior to completing BDI, participants were asked a screener question (App. B, Sec. II, Q. 22) "*In the past month, how often have you been feeling down, depressed, or hopeless?"* All undergraduates reported *not at all*, while there was variability in the graduate population - 55.6% reported *not at all,* 11.1% reported *several days,* and 33.3% reported *more than half the days*.

Note that the BDI was not used as a diagnostic tool in this experiment; rather, to quantify the level of perceived depression in students through a reliable and valid tool. Averaged across all students, the mean BDI score was 6.4±9.0 indicating normal emotional ups and downs, as described by Beck et al (1961). Scores ranged from 0 to 27 where scores greater than 10 are considered to have mild, moderate depression. There was a significant difference between the

mean BDI scores of undergraduate and graduate students based on a Mann-Whitney test (U = 5.00; $p = 0.002$). The mean BDI score was 0.9 ±2.1 for undergraduate students and was 11.3 ±10.1 for graduate students (see **Table 3.1** for percentage of students depicting different levels of depression). These scores also varied by employment status where unemployed students received a score of 6.9 ±9.9 and employed students received a mean score of 5.9 ±8.6. However, this difference did not achieve significance (U = 26.50; $p = 0.349$). In comparing the scores on the BDI to the screener question, all participants who reported *more than half the days* scored 20 or higher, while the scores of those who reported *several days* ranged from 2 to 19.

Sleep Patterns. Standardized measures were not used to analyze sleep patterns. However, several questions throughout the Qualtrics questionnaire were aimed towards sleep patterns (App. B, Sec. II, Q. 17-18). Results revealed that, on average, graduate students spend between 6.3 and 7.3 hours sleeping per night, whereas undergraduates reported between 7 and 8 hours. Within the graduate population, 33.3% selected that they had either lost sleep or had difficulty falling or staying asleep rather more than usual, while the remaining either selected not at all or no more than usual. In contrast, all undergraduate students selected the latter two responses. Further, while the number of hours slept for unemployed students was between 6.8 and 7.8, within the employed population, the average numbers of hours slept was between 6.5 and 7.5 hours.

In response to trouble concentration on things, all undergraduates and 44% of graduates reported they do not exhibit difficulty, while 22% of graduates reported they have difficulty concentrating several days, and 33% reported either difficulty concentrating more than half the days or nearly every day in the past two weeks (App. B, Sec. II, Q. 27).

Voice Use and Symptoms

Voice Training. In response to clinical training, 8 undergraduate and 3 graduate students (N=11; 64%) reported never using their voice with patients or not completing clinical training, while 3 graduate students (17%) reported use of between 2 and 4 hours a day, and 3 graduate students (17%) reported use between 5 and 7 hours a day (App. B, Sec. II, Q. 3). Additionally, 6 students (35%) reported they had received formal music training. Of these, 33% were undergraduates. All students who reportedly received formal music training reported not currently practicing (App. B, Sec. II, Q. 35 – 36)**.**

Voice Use. Overall, 9 students (44% undergraduate) responded vocal use between 4 and 6 hours, 3 students (66% undergraduate) responded 6-8 hours, 3 students (all graduate) responded less than 4 hours, and 2 students (all undergraduate) responded 10 hours or more (App. B, Sec. II, Q. 31).

Vocal Hygiene. All students responded that they lose their voice less than 1 time per month, with the majority reporting that they lose their voice less than 1 time per year, if ever (64%). Further, students reported that they occasionally (41%) or rarely (52%) clear their throat (App. B, Sec. II, Q. 39-42). Only 11.7% of students reported drinking 60 ounces or more of water a day. Interestingly, these students additionally reported no caffeine consumption on a daily basis. The majority of students (64.7%) reported drinking anywhere from 21 to 60 oz of water per day, with caffeine consumption varying anyway from none to 2 cups.

Pre-Vocal Fatigue Index. In Section III of the questionnaire, students completed the VFI, which revealed scores ranging from 19 to 52, with a mean of 30.6 ±8.9. Further, the mean scores of graduate students 33.7 ±10.1 were higher than the mean of undergraduate students 26

±4.5. It is important to note that while the scores had a range of 33 for graduate students, the fatigue levels in undergraduate students only varied by a range of 10 (raw scores from 20 to 30). Of the questions scored, the highest rated were related to improved vocal function after rest, followed by difficulty to project voice. The lowest rated question was related to experiencing pain in the neck by the end of the day, where only one participant reported that she sometimes experiences this symptom.

Post-Vocal Fatigue Index. Following the vocal loading task, each student completed the adapted Borg CR10 for Vocal Effort Rating scale (Van Leer & Mersbergen, 2017) and a secondary VFI measurement for comparison. Across graduates and undergraduates, the mean score on the effort scale was 6, indicating that the amount of effort varied between somewhat severe and severe. Mean ratings for graduate students were 6.2 (range = 3 to 8), while for undergraduates the mean was 5.7 (range = 2 to 7).

Post-VFI revealed scores ranging from 19 to 63, with a mean of 38.7 ±13.4 across all students. The mean VFI scores of graduate students post-vocal loading was 42.2 ± 14.6 and was higher than the mean of undergraduate students 34.7 ± 11.6 in congruence with pre-VFI scores. Further, scores from graduate students had a range of 41 (22 to 63), while the undergraduate students had a range of 29 (19 to 48).

Objective Measures during Vocal Loading Task

This section answers the research question 2) How do graduate and undergraduate students vary their Fundamental Frequency (F0) and Sound Pressure Level (SPL) during the VLT?

Fundamental Frequency (F0)

During the vocal loading task, mean F0 was acquired during each interval (Total = 6). On average, graduates appropriately varied F0 across intervals as instructed, where intervals 1, 3, and 5 represented increased F0 targets, and intervals 2, 4, and 6 represented decreased F0 targets. In contrast, undergraduates demonstrated more inconsistency (**Table 3.2).** Individual differences between students are depicted in **Figures 3.2** (graduates) and **3.3** (undergraduates).

The abscissa on these figures represent intervals 1 through 6 with alternating load conditions (LLR and HLR). The ordinate on these figures represent F0 (Hz) computed from the LingWAVES software. Note that students were not given a target F0 for the different loads and were instead asked to vary F0 based on the cartoon characters provided to them by the principal investigator in the form of pictures. Each of the colored lines represent individual participants. Graduate students **(Figure 3.2)** performed the task more accurately compared to the undergraduate students **(Figure 3.3)** as evidenced via the F0 shifts between LLR and HLR intervals. Graduates increased their pitch in consonance with the "Minnie Mouse" voice during intervals 1 and 3 and decreased their pitch in consonance with "Mufasa" voice during intervals 2 and 4. Graduate students, however, did not follow the correct pitch and voice quality shifts during the last two intervals of the VLT. During interval 5, graduate students remained at a lower pitch and during interval 6, graduate students increased their pitch. In undergraduate students, with the exception of participants 5 and 10, patterns were variable regardless of load, with the majority maintaining a consistent F0 throughout the intervals, as demonstrated in **Figure 3.3.** Although individual trends varied across the two levels of education, a Mann- Whitney test indicated that mean F0 during HLR condition did not significantly vary between graduate and undergraduate students, U = 32.00; $p = 0.700$.

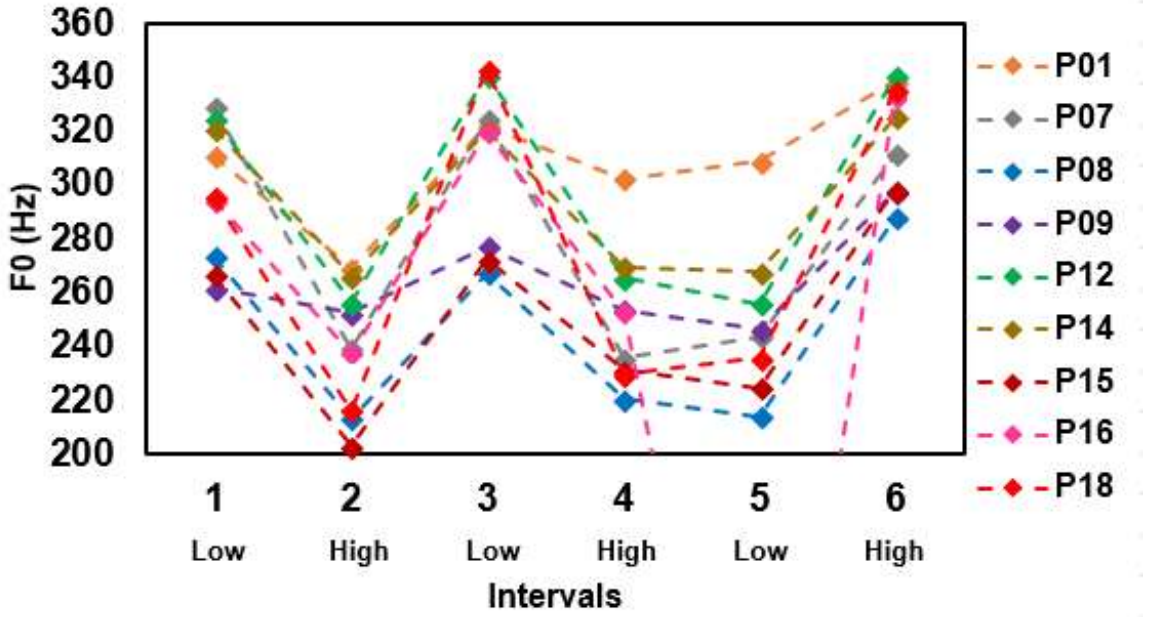

Figure 3.2 F0 (Hz) across the six VLT intervals for graduate students.

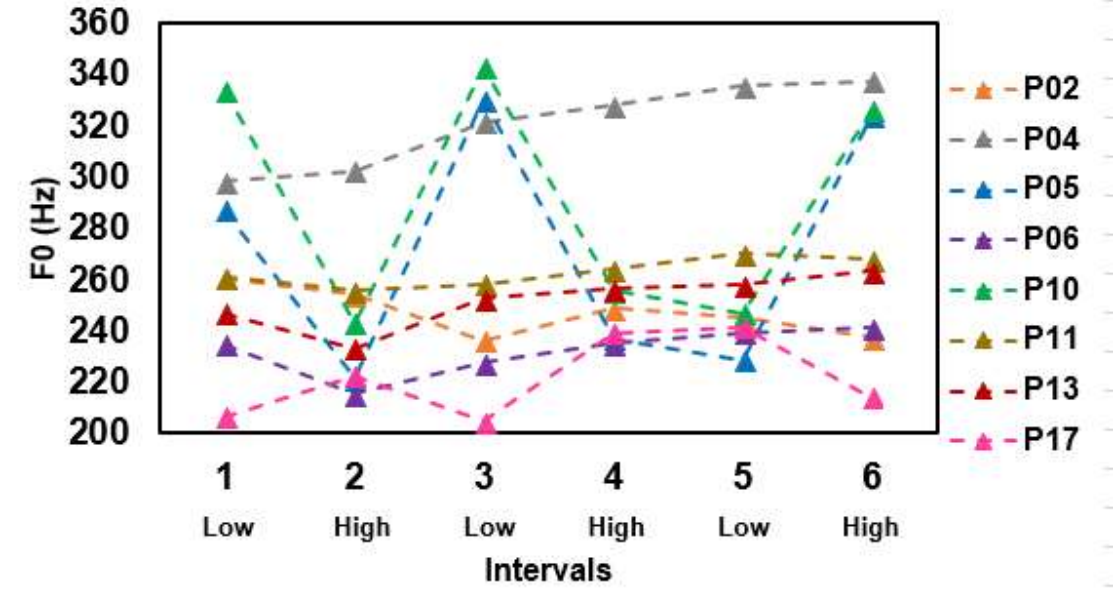

Figure 3.3 F0 (Hz) across the six VLT intervals for undergraduate students.

Sound Pressure Level (SPL)

One of the main VLT variables to induce vocal fatigue was intensity where participants were required to maintain a pre-determined intensity level (**Equation 1**) during each interval. **Table 3.3** depicts the intensity level set on the LingWAVES software as a goal for the LLR and HLR conditions along with what each participant achieved. Intensity was averaged across the three high intervals and is depicted as 'Avg. High' in the table. Although there was not a specific goal for the LLR, values had to be inputed on the LingWAVES software, and therefore, habitual reading levels obtained from the passage reading pre-VLT were used as goals. Similar to F0, individual differences between students are depicted in **Figures 3.4** (graduates) and **3.5** (undergraduates). The abscissa on these figures represent intervals 1 through 6 with alternating load conditions (LLR and HLR). The ordinate on these figures represent SPL (dB) computed from the LingWAVES software. Unlike the F0, both graduate and undergraduate students were able to successfully increase their SPL to meet the targets for all intervals. Further, a Mann-Whitney test indicated that mean SPL during HLR condition did not significantly vary between graduate and undergraduate students $U = 29.50$; $p = 0.531$.

Effects of Vocal Loading Tasks on Subjective and Objective Measures of Vocal Fatigue

This section answers the research questions 3) Does perceived vocal fatigue as measured by the VFI (subjective) change post- vocal exertion? and 4) Do acoustic measures of F0 and SPL (objective measures) change post-vocal exertion?

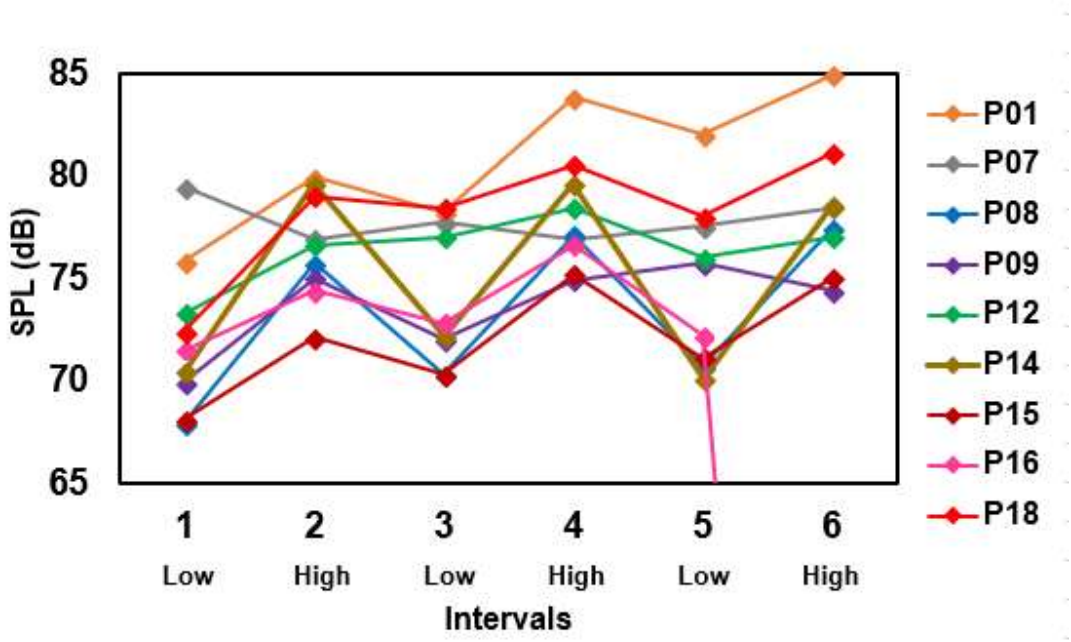

Figure 3.4 SPL (dB) across the six VLT intervals for graduate students.

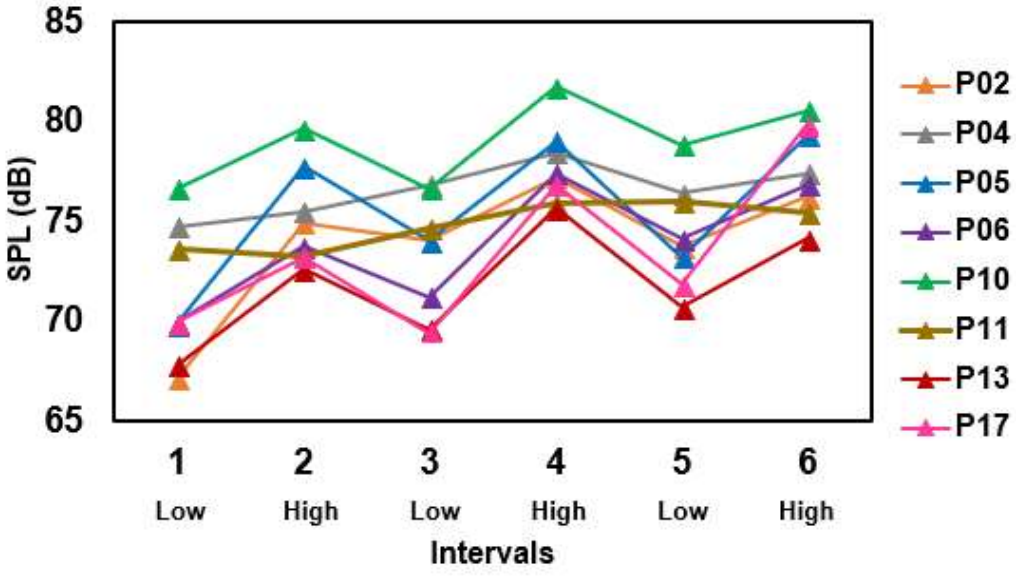

Figure 3.5 SPL (dB) across the six VLT intervals for undergraduate students.

As described in the methods section, subjective measure of vocal fatigue was obtained via VFI scores pre- and post-vocal loading tasks. Objective measures of vocal fatigue (F0 and SPL) were computed from the pre- and post- recordings of the phonation and "Rainbow Passage" from all participants. Multiple Wilcoxon signed-rank tests were completed independently in graduate and undergraduate students to study effects of vocal loading on VFI scores, mean F0 during phonation and reading, and mean SPL during phonation and reading.

Within the graduate students, there was a significant difference between all pre- and post-outcome measures except F0 during phonation. First, the median (Mdn) ranks of post-VFI (Mdn = 42) was significantly higher than pre-VFI (Mdn = 32) indicating that graduate students perceived that their voice was tired/fatigued after the 30 min VLT ($Z = -2.52$; $p = 0.012$). Second, the median ranks of post-SPL during phonation (Mdn = 73.9 dB) was significantly higher than pre-SPL (Mdn = 69.6 dB) indicating the carry-over effects after the 30 min VLT ($Z = -2.310$; $p = 0.021$). Third, the median ranks of post-SPL during reading (Mdn = 66.8 dB) was significantly higher than pre-SPL (Mdn = 62.4 dB) also indicating the carry-over effects ($Z = -2.547$; $p = 0.011$). Finally, median ranks of post-F0 during reading (Mdn = 206.47 Hz) was significantly higher than pre-F0 during reading (Mdn = 188.44 Hz) perhaps due to similar carry-over effects ($Z = -2.666$; $p = 0.008$).

Within the undergraduate students, there was a significant difference between all pre- and post-outcome measures. The median (Mdn) ranks of post-VFI (Mdn = 32) was significantly higher than pre-VFI (Mdn = 28.5) indicating that undergraduate students perceived that their voice was tired/fatigued after the 30 min VLT ($Z = -2.04$; $p = 0.042$). Median ranks of post-SPL during phonation and reading (Mdn = 71.9 dB; 69.6 dB) were significantly higher than pre-SPL (Mdn = 68.1 dB; 66.6 dB) indicating carry-over effects after 30 min of VLT ($Z = -2240$; $p =$

0.025; Z = -2.380; *p = 0.017)*. Similarly, median ranks of post-F0 during phonation and reading (Mdn = 229.3 Hz; 217.4 Hz) were significantly higher than pre-F0 (Mdn = 213.8 Hz; 204.5 Hz) perhaps due to similar carry-over effects (Z = -2.521; *p = 0.012*; Z = -2.521; *p = 0.012*). Together, these results demonstrate that effectiveness of VLT used in this study in eliciting vocal fatigue.

Effects of Psychosocial Scores on Perceived and Quantitative Assessment of Fatigue

This section answers the research questions 5) Is there a correlation between psychosocial factors and perceived vocal fatigue? And 6) Do psychosocial factors impact acoustic measurements pre- and post-vocal exertion?

In this section, a total psychosocial score was derived from sleep, BDI, and PSS, as a metric for psychosocial deficits. Multiple regressions were performed to determine relationships between the psychosocial scores and VFI as well as acoustic measures of F0 and SPL for phonation and reading tasks. Regressions were independently computed for graduate and undergraduate students to analyze if education level differentially affected these relationships. Abscissa on **Figures 3.6** to **3.10** represent the distribution of the total psychosocial scores, while the ordinate on **Figures 3.6** to **3.10** represent the difference between pre- and post-outcome measures. A positive difference score indicates that post- measure was higher than the pre-measure (potentially indicating greater vocal fatigue) and a negative difference score indicates that the participants had a higher pre-measure score/value compared to post-measure score/value (potentially indicating a higher baseline fatigue level).

Psychosocial Scores vs. Difference in VFI Scores

In order to establish whether there was a relationship between psychosocial score and difference between pre- and post-VFI, a Pearson's r correlation was completed. Results revealed a higher correlation for undergraduate students (r = 0.61) when compared to graduate students (r = 0.38). These results are further depicted by the linear regressions and the amount of variance is explained in the difference scores via R^2 values **(Figure 3.6)**.

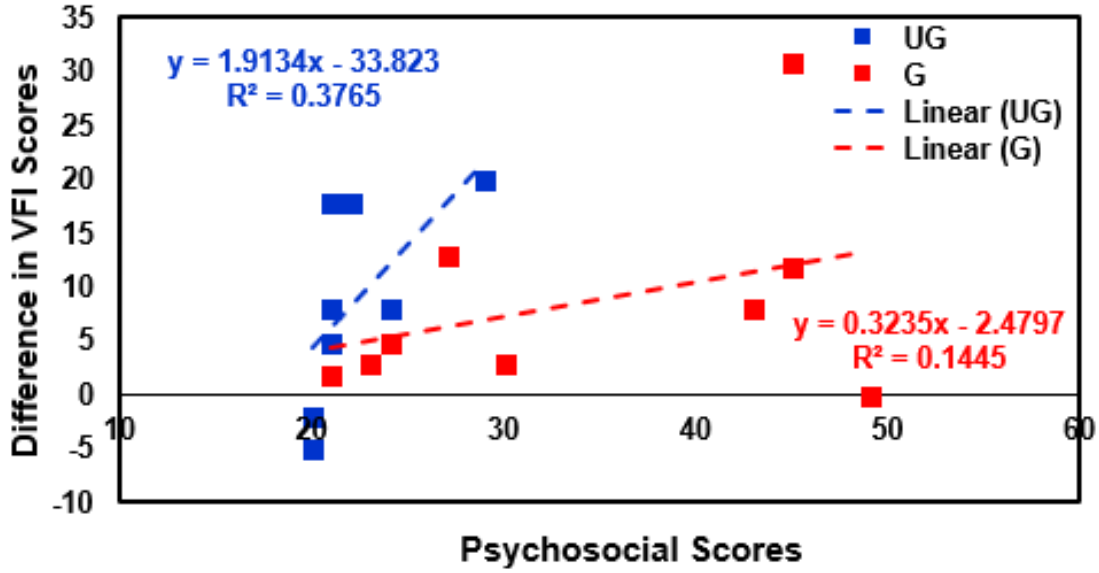

Figure 3.6 Psychosocial scores vs. Difference in VFI score.

Psychosocial Scores vs. Differences in F0

Figures 3.7 and **3.8** show the relationship between psychosocial scores and differences in pre-post mean F0 (Hz) during phonation **(Figure 3.7)** and reading **(Figure 3.8).** For undergraduate students, as psychosocial scores increased, the difference scores decreased, indicating a negative correlation (r = -0.41) during phonation task. These results suggest that when the stress/depression levels increased, participants already demonstrated symptoms of elevated pitch resulting in smaller changes post-VLT evidenced by smaller values of difference

scores. In contrast, for graduate students, as psychosocial scores increased, the difference scores slightly increased during the phonation task (r = 0.12).

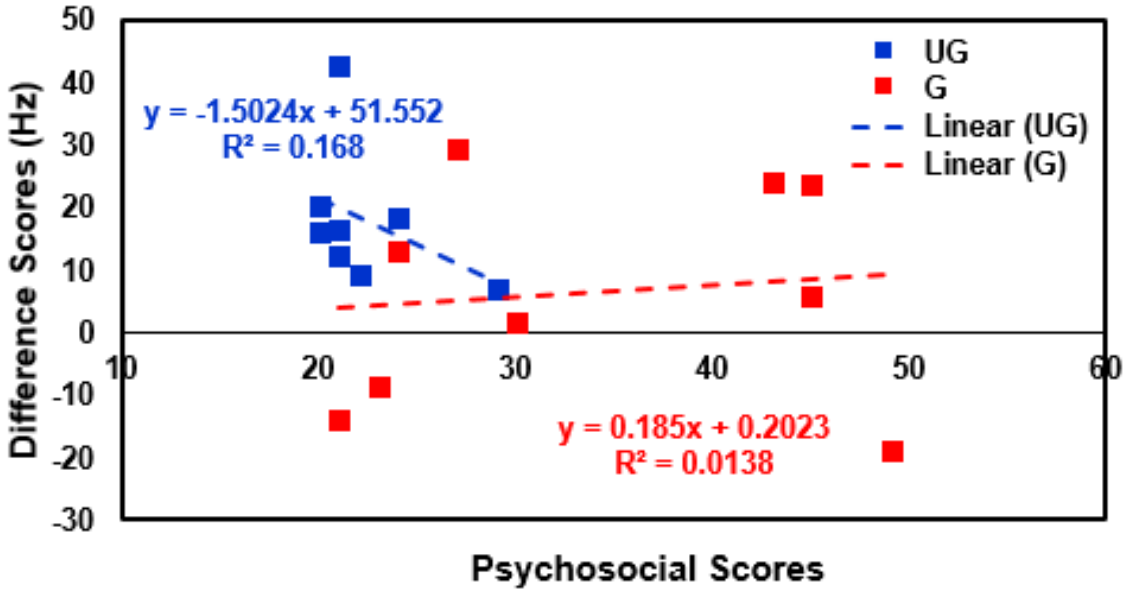

Figure 3.7 Psychosocial scores vs. Differences in F0 (Hz) during phonation.

On the reading task **(Figure 3.8),** as the psychosocial scores increased in undergraduate students, the difference between the pre- and post-mean F0 (Hz) decreased (r = -0.27). Alternatively, this relationship was non-linear for graduate students. A polynomial function showed that that as psychosocial scores increased, difference scores decreased; however, for more severe psychosocial scores (>40), difference between the pre-post mean F0 (Hz) began to increase. This result demonstrates that when some graduate students are highly stressed/depressed, their F0 significantly increased post-VLT.

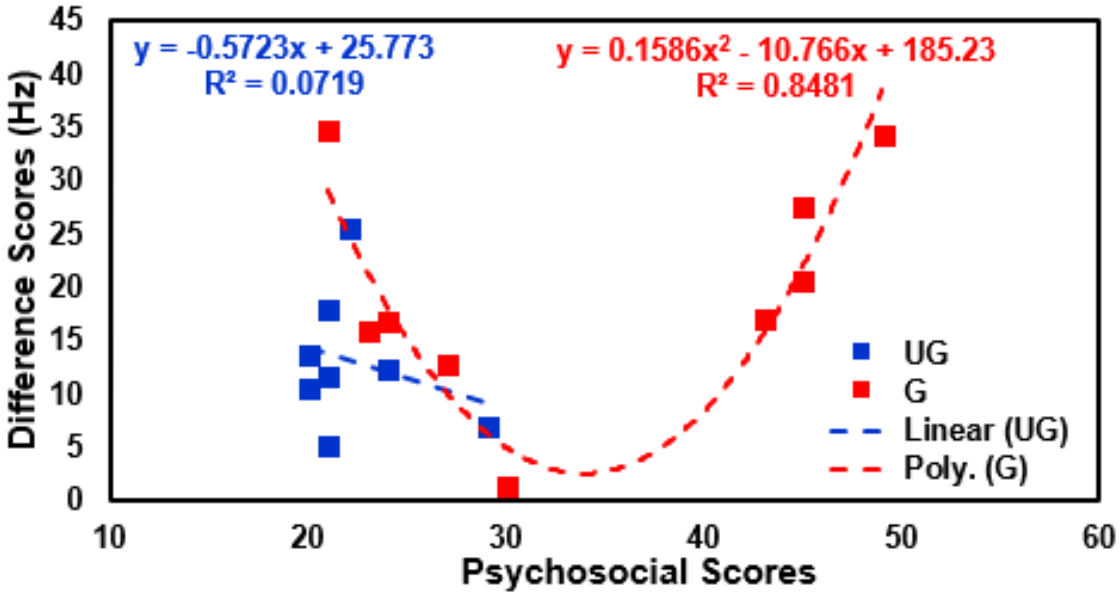

Figure 3.8 Psychosocial scores vs. Differences in F0 (Hz) during reading.

Psychosocial Scores vs. Differences in SPL

Figures 3.9 and **3.10** show the relationship between psychosocial scores and differences in pre-post mean SPL (dB) during phonation **(Figure 3.9)** and reading **(Figure 3.10).** For undergraduate students, as the psychosocial scores increased, the difference between the pre- and post-SPL during phonation decreased, indicating a negative correlation of -0.13. For graduate students, as the psychosocial scores increased, the difference between pre- and post-SPL increased, with a correlation of 0.68. Among all the correlations so far, the last one between SPL and psychosocial scores in graduates is the strongest.

On the reading task **(Figure 3.10),** a positive correlation was observed for both undergraduates and graduates. As the psychosocial scores increased, difference scores between the pre- and post-SPL (dB) increased. This correlation was r = 0.16 for undergraduates and was r = 0.43 for graduates.

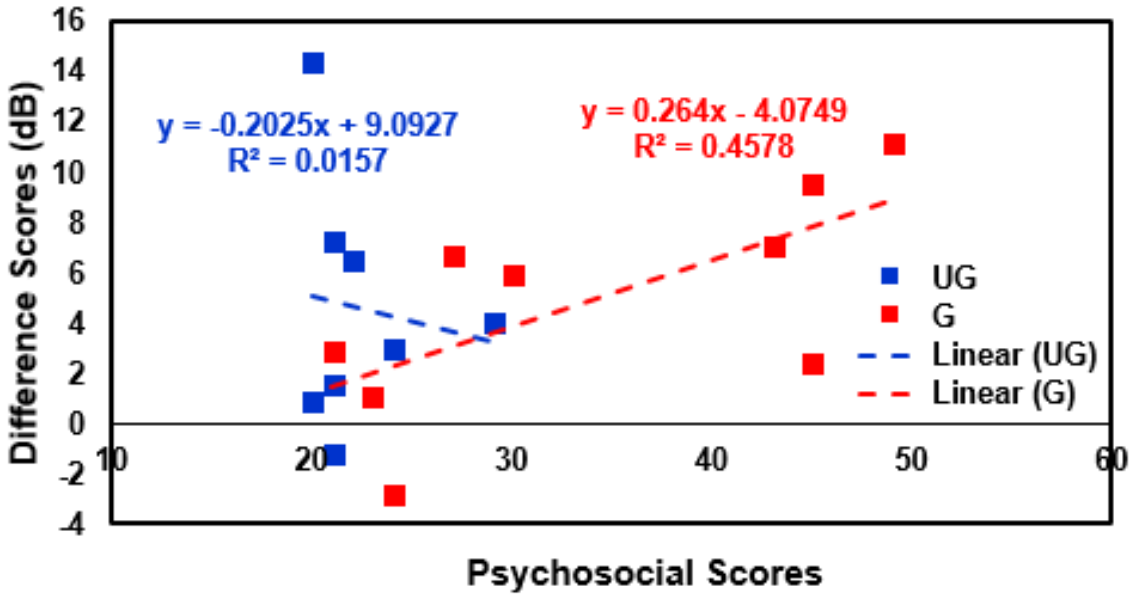

Figure 3.9 Psychosocial scores vs. Differences in SPL (dB) during phonation.

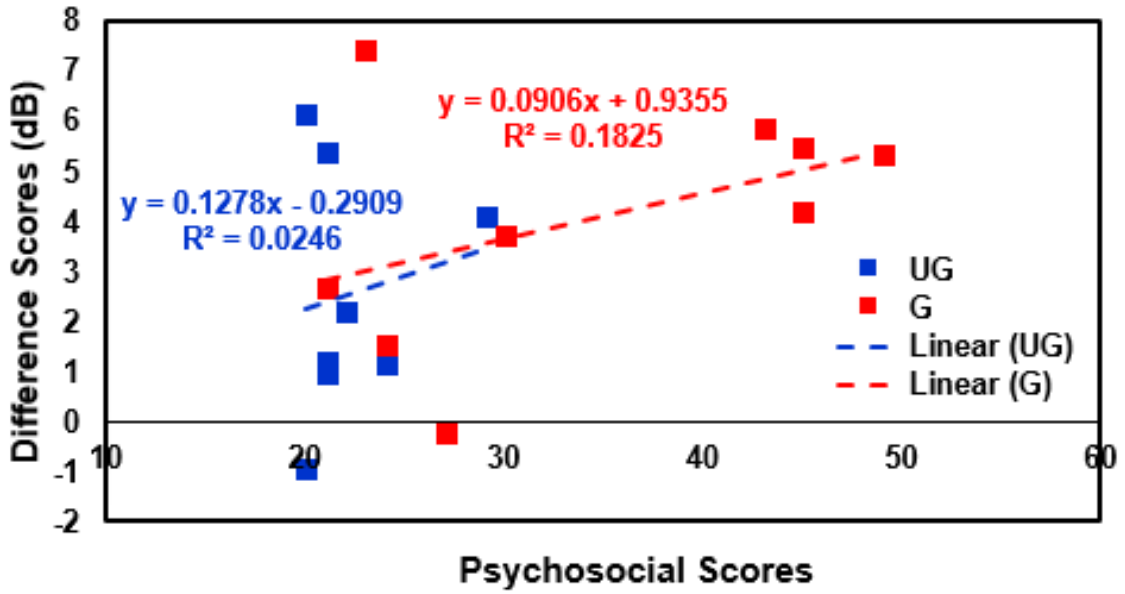

Figure 3.10 Psychosocial scores vs. Differences in SPL (dB) during reading.

Table 3.1 Percentage of undergraduates and graduates depicting levels of depression on BDI.

Scaled BDI Score	Undergraduates (N = 8)	Graduates (N = 9)
0; participant reported not feeling any symptoms	75%	N/A
1-10; normal emotional ups and downs	25%	55.6%
17-20; borderline clinical depression	N/A	33.3%
21-30; moderate depression	N/A	11.1%

** Scores between 11-16 and above 30 were not included in this table, as no participants scored in this range.*

Table 3.2 Average F0 in Hz during each interval of the VLT for undergraduates and graduates.

Average F0 (Hz)	**Interval 1**	**Interval 2**	**Interval 3**	**Interval 4**	**Interval 5**	**Interval 6**
Undergraduate	266.15	258.08	243.49	258.19	271.73	276.35
Graduate	297.22	239.08	309.44	250.91	249.40	318.21

Table 3.3 Goals and Average (Avg.) SPL values (in dB) achieved by individual participants on the VLT.

Graduate									
Participants	***1***	***7***	***8***	***9***	***12***	***14***	***18***	***15***	***16***
Low Goal	59.4	64.7	67.0	56.5	62.4	64.4	66.9	59.8	60.6
Avg Low	78.7	78.2	69.6	72.5	75.4	70.9	76.3	69.8	72.2
High Goal	68.3	74.5	77.0	65.0	71.8	74.0	76.9	68.7	69.7
Avg High	82.9	77.4	76.7	74.8	77.3	79.2	80.2	74.1	75.5
Undergraduate									
Participants	***2***	***4***	***5***	***6****	***10***	***11****	***13***	***17***	
Low Goal	64.3	67.2	66.1	69.2	68.8	71.8	61.7	64.0	
Avg Low	71.6	76.0	72.3	71.7	77.3	74.7	69.4	70.4	
High Goal	74.0	77.2	76.0	79.5	79.1	82.6	71.0	73.6	
Avg High	76.1	77.1	78.7	76.0	80.6	74.8	74.1	76.6	

* Values are averaged across intervals 1, 3, and 5 for the low load condition and 2, 4, and 6 for the high load condition. Asteriks next to participant # indicate that the high goal was not achieved.

CHAPTER FOUR:

DISCUSSION

This study was designed to determine a) how psychosocial factors affected subjective and objective measures of vocal fatigue, b) if and how these outcome measures changed pre-post vocal exertion evaluated through the adapted LingWAVES protocol, and c) if there was an effect of education or employment on some of these variables.

In this study, all participants were female, and this could have been due to the high prevalence of this gender in the field of speech-language pathology. According to the 2016-2017 Communication Sciences and Disorders Education Survey - National Aggregate Data Report by ASHA, males were highly underrepresented in undergraduate and graduate level programs compared to their female counterparts (~4.5%; *ASHA*).

The employment rates were equally distributed in the current study. While the PSS did not differ based on employment status, it was observed that depression evaluated via overall BDI score was higher in unemployed students. Further, employed students reported higher levels of vocal fatigue as demonstrated by the higher overall scores on the VFI. These results are not surprising given that additional vocal use during employment along with college and social communication during the day lead to increased vocal dose and subsequently lead to increased vocal effort and weakness of the laryngeal muscles.

With respect to level of education, graduate students reported higher levels of depression compared to undergraduates. It is likely that the availability of time and therefore the ability to participate in multiple social events on campus may have helped undergraduate students.

Contradictory to a general assumption, our study did not find any differences in the amount of sleep between the two education levels. It is likely that while the hours of sleep per night did not vary, the average sleep over time may have been reduced (not tested in this study). Furthermore, one of limitations of this study was that sleep was not evaluated extensively as the PSS or BDI and therefore, the total psychosocial scores may have been heavily weighted by stress and depression. Finally, in this study informal questions on anxiety (feelings of worry) were incorporated and a logical extension would be to test it using standard scales such as State-Trait Anxiety Inventory (STAI; Spielberger et al., 1983). Indeed, a recent study on students in the healthcare professions including speech-language pathology, reported prevalence of higher anxiety levels (Macauley et al., 2018).

This study also examined if graduate students used more voice during the day due to their clinic commitments. However, results revealed that undergraduate students also used their voice equivalently. In this study, this question was framed as "voice use within past 24 hours" to identify and confirm that participants did not have higher baseline levels of fatigue. A future study with larger sample size is required to specifically examine the question on the differences in voice use between the two levels of education and how they impact vocal fatigue. Although this study did not explicitly control for vocal hygiene practices, question on amount of water intake indicated that students did not drink adequate amounts of water each day. Two additional limitations need to be noted: a) examples were not provided for the question on acid reflux and it is likely that students may have responded differently with specific information, and b) while self-reports about medical history was obtained, stroboscopic evaluations were not conducted to confirm the absence of structural deficits and/or examine the potential influence of reflux.

Vocally demanding tasks that stress the vocal mechanism, or vocal loading tasks (VLTs), have been used extensively in the literature both within and outside of the laboratory settings, especially in professional voice users, to understand the mechanism of vocal fatigue. However, as shown in the review article by Fujiki et al. (2017), the tasks vary considerably in types of stressors, durations, and outcome measurements. In this study the standard LingWAVES vocal loading protocol was slightly modified to elicit more vocal fatigue. Specifically, in addition to increasing SPL, all participants also altered pitch and voice quality. Furthermore, the current study is one among the few to calibrate intensity thresholds adaptively for each participant as well as to provide visual feedback for the different voice alterations (i.e., "Minnie Mouse" & "Mufasa"). Although a detailed analysis of objective measures during each interval was not completed to identify how quickly the laryngeal mechanism fatigued, results from the pre- and post-VLT recordings of phonation and reading passage indicate the modified VLT was effective in inducing adequate amount of vocal fatigue within a 30-min duration. Increases in difference scores of F0 and SPL indicate greater activity of the laryngeal muscles (Schloneger & Hunter, 2017). These results are consistent with several prior findings with similar durations (Boominathan, Anitha, Shenbagavalli, & Dinesh, 2010; Remacle, Schoentgen, Finck, Bodson, & Morsomme, 2014; Remacle, Finck, Roche, Morsomme, 2012; Stemple, Stanley, & Lee, 1995). Follow-up measures on each interval, as well comparison of conventional VLT with the modified version, will provide greater insights into optimization of the task protocol for different populations.

In this study, only two objective measures (F0 and SPL) were computed. Further analyses using other measures such as noise-to-harmonic ratio (NHR), cepstral peak prominence (CPP;

Lowell, Colton, Kelley, & Hahn, 2011), and pitch strength (PS; Eddins, Anand, Camacho, & Shrivastav, 2016) are recommended to capture the changes in voice quality.

While most of the participants irrespective of the level of education were able to follow directions well and change their vocal intensity, this was not the case for F0. Only graduate students were able to consistently follow directions. It is likely that the presence of visual feedback of SPL provided by the LingWAVES software reduced the amount of cognitive load. It is also possible that the background training in voice science and disorders may have further helped graduate students to perform the VLT with ease. It is important to note that all participants did not meet their voice quality requirements during final intervals (5 and 6) where interval 5 should have been the "higher pitch" as seen in "Minnie Mouse" voice and interval 6 should have been the "lower pitch" as seen in "Mufasa". Addition of short practice trials (e.g., 6 x 1 min intervals = 6 min) in future experiments may improve the performance on VLT tasks. Finally, real-world environments with high ambient noise may induce fatigue in a shorter period of time and/or induce a greater magnitude of fatigue.

In the current study, although psychosocial factors was of primary interest, due to convenience sampling, there was not a wide continuum of scores or a clear demarcation between graduate and undergraduate students. The amount of stress all participants underwent was moderate. On the other hand, graduate students were more depressed than undergraduates. It is likely that the inclusion of two doctoral students may have slightly elevated these scores. Interestingly, in a larger study with 197 female Dutch speech-language pathology students, authors found no psychosocial handicapping effect based on the subsection scores on the Voice Handicap Index (VHI; Van Lierde, et al., 2010). Examination of the relationship between the psychosocial scores and the various subjective and objective outcome measures revealed that

only difference scores of VFI and the SPL values during phonation were moderate-highly correlated. This effect could have been due to limited distribution/range of the total psychosocial scores as well as issues related to following the VLT. It is also plausible that the time lag between completion of the psychosocial survey and the VLT for some participants could have influenced some of these results.

College students in general are known to sleep less, be more stressed, anxious, depressed (Pilcher et al., 1997). Students seeking to become professional voice users may frequently experience heavy vocal demands and may not necessarily follow a healthy lifestyle including healthy vocal habits. This study was intended to conduct a preliminary investigation on the impact of psychosocial factors on perceived and subjective assessment of vocal fatigue in prospective vocal professionals (students majoring in speech-language pathology). Specifically, education level was also examined. Given that amount of voice use was not adequate in graduate speech-language pathology students, future studies may benefit from a) including a) criteria for the amount of voice use through number of clients or b) including students who work in full-time externship activities (~40 hours/week) similar to a professional voice user or a certified speech-language pathologist. Further, psychosocial symptoms and symptoms from VFI may have shown stronger associations with addition of a quality of life scale such as VHI.

REFERENCES

Aaronson, L. S., Teel, C. S., Cassmeyer, V., Neuberger, G. B., Pallikkathayil, L., Pierce, J., …Wingate, A. (1999). Defining and measuring fatigue. *Journal Of Nursing Scholarship*, 31(1), 45-50.

Allard, E. R., & Williams, D. F. (2008). Listeners' perceptions of speech and language disorders. *Journal of Communication Disorders*, 41(2), 108-123.

Alpert, M. Pouget, E.R., & Silva, R.R., (2001). Reflections of depression in acoustic measures of the patient's speech. *Journal of Affective Disorders,* 66(1), 59-69.

American Speech-Language-Hearing Association (1993). Definitions of communication disorders and variations [Relevant Paper]. Available from www.asha.org/policy.

American Speech-Language-Hearing Association. (n.d.) Voice Disorders. [Practice Portal]. Retrieved May, 25, 2018, from www.asha.org/Practice-Portal/Clinical-Topics/Voice-Disorders.

Assad, J. P., Magalhaes, M. C., Santos, J. N., & Gama, A. C. (2017). Vocal dose: an integrative literature review. *Revista CEFAC: Atualizacao Cientifica Em Fonoaudiologia E Educacao*, (3), 429.

Astin, A.W., & Sax, L.J., (1998). How undergraduates are affected by service participation. *Journal of College Student Development*, 39(3), 251-263.

Aydogdu, B.N., Celik, H., Eksi, H., (2017). The predictive role of interpersonal sensitivity and emotional self-efficacy on psychological resilience among young adults. *Eurasian Journal of Educational Research, 69, 37-54.*

Bagwell, D.K. (2013). Quality of life, *Salem Press Encyclopedia of Health*, Ipswich, MA.

Baylor, C., Yorkston, K., Eadie, T., Miller, R., & Amtmann, D. (2008). Levels of speech usage: A self-reported scale for describing how people use speech. *Journal Of Medical Speech-Language Pathology*, 16(4), 191.

Beck, A., Verticchio, H., Seeman, S., Milliken, E., & Schaab, H., (2017). A mindfulness practice for communication sciences and disorders undergraduate and speech-language pathology graduate students: Effects on stress, self-compassion and perfectionism. *American Journal of Speech-Language Pathology*, 26, 893-907

Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry* (4), 561-571.

Behlau, M., & Oliveira, G. (2009). Vocal hygiene for the voice professional. *Curr Opin Otolaryngol Head Neck Surg,* 17(3), 149-154.

Behrman, A., Rutledge, J., Hembree, A., Sheridan, S. (2008). Vocal hygiene education, voice production therapy, and the role of patient adherence: A treatment effectiveness study in women with phonotrauma. *Journal of Speech, Language, and Hearing Research,* 51, 350-366.

Bhattacharyya, N. (2014). The prevalence of voice problems among adults in the United States. *Laryngoscope,* 124(10),2359-62.

Boominathan, P., Anitha, R., Shenbagavalli, M., & Dinesh, G. (2010). Voice characteristics and recovery patterns in indian adult males after vocal loading. *Journal Of The All India Institute Of Speech & Hearing*, 29(2), 220-231.

Boucher, V.J., & Ayad, T., (2010) Physiological attributes of vocal fatigue and their acoustic effects: A synthesis of findings for a criterion-based prevention of acquired voice disorders. *Journal of Voice*, 24(3), 324-336

Buekers, R. (1998) Are voice endurance tests able to assess vocal fatigue? *Clin. Otolaryngol,* 23, 533-538.

Bulbotz Jr, W. C., Brown, F., & Soper, B. (2001). Sleep habits and patterns of college students: a preliminary study. *Journal of American College Health*, 50(3), 131-135.

Cantor Cutiva, L. C., & Burdorf, A. (2014). Factors associated with voice-related quality of life among teachers with voice complaints. *Journal of Communication Disorders,* 52, 134-142.

Cantor Cutiva, L.C., Vogel, I., & Burdorf, A., (2013). Voice disorders in teachers and their associations with work related factors: A systematic review. *Journal of Communication Disorders*, 46, 143-155.

Caraty, M. J., & Montacié, C. (2014). Vocal fatigue induced by prolonged oral reading: Analysis and detection. *Computer Speech & Language*, 28(2), 453-466.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior,* 24, 385-396.

Cohen, S., & Wills, T.A., (1985). Stress, social support, and the buggering hypothesis. *Psychological Bulletin*, 98(2), 310-357.

Council of Academic Programs in Communication Sciences and Disorders and the American Speech-Language Hearing Association. (2017). *CSD Education survey national aggregate data report: 2016-2017 acadenuc year,* Retrieved from www.asha.org and www.capcsd.org

D'Haeseleer, E., Claeys, S., Meerschman, I., Bettens, K., Degeest, S., Dijckmans, C., . . . Van Lierde, K. (2017). Vocal characteristics and laryngoscopic findings in future musical theater performers. *Journal of Voice*, 31(4), 462-469.

Echternach, M., Nusseck, M., Dippold, S., Spahn, C., & Richter, B. (2014). Fundamental frequency, sound pressure level and vocal dose of a vocal loading test in comparison to a real teaching situation. *Eur Arch Otorhinolaryngol*, 271(12), 3263-3268.

Eddins, D. A., Anand, S., Camacho, A., & Shrivastav, R. (2016). Modeling of breathy voice quality using pitch-strength estimates. *Journal of Voice*, 30(6), 774-e1.

Fairbanks, G. (1960). Voice and articulation drillbook (2nd ed.). New York: Harper & Row.

Fairfield, C., & Richards, B. (2007). Reported Voice Difficulties in Student Teachers: A Questionnaire Survey. *British Journal of Educational Studies*, 55(4), 409-425.

Fenzel, L.M., & Peyrot, M. (2005). Comparing college community participation and future service behaviors and attitudes. *Michigan Journal of Community Service Learning*, 23-31.

Ferreira, L.P., Guerra, J.R., Loiola, C.M., & Assis Moura Ghirardi. A.C., (2012). Relationship between vocal symptoms in college students and their possible causes. *International Archives of Otorhinolaryngology*, 16(3), 306-331.

Fujiki, R. B., & Sivasankar, M. P. (2017). A review of vocal loading tasks in the voice literature. *Journal of Voice*, 31(3), 388 e333-388 e339.

Gavigan, C. A. (2017). The relationship between measures of vocal fatigue metrics and pulmonary function test results: Michigan State University. Communicative Sciences and Disorders.

Goldberg, D. P., & Hillier, V. F. (1979). A scaled version of the General Health Questionnaire. *Psychological Medicine*, 9(1), 139-145.

Gottliebson, R. O., Lee, L., Weinrich, B., & Sanders, J. (2007). Voice problems of future speech-language pathologists. *Journal of Voice*, 21(6), 699-704.

Guzmán, M., Malebrán, M. C., Zavala, P., Saldívar, P., & Muñoz, D. (2013). Acoustic changes of the voice as signs of vocal fatigue in radio broadcasters: Preliminary findings. *Acta Otorrinolaringologica (English Edition)*, 64(3), 176-183.

Hamilton, M.A., (1960). A rating scale for depression. *Journal of Neurology, Neurosurgery, and Psychiatry*, 23, 56-62.

Hunter, E. J., & Titze, I. R. (2009). Quantifying vocal fatigue recovery: dynamic vocal recovery trajectories after a vocal loading exercise. *Annals of Otology, Rhinology & Laryngology*, 118(6), 449-460.

Hunter, E. J., & Titze, I. R. (2010). Variations in intensity, fundamental frequency, and voicing for teachers in occupational versus nonoccupational settings. J*ournal of Speech, Language, and Hearing Research: JSLHR*, 53(4), 862-875.

Ilomäki, I, Kankare, E., Tyrmi, J., Kleemola, L., & Geneid, A., (2017). Vocal fatigue symptoms and laryngeal status in relation to vocal activity limitation and participation restriction. *Journal of Voice*, 31(2) 238.e7-248.e10.

Isetti, D.D., & Meyer, D. (2014). Workplace productivity and voice disorders: A cognitive interviewing study on presenteeism in individuals with spasmodic dysphonia. *Journal of Voice*, 28(6), 700-710.

Isetti, D. D., Baylor, C. R., Burns, M. I., & Eadie, T. L. (2017). Employer reactions to adductor spasmodic dysphonia: Exploring the influence of symptom severity and disclosure of diagnosis during a simulated telephone interview. *American Journal of Speech-Language Pathology*, 26(2), 469-482.

Jacobson, B. H., Johnson, A., Grywalski, C., Silbergleit, A., Jacobson, G., Benninger, M. S., & Newman, C. W. (1997). The Voice Handicap Index (VHI): Development and validation. *American Journal of Speech-Language Pathology*, 6(3), 66-69.

Kawachi, I., & Berkman, L.F., (2001). Social ties and mental health. *Journal of Urban Health*, 78(3), 458-467.

Kostyk, B., & Rochet, A. P. (1998). Laryngeal airway resistance in teachers with vocal fatigue: A preliminary study. *Journal of Voice*, 12(3), 287-299.

Kroenke, K., Spitzer, R. L., Williams, J. B. W., & Löwe, B. (2010). The patient health questionnaire somatic, anxiety, and depressive symptom scales: A systematic review. *General Hospital Psychiatry*, 32(4), 345-359.

Laukkanen, A. M., Ilomaki, I., Leppanen, K., & Vilkman, E. (2008). Acoustic measures and self-reports of vocal fatigue by female teachers. *Journal of Voice*, 22(3), 283-289.

Laukkanen, A., Järvinen, K., Artkoski, M., Waaramaa-Mäki-Kulmala, T., Kankare, E., Sippola, S. . . Salo, A. (2004). Changes in voice and subjective sensations during a 45-min vocal loading test in female subjects with vocal training. *Folia Phoniatrica Et Logopaedica*, 56(6), 335-346.

Lopez, J. M., Catena, A., Montes, A., & Castillo, M. E. (2017). Effectiveness of a short voice training program for teachers: A preliminary study. *Journal of Voice*.

Lowell, S. Y., Colton, R. H., Kelley, R. T., & Hahn, Y. C. (2011). Spectral-and cepstral-based measures during continuous speech: capacity to distinguish dysphonia and consistency within a speaker. *Journal of Voice,* 25(5), e223-e232.

Macauley, K., Plummer, L., Bemis, C., Brock, G., Larson, C., & Spangler, J. (2018). Prevalence and predictors of anxiety in healthcare professions students. *Health Professions Education.*

Martins, R. H., Pereira, E. R., Hidalgo, C. B., & Tavares, E. L. (2014). Voice disorders in teachers: A review. *Journal of Voice,* 28(6), 716-724.

Merrill, R., Tanner, K., Merrill, J., McCord, M. D., Beardsley, M. M., & Steele, B. (2013). Voice symptoms and voice-related quality of life in college students. *Annals of Otology, Rhinology & Laryngology,* 122(8), 511-519.

Misono, S., Peterson, C. B., Meredith, L., Banks, K., Bandyopadhyay, D., Yueh, B., & Frazier, P. A. (2014). Psychosocial distress in patients presenting with voice concerns. *Journal Of Voice,* 28(6), 753-761.

Mundt, J.C., Snyder, P.J., Cannizzaro, M.S., Chappie, K., & Geralts, D.S., (2007). Voice acoustic measures of depression severity and treatment response collected via interactive voice response (IVR) technology. *J Neurolinguistics*, 20(1), 50-64.

Nanjundeswaran, C., Jacobson, B. H., Gartner-Schmidt, J., & Verdolini Abbott, K. (2015). Vocal Fatigue Index (VFI): Development and Validation. *Journal of Voice*, 29(4), 433-440.

National Institute on Deafness and Other Communication Disorders (2014). Taking Care of Your Voice [Relevant Paper]. Available from www.nidcd.nih.gov/health

Ohlsson, A. C., Andersson, E. M., Sodersten, M., Simberg, S., Claesson, S., & Barregard, L. (2016). Voice disorders in teacher students: A prospective study and a randomized controlled trial. *Journal of Voice,* 30(6), 755 e713-755 e724.

Park, C., (2002) Neither fish nor fowl? The perceived benefits and problems of using graduate teaching assistants (GTAs) to teach undergraduate students. *Higher education review*, 35(1), 50-62.

Park, Y. J., & Park, Y. B. (2015). Relationships between pathological patterns and vocal qualities estimated by acoustic parameters. *Chin J Integr Med*, 21(5), 346-354.

Pilcher, J., Ginter, D., & Sadowsky, B. (1997). Sleep quality versus sleep quantity: Relationships between sleep and measures of health, well-being and sleepiness in college students. *Journal of Psychosomatic Research*, 42(6), 583-596.

Przysiezny, P.E., & Przysiezny, L.T.S., (2015). Work-related voice disorders. *Brazilian Journal of Otorhinolaryngology*, 81(2), 202-211.

Qualtrics. (2018). Qualtrics. Retrieved from https://qualtrics.com

Ragan, K. (2016). The impact of vocal cool-down exercises: A subjective study of singers' and listeners' perceptions. *Journal of Voice*, 30(6), 764 e761-764 e769.

Rammage, L.A., Nichol, H., Morrison, M.D. (1987) The psychopathology of voice disorders. *Human Communication Canada*, 11(4), 21-25.

Remacle, A., Finck, C., Roche, A., & Morsomme, D. (2012). Vocal impact of a prolonged reading task at two intensity levels: Objective measurements and subjective self-ratings. *Journal of Voice*, (4). e177.

Remacle, A., Garnier, M., Gerber, S., David, C., & Petillon, C. (2018). Vocal change patterns during a teaching day: Inter- and intra-subject variability. *Journal of Voice*.

Remacle, A., Schoentgen, J., Finck, C., Bodson, A., & Morsomme, D. (2014). Impact of vocal load on breathiness: Perceptual evaluation. Logopedics Phoniatrics Vocology, 39(3), 139-146.

Roy, N., Merrill, R.M., Gray, S.D., Smith, E.M., (2005). Voice disorders in the general population: Prevalence, risk factors, and occupational impact. *The Laryngoscope*, 115(11), 1988-1995. doi:10.1097/01.mlg.0000179174.32345.41.

Sajatovic, M., Chen, P., & Young, R.. (2015). Rating scales in bipolar disorder. *Clinical Trial Design Challenges in Mood Disorders*. 105-136.

Scherer, K. R. (1978). Personality inference from voice quality: The loud voice of extroversion. *European Journal of Social Psychology*, 8, 467-487.

Schloneger, M. J., & Hunter, E. J. (2017). Assessments of voice use and voice quality among college/university singing students ages 18-24 through ambulatory monitoring with a full accelerometer signal. *Journal of Voice*, 31(1), 124 e121-124 e130.

Searl, J., & Bailey, E. (2014). Vocal behaviors of student actors and student speech-language pathologists. *Voice and Speech Review*, 8(1), 5-26.

Seifert, E., & Kollbrunner, J. (2005). Stress and distress in non-organic voice disorders. *Swiss Med Weekly*, 135, 387-397.

Simberg, S., Sala, E., & Ronnemaa, A. M. (2004). A comparison of the prevalence of vocal symptoms among teacher students and other university students. *Journal of Voice*, 18(3), 363-368.

Smith, E., Verdolini, K., Gray, S., Nichols, S., Lemke, J., Barkmeier, J., Dove, H., Hoffman., H. (1996). Effect of voice disorders on quality of life. *Journal of Medical Speech-Language Pathology*, 4(4), 223-244.

Solomon, N. P. (2008). Vocal fatigue and its relation to vocal hyperfunction.. *International Journal of Speech Language Pathology*, 10(4), 254-266.

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). Consulting Psychologists Press; Palo Alto, CA: 1983. *Manual for the state-trait anxiety inventory*.

State of New Hampshire Employee Assistance Program (EAP; n.d.). Perceived stress scale [Relevant Paper]. Available from https://das.nh.gov

Stemple, J., Stanley, J., Lee, L. (1995), Objective measures of voice production in normal subjects following prolonged voice use. *Journal of Voice,* 9, 127-133.

Titze, I. R., Lemke, J., & Montequin, D. (1997). Population in the U.S. workforce who rely on voice as a primary tool of trade: A preliminary report. *Journal of Voice,* 11(3), 254-259.

Van Houtte, E., Claeys, S., Wuyts, F., & Van Lierde, K. (2011). The impact of voice disorders among teachers: vocal complaints, treatment-seeking behavior, knowledge of vocal care, and voice-related absenteeism. *Journal of Voice*, 25(5), 570-575.

Van Houtte, E., Van Lierde, K., D'Haeseleer, E., & Claeys, D. (2009). The prevalence of laryngeal pathology in a treatment-seeking population with dysphonia. *The Laryngoscope*, 120, 306–312.

Van Leer, E., & Van Mersbergen, M., (2017). Using the Borg CR10 physical exertion scale to measure patient-perceived vocal effort pre and post treatment. *Journal of Voice*, 31(3), 389.e19-389.e25.

Vertigan, A.E., Kapela, S.M., Franke, I., & Gibson, P.G., (2017) The effect of a vocal loading test on cough and phonation in patients with chronic cough. *Journal of Voice*, 31(6), 763-772.

Van Lierde, K. M., D'haeseleer, E., Wuyts, F. L., De Ley, S., Geldof, R., De Vuyst, J., & Sofie, C. (2010). The objective vocal quality, vocal risk factors, vocal complaints, and corporal pain in Dutch female students training to be speech-language pathologists during the 4 years of study. *Journal of Voice*, 24(5), 592-598.

Vilkman, E. (2000). Voice problems at work: A challenge for occupational safety and health arrangement. *Folia Phoniatrica et Logopaedica: International Journal of Phoniatrics, Speech Therapy and Communication Pathology*, 52(1-3), 120-125.

Vilkman, E., Lauri, E. R., Alku, P., Sala, E., & Sihvo, M. (1999). Effects of prologonged oral reading on fundamental frequency, SPL, subglottal pressure and amplitude characteristics of glottal flow waveforms. *Journal of Voice*, 13(2), 303-315.

Weekly, E. M., Carroll, L. M., Korovin, G. S., & Fleming, R. (2017). A vocal health survey among amateur and professional voice users. *Journal of Voice*.

Welham, N. V., & Maclagan, M. A. (2003). Vocal fatigue: Current knowledge and future directions. *Journal of Voice*, 17(1), 21-30.

WEVOSYS. (2014). LingWAVES. In. Forchheim, Germany.

White, E.B., & Williams, G., (1952). Charlotte's web. New York: Harper & Row Publishers.

Yiu, E. M., & Chan, M. M. (2003). Effects of hydration and vocal rest on the vocal fatigue in amateur karaoke singers. *Journal of Voice*, 17(2), 216-227.

Ziadni, M. S., Carty, J. N., Doherty, H. K., Porcerelli, J. H., Rapport, L. J., Schubiner, H., & Lumley, M. A. (2018). A life-stress, emotional awareness, and expression interview for primary care patients with medically unexplained symptoms: A randomized controlled trial. *Health Psychology*, 37(3), 282-290.

Zraick R.I., Risner, B.Y., (2008). Assessment of quality of life in persons with voice disorders. *Curr Opin Otolaryngol Head Neck Surg*, 16(3), 188-93.

APPENDICES

Appendix A: Informed Consent

Informed Consent to Participate in Research Involving Minimal Risk

Pro # 00033638

You are being asked to take part in a research study. Research studies include only people who choose to take part. This document is called an informed consent form. Please read this information carefully and take your time making your decision. Ask the researcher or study staff to discuss this consent form with you, please ask him/her to explain any words or information you do not clearly understand. The nature of the study, risks, inconveniences, discomforts, and other important information about the study are listed below.

We are asking you to take part in a research study called:

Relationship between Vocal Fatigue and Physical/Psychological Factors in Prospective Vocal Professionals

You will be presented with information relevant to physical, vocal, and mental health and asked to answer some questions about it. Please be assured that your responses will be kept completely confidential.

The person who is in charge of this research study is Camille Gray. This person is called the Principal Investigator. However, other research staff may be involved and can act on behalf of the person in charge. She is being guided in this research by a faculty mentor (Supraja Anand, Ph.D). If you would like to contact the Principal Investigator in the study to discuss this research, please e-mail Camille Gray at camille.gray@mail.usf.edu, or at anand-smslab@usf.edu

The research will be conducted at University of South Florida, Tampa Campus.

Purpose of the study

The purpose of this study is to understand how physical and psychological factors affect voice. Findings from this research will help us to understand the mechanism of vocal fatigue and will also help in better evaluation and treatment of voice symptoms in people with vocally demanding careers.

Why are you being asked to take part?

A maximum of 100 students at the undergraduate and graduate level currently enrolled in vocally demanding majors, including but not limited to Speech Language Pathology and Music, will be recruited from the University of South Florida community.

Inclusion Criteria:

- Native Speakers of American English.
- 18-35 years of age.
- Absence of co-morbid health conditions involving voice, respiration, and swallowing.
- Currently enrolled at least half-time at the University of South Florida in undergraduate or graduate studies.

Exclusion Criteria

- Participants with history of smoking, chronic alcohol use.
- Participants who have upper respiratory infections on the day of testing.
- Participants who have a history of asthma or other respiratory disorders.
- Participants with self-reported reflux disease.

Study Procedures:

If you take part in this study, you will be asked to:
Qualtrics Survey will be created with five sections, including 1.) Informed Consent, 2.) Personal and Demographic, 3.) Education and Health, 4.) General Questions on Mental Health Status and Vocal Use and Habits, and 5.) Standardized Surveys. Please note that the survey will be best displayed on a laptop or desktop computer. Some features may be less compatible for use on a mobile device.

Speaking Tasks: Participants will complete one or more of the following speech tasks

- Participants will be asked to complete speech tasks (e.g., prolonged vowel /a/ for approximately 5 seconds; reading passage) for pre-Vocal Loading Task volume (in dB) and quality.
- Participants will be asked to phonate/read a passage at increased loudness.
- Participants will be asked to phonate/read a passage at increased pitch.
- Participants will complete the speech tasks for post-Vocal Loading Task.

Outcome Measures:

a) Perceived fatigue evaluated by perceived effort/tiredness on a visual analog scale and severity scale (e.g., Borg Rating of Perceived Exertion, Borg, 1998).
b) Acoustic Measures related to pitch, loudness, and quality of voice (e.g., Sound Pressure Level in dB).
c) Standardized Vocal survey (e.g., Vocal Fatigue Index).

Total Number of Participants

Approximately 100 individuals will take part in this study at USF.

Alternatives

You do not have to participate in this research study. There are no alternatives to participation in this study.

Benefits

You will receive no direct benefit(s) by participating in this research study. Your participation will help further knowledge in assessment and treatment of professional voice users.

Risks or Discomfort

The following risks may occur:

- Voice recording are non-invasive and routine tasks. The following minimal risk adverse events, though extremely rare, may occur as a result of participation in this study.
- Speakers may experience minor discomfort from wearing microphone.
- Speakers may feel claustrophobic inside the sound booth.
- Sometimes depression inventories trigger uncomfortable feelings. Thus, participants may experience some discomfort when completing these tests.
- Speakers may experience vocal discomfort.

Compensation

You will receive $10/hour in gifts cards for participation if you qualify after you complete the speaking tasks in the research lab.

Costs

It will not cost you anything to take part in the study.

Privacy and Confidentiality

We will keep your study records (audio recorded files, any paper documents, and your survey responses) private and confidential. Any paper documents will be secured in a locked cabinet in the research lab (PCD 3016) and will not include identifying information. All paper documents will have a unique alphanumeric ID. All the excel sheets on the computer will be password protected. All the audio files are also assigned the same alphanumeric code. Access to the research lab and computers are restricted and your information will be visible only to the members approved by the IRB.

We may present/publish what we learn from this study. If we do, we will not include your name. We will not publish anything that would let people know who you are.

Voluntary Participation / Withdrawal

You should only take part in this study if you want to volunteer. You should not feel that there is any pressure to take part in the study. You are free to participate in this research or withdraw at any time. There will be no penalty or loss of benefits you are entitled to receive if you stop taking part in this study. Your decision to participate or not to participate will not affect your student status (course grade) or job status.

You can get the answers to your questions, concerns, or complaints

If you have any questions, concerns or complaints about this study, or experience an unanticipated problem, call Dr. Supraja Anand at (813) 974-3213.

If you have questions about your rights as a participant in this study, or have complaints, concerns or issues you want to discuss with someone outside the research, call the USF IRB at (813) 974-5638 or contact by email at RSCH-IRB@usf.edu.

You will have the opportunity to view this form again and ask the Primary Investigator additional questions you may have during your scheduled appointment prior to completion of the speech task. You will receive a signed copy of this form on that date.

At this time, please review the above Informed Consent form. Consent will be obtained through your response at the bottom of this page. Please select "I consent, begin the study" below to agree that you have read this informed consent form and wish to participate. If you no longer wish to participate, please select "I do not consent, I do not wish to participate" and the survey will automatically end. If you do not wish to participate, your name and contact information will not be collected.

By clicking the button below, you acknowledge that your participation in this study is voluntary, you are 18 years of age, and that you are aware that you may choose to terminate your participation in the study at any time and for any reason.

Consent to Take Part in this Research Study

I freely give my consent to take part in this study as agreed above and on the Qualtrics survey. I understand that by selecting "I consent" on the survey and by signing below I am agreeing to take part in research. I understand that I will receive a copy of this form on the speech task date.

_____ _____

Signature of Person Taking Part in Study Date

_____

Printed Name of Person Taking Part in Study

Statement of Person Obtaining Informed Consent

I have carefully explained to the person taking part in the study what he or she can expect from their participation. I confirm that this research subject speaks the language that was used to explain this research and is receiving an informed consent form in their primary language. This research subject has provided legally effective informed consent.

_____ _____

Signature of Person obtaining Informed Consent Date

_____

Printed Name of Person Obtaining Informed Consent

Appendix B: Qualtrics Survey

Section I. Personal Demographics and Employment

The following questions will be related to your personal demographics and contact information, to schedule the speaking exercise should you choose to participate. Please note that this information will be kept private and will only be known the Primary Investigator and her Faculty Mentor.

1. What is your name?
2. For the follow up speaking task, what is your e-mail/phone number? Please enter how to best contact you.

3. What is your age?
    a) 18-20
    b) 21-23
    c) 24-26
    d) 27-29
    e) 30-35

4. What is your gender?
    a) Male
    b) Female
    c) Transgender

5. What is your ethnicity?
    a) Hispanic or Latino
    b) Not Hispanic or Latino

6. What is your race?
    a) White
    b) Black or African American
    c) American Indian or Alaska Native
    d) Asian
    e) Native Hawaiian or Pacific Islander
    f) Other

7. What is your current employment status? Select all that apply.
    a) Employed full time
    b) Employed part time
    c) Unemployed looking for work
    d) Unemployed not looking for work
    e) Retired
    f) Student
    g) Disabled

Section II. Education and Health

The following questions will address your education status and enrollment at USF.

1. What is your classification as a student?
   a) Graduate
   b) Undergraduate

2. How many credit hours are you taking?
   a) 6-12 (undergraduate)
   b) 12-15 (undergraduate)
   c) 15-18 (undergraduate)
   d) 19 or more (undergraduate)
   e) 3-6 (graduate)
   f) 7-9 (graduate)
   g) 10 or more (graduate)

3. If you are completing clinical training, how often do you use your voice with patients?
   a) Never
   b) Between 2-4 hours a day
   c) Between 5-7 hour a day
   d) More than 8 hours a day
   e) N/A - not completing clinical training.

4. If you are an undergraduate, do you plan to complete graduate studies or beyond?
   a) Yes
   b) No
   c) Undecided
   d) I am a graduate student

5. What is your current major?
   a) Music
   b) Speech-Language Pathology
   c) Acting
   d) Other _____

The following questions have to do with specific health issues that may impact your vocal quality or influence your participation in this survey (e.g., vision). Please answer as honestly as possible.

6. Have you had the flu, pneumonia, or throat infections in the last 2 weeks?
    a) Yes
    b) No

7. Have you smoked (including cigarettes, recreational drugs, and hookah) in the past 5 years?
    a) Yes
    b) No

8. Are you currently on any medications for sinuses, allergies, or asthma?
    a) Yes
    b) No

9. Do you have acid reflux?
    a) Yes
    b) No

10. Do you have seasonal allergies?
    a) Yes
    b) No

11. Do you have any vision difficulties?
    a) Yes
    b) No

The following questions were adapted from "A Scaled Version of the General Health Questionnaire" as presented by D.P. Goldberg and V.F. Hillier (1979).

Please read the following carefully:
We would like to know if you have had any medical complaints, and how your health has been over the past few weeks. Remember that we want to know about recent complaints and not those that you've had in the past.
Have you recently...

12. Been feeling perfectly well and in good health?
    a) Better than usual
    b) Same as usual
    c) Worse than usual
    d) Much worse than usual

13. Been feeling in need of alcohol?
    a) Not at all
    b) No more than usual
    c) Rather more than usual
    d) Much more than usual

14. Felt that you are ill?
    a) Not at all
    b) No more than usual
    c) Rather more than usual
    d) Much more than usual

15. Been getting any pains, tightness, or pressure in your head?
    a) Not at all
    b) No more than usual
    c) Rather more than usual
    d) Much more than usual

16. Been having hot or cold spells?
    a) Not at all
    b) No more than usual
    c) Rather more than usual
    d) Much more than usual

17. Lost sleep or had difficulty falling or staying asleep.
    a) Not at all
    b) No more than usual
    c) Rather more than usual
    d) Much more than usual

18. Approximately how many hours of sleep do you get a night?
    a) 1-2
    b) 3-4
    c) 5-6
    d) 7-8
    e) 9-10
    f) More than 10

19. Been feeling any of the following? Check all that apply.
    a) Worried
    b) Strained
    c) Stressed
    d) Edgy
    e) Bad-Tempered
    f) Scared for no reason
    g) Panicked for no reason
    h) Nervous
    i) Strung-up

20. Felt on the whole you were doing things well? (e.g., school work, socialization, etc...,)
    a) Better than usual
    b) About the same
    c) Less well than usual
    d) Much less well than usual

The following questions were adopted from the Patient Health Questionnaire (PHQ-SADS). Please answer as honestly as possible. Please note that if you are experiencing severe anxiety or depression symptoms, we encourage you to contact the USF counseling center at 813-974-2831.

Over the last 2 weeks, how often have you been bothered by any of the following problems?

21. Little interest or pleasure in doing things
    a) Not at all
    b) Several days
    c) More than half the days
    d) Nearly every day

22. Feeling down, depressed, or hopeless
    a) Not at all
    b) Several days
    c) More than half the days
    d) Nearly every day

23. Trouble falling or staying asleep, or sleeping too much
    a) Not at all
    b) Several days
    c) More than half the days
    d) Nearly every day

24. Feeling tired or having little energy
    a) Not at all
    b) Several days
    c) More than half the days
    d) Nearly every day

25. Poor appetite or overeating
    a) Not at all
    b) Several days
    c) More than half the days
    d) Nearly every day

26. Feeling bad about yourself, or that you are a failure or have let yourself or your family down
    a) Not at all
    b) Several days
    c) More than half the days
    d) Nearly every day

27. Trouble concentrating on things, such as reading the newspaper or watching television
    a) Not at all
    b) Several days
    c) More than half the day
    d) Nearly every day

28. Moving or speaking so slowly that other people could have noticed - or the opposite - being so fidgety or restless that you have been moving around a lot more than usual.
    a) Not at all
    b) Several days
    c) More than half the days
    d) Nearly every day

29. Thoughts that you would be better off dead or of hurting yourself in some way
    a) Not at all
    b) Several days
    c) More than half the days
    d) Nearly every day

30. If you checked off any problems on this questionnaire, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?
    a) Not difficult at all
    b) Somewhat difficult
    c) Very difficult
    d) Extremely difficult

The following questions will discuss your vocal health and habits.

31. In the past 24 hours, you have used your voice...
    a) Infrequently (less than 4 hours)
    b) Somewhat infrequently (between 4-6 hours)
    c) Somewhat frequently (between 6-8 hours)
    d) Frequently (10 hours or more)

32. Regarding your SPOKEN voice, you consider it (check all that apply)
    a) Beautiful
    b) Pleasant
    c) Clear
    d) Strong
    e) Soft
    f) Ugly
    g) Stingy
    h) Muffled
    i) Weak
    j) Rough

33. With regards to your singing habits, you...
    a) Almost never sing
    b) Only sing in the shower/car
    c) Sing at least once a week
    d) Sing daily

34. Are you part of a band?
    a) Yes
    b) No

35. Do you have formal music training? If yes, how long?
    a) Yes _____
    b) No

36. Are you currently practicing music? If yes, how often?
    a) Yes _____
    b) No

37. Do you currently feel hoarseness in your voice?
    a) Yes
    b) No

38. Are you currently feeling pain in the following areas? Select all that apply.
    a) Neck
    b) Jaw
    c) Shoulder
    d) Throat
    e) None of the above

39. How often do you lose your voice?
    a) Almost never (1 time per year)
    b) Rarely (1 time per every 6 months)
    c) Occasionally (1 time per every month)
    d) Often (1 time per week)
    e) Usually only at the end of the day
    f) I have never lost my voice

40. How much water do you drink in a day?
    a) None
    b) Between 4-20 oz
    c) 21-40 oz
    d) 41-60 ox
    e) +60 oz

41. How much caffeine do you drink a day? This includes coffee and other caffeinated beverages.
    a) None
    b) 1 cup
    c) 2 cups
    d) 3+ cups

42. How frequently do you clear your throat?
    a) Never
    b) Rarely
    c) Occasionally
    d) Constantly
    e) Always

43. How often do you experience symptoms of acid reflux?
    a) Never (1 time per year)
    b) Almost Never (1 time per 6 months)
    c) Sometimes (1 or 2 times per month)
    d) Almost always (1 or 2 times per week)
    e) Always (1 time per day or more)

44. How often do you have drying sensations in your mouth or throat?
    a) Never (1 time per year)
    b) Almost never (1 time per 6 months)
    c) Sometimes (1 or 2 times per month)
    d) Almost always (1 or 2 times per week)
    e) Always (1 time per day or more)

Section III. Vocal Fatigue Index

These are some symptoms usually associated with voice problems. Select the response that indicates how frequently you experience the same symptoms.

1. I don't feel like talking after a period of voice use
   a) Never
   b) Sometimes
   c) About half the time
   d) Most of the time
   e) Always

2. I experience pain in the neck at the end of the day with voice use
   a) Never
   b) Sometimes
   c) About half the time
   d) Most of the time
   e) Always

3. I experience throat pain at the end of the day with voice use
   a) Never
   b) Sometimes
   c) About half the time
   d) Most of the time
   e) Always

4. My voice feels sore when I talk more
   a) Never
   b) Sometimes
   c) About half the time
   d) Most of the time
   e) Always

5. My voice feels tired when I talk more
   a) Never
   b) Sometimes
   c) About half the time
   d) Most of the time
   e) Always

6. I experience increased sense of effort with talking
    a) Never
    b) Sometimes
    c) About half the time
    d) Most of the time
    e) Always

7. My voice gets hoarse with voice use
    a) Never
    b) Sometimes
    c) About half the time
    d) Most of the time
    e) Always

8. It feels like work to use my voice
    a) Never
    b) Sometimes
    c) About half the time
    d) Most of the time
    e) Always

9. I tend to generally limit my talking after a period of voice use
    a) Never
    b) Sometimes
    c) About half the time
    d) Most of the time
    e) Always

10. My throat aches with voice use
    a) Never
    b) Sometimes
    c) About half the time
    d) Most of the time
    e) Always

11. I experience discomfort in my neck with voice use
    a) Never
    b) Sometimes
    c) About half the time
    d) Most of the time
    e) Always

12. I run out of air when I talk
    a) Never
    b) Sometimes
    c) About half the time
    d) Most of the time
    e) Always

13. I avoid social situations when I know I have to talk more
    a) Never
    b) Sometimes
    c) About half the time
    d) Most of the time
    e) Always

14. I feel I cannot talk to my family after a work day
    a) Never
    b) Sometimes
    c) About half the time
    d) Most of the time
    e) Always

15. My voice feels better after I have rested
    a) Never
    b) Sometimes
    c) About half the time
    d) Most of the time
    e) Always

16. It is effortful to produce my voice after a period of voice use
    a) Never
    b) Sometimes
    c) About half the time
    d) Most of the time
    e) Always

17. The effort to produce my voice decreased with rest
    a) Never
    b) Sometimes
    c) About half the time
    d) Most of the time
    e) Always

18. My shortness of breath with talking decreased after a period of rest
    a) Never
    b) Sometimes
    c) About half the time
    d) Most of the time
    e) Always

19. I find it difficult to project my voice with voice use
    a) Never
    b) Sometimes
    c) About half the time
    d) Most of the time
    e) Always

20. My voice feels weak after a period of voice use
    a) Never
    b) Sometimes
    c) About half the time
    d) Most of the time
    e) Always

21. The hoarseness of my voice gets better with rest
    a) Never
    b) Sometimes
    c) About half the time
    d) Most of the time
    e) Always

Section IV: Perceived Stress Scale

The following questions are related to how much stress you feel that you are under currently.

1. In the last month, how often have you been upset because of something that happened unexpectedly?
   a) Never
   b) Almost Never
   c) Sometimes
   d) Fairly Often
   e) Very Often

2. In the last month, how often have you felt that you were unable to control the important things in your life?
   a) Never
   b) Almost Never
   c) Sometimes
   d) Fairly Often
   e) Very Often

3. In the last month, how often have you felt nervous and "stressed"?
   a) Never
   b) Almost Never
   c) Sometimes
   d) Fairly Often
   e) Very Often

4. In the last month, how often have you felt confident about your ability to handle your personal problems?
   a) Never
   b) Almost Never
   c) Sometimes
   d) Fairly Often
   e) Very Often

5. In the last month, how often have you felt that things were going your way?
   a) Never
   b) Almost Never
   c) Sometimes
   d) Fairly Often
   e) Very Often

6. In the last month, how often have you found that you could not cope with all the things that you had to do?
    a) Never
    b) Almost Never
    c) Sometimes
    d) Fairly Often
    e) Very Often

7. In the last month, how often have you been able to control irritations in your life?
    a) Never
    b) Almost Never
    c) Sometimes
    d) Fairly Often
    e) Very Often

8. In the last month, how often have you felt that you were on top of things?
    a) Never
    b) Almost Never
    c) Sometimes
    d) Fairly Often
    e) Very Often

9. In the last month, how often have you been angered because of things that were outside of your control?
    a) Never
    b) Almost Never
    c) Sometimes
    d) Fairly Often
    e) Very Often

10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?
    a) Never
    b) Almost Never
    c) Sometimes
    d) Fairly Often
    e) Very Often

Section V: Beck's Depression Inventory

The following questions are related to depression. Please note that some questions may cause discomfort or sadness. You are under no obligation to complete this survey should you feel uncomfortable with continuing. If you experience worsening symptoms of depression or anxiety, please contact the USF Counseling Center, as previously stated. Their contact information is as follows:

USF Counseling Center
http://www.usf.edu/student-affairs/counseling-center/
813-974-2831

Please check the answer that applies best to your current situation.

1.
   a) I do not feel sad
   b) I feel sad
   c) I am sad all the time and I can't snap out of it
   d) I am so sad and unhappy that I can't stand it.

2.
   a) I am not particularly discouraged about the future
   b) I feel discouraged about the future
   c) I feel I have nothing to look forward to
   d) I feel the future is hopeless and that things cannot improve

3.
   a) I do not feel like a failure
   b) I feel I have failed more than the average person
   c) As I look back on my life, all I can see is a lot of failures
   d) I feel I am a complete failure as a person

4.
   a) I get as much satisfaction out of things as I used to
   b) I don't enjoy things the way I used to
   c) I don't get real satisfaction out of anything anymore
   d) I am dissatisfied or bored with everything

5.
   a) I don't feel particularly guilty
   b) I feel guilty a good part of the time
   c) I feel quite guilty most of the time
   d) I feel guilty all of the time

6.

a) I don't feel I am being punished
b) I feel I may be punished
c) I expect to be punished
d) I feel I am being punished

7.

a) I don't feel disappointed in myself
b) I am disappointed in myself
c) I am disgusted with myself
d) I hate myself

8.

a) I don't feel I am any worse than anybody else
b) I am critical of myself for my weaknesses or mistakes
c) I blame myself all the time for my faults
d) I blame myself for everything bad that happens

9.

a) I don't have any thoughts of killing myself
b) I have thoughts of killing myself, but I would not carry them out
c) I would like to kill myself
d) I would kill myself if I had the chance

10.

a) I don't cry any more than usual
b) I cry more now than I used to
c) I cry all the time now
d) I used to be able to cry, but now I can't cry even though I want to

11.

a) I am no more irritated by things than I ever was
b) I am slightly more irritated now than usual
c) I am quite annoyed or irritated a good deal of the time
d) I feel irritated all the time

12.

a) I have not lost interest in other people
b) I am less interested in other people than I used to be
c) I have lost most of my interest in other people
d) I have lost all of my interest in other people

13.

a) I make decisions about as well as I ever could
b) I put off making decisions more than I used to
c) I have greater difficulty in making decisions more than I used to
d) I can't make decisions at all anymore

14.

a) I don't feel that I look any worse than I used to
b) I am worried that I am looking old or unattractive
c) I feel there are permanent changes in my appearance that make me look unattractive
d) I believe that I look ugly

15.

a) I can work about as well as before
b) It takes an extra effort to get started at doing something
c) I have to push myself very hard to do anything
d) I can't do any work at all

16.

a) I can sleep as well as usual
b) I don't sleep as well as I used to
c) I wake up 1-2 hours earlier than usual and find it hard to get back to sleep
d) I wake up several hours earlier than I used to and cannot get back to sleep

17.

a) I don't get more tired than usual
b) I get tired more easily than I used to
c) I get tired from doing almost anything
d) I am too tired to do anything

18.

a) My appetite is no worse than usual
b) My appetite is not as good as it used to be
c) My appetite is much worse now
d) I have no appetite at all anymore

19.

a) I haven't lost much weight, if any, lately
b) I have lost more than five pounds
c) I have lost more than ten pounds
d) I have lost more than fifteen pounds

20.

a) I am no more worried about my health than usual
b) I am worried about physical problems like aches, pains, upset stomach, or constipation
c) I am very worried about physical problems and it's hard to think of much else
d) I am so worried about my physical problems that I cannot think of anything else

21.

a) I have not noticed any recent changes in my interest in sex
b) I am less interested in sex than I used to be
c) I have almost no interest in sex
d) I have lost interest in sex completely

Appendix C: Perceived Stress Scale Scoring

***The following was acquired from Cohen et al. (1983) and State of New Hampshire Employee Assistance Program (n.d.).*

PSS-10 scores are obtained by reversing the scores on the four positive items, e.g., 0=4, 1=3, 2=2, etc. and then summing across all 10 items. Items 4, 5, 7, and 8 are the positively stated items.

Individual scores on the PSS can range from 0 to 40 with higher scores indicating higher perceived stress.

► Scores ranging from 0-13 would be considered low stress.
► Scores ranging from 14-26 would be considered moderate stress.
► Scores ranging from 27-40 would be considered high perceived stress.

Appendix D: Vocal Loading Task Instructions

Now we are going to complete the voice task. The parameters for the vocal loading task are tailored to your voices loudness. You will be asked to read “Charlotte’s Web” at different pitches and volumes. When the line is lower, which is your normal loudness, I want you to read in a “Minnie Mouse” voice. When the line is higher, I want you to read in a “Mufasa” voice, as if you’re commanding. I will show you pictures to let you know what voice I want you to maintain and when I want you to switch. Additionally, if your voice falls below the target loudness a large blue arrow will appear on screen.

I want you to keep going until I tell you to stop. After you are done, you will complete a short survey and the sustained /a/ and Rainbow Passage one more time.

Do you have any questions before you begin?