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Vocal Function Exercises for Normal Voice: With and Without Semi-Occlusion

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VOCAL FUNCTION EXERCISES FOR NORMAL VOICE: WITH AND WITHOUT SEMI-OCCLUSION

THESIS

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Communication Sciences and Disorders in the College of Health Sciences at the University of Kentucky

By

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ABSTRACT OF THESIS

VOCAL FUNCTION EXERCISES FOR NORMAL VOICE: WITH AND WITHOUT SEMI-OCCLUSION

The primary purpose of this investigation was to explore the effects of varying degrees of vocal tract semi-occlusion in Vocal Function Exercises (VFEs) on attainment of pre- established maximum phonation time (MPT) goals in individuals between the ages of 18 and 45 with normal voice. Individuals were randomized into three experimental groups: the traditional VFE with a semi-occluded vocal tract (SOVT), modified /o/ with partial occlusion, and modified /a/ without significant occlusion. For six weeks, the participants completed the four exercises two times each, twice daily on corresponding vocal tract postures assigned by group. Results indicated significant change in percent of MPT goal attained for the traditional VFE group. Neither modified vocal tract group resulted in significant change. Decreased occlusion appears insufficient in producing substantial change in voice production despite increased compliance compared to the traditional VFE group.

KEYWORDS: Vocal Function Exercises, vocal tract posture, maximum phonation time, compliancy, voice disorders

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Chapter One: Introduction

The semi-occluded vocal tract (SOVT) posture has been described in the literature and studied along a continuum of occlusion (Dargin, DeLaunay, & Searl, 2016). Variations of semi-occlusion include straw phonation, straw phonation with water resistance, lip trills, tongue trills, y-buzz, hand over mouth, and voiced bilabial fricatives. A variety of therapeutic approaches for treatment of voice disorders employ SOVT posture including Resonant Voice Therapy, Accent Method, and Vocal Function Exercises (Kapsner-Smith, Hunter, Kirkham, Cox, & Titze, 2015).

Resonant Voice Therapy (RVT) is a voice treatment approach that produces oral vibratory sensations by using fricatives and nasal consonants /m/, /n/, and /ŋ/ as key training gestures embedded in connected speech (Kapsner-Smith et al., 2015; Verdolini, Druker, Palmer, & Samawi, 1998). Similarly, the Accent Method (AM) incorporates voiced fricatives, which provide oral semi-occlusions, in a rhythmic manner. The exercises progress from non-speech to connected speech exercises (Kapsner-Smith et al., 2015). A third example is, Vocal Function Exercises (VFEs) a physiologic voice therapy approach "designed to strengthen and balance the laryngeal musculature and balance airflow to muscular effort" (Stemple, Lee, D'Amico, & Pickup, 1994, p. 271). The vocal tract posture used in VFEs is similar to a whistling mouth posture, with the lips tightly rounded and the pharynx expanded (Croake, Andreatta, & Stemple, 2016). A sympathetic vibration should be felt on the lips (Stemple, 2005).

SOVT postures have been theorized to heighten the interaction between the source (glottis) and the filter (supraglottic configuration), which allows for the vocal folds and the vocal tract to work synergistically (Kapsner-Smith et al., 2015; Titze,

2006). When the vocal tract is partially occluded, the air pressure above and between the vocal folds increases and maintains the vocal folds in a slightly separated position. This slight separation is thought to decrease the likelihood of vocal fold tissue damage while warming up the voice across a range of pitches and sustained tasks (Dargin et al., 2016). What follows is a more detailed discussion of the VFE protocol, a physiologic voice therapy technique that uses a SOVT posture.

VFE protocol

The VFE protocol was initially described in a double blind placebo-controlled study by Stemple et al. (1994) and additionally explained with greater detail by Stemple (2005). VFEs are a voice exercise program consisting of four exercises described below:

1. Warm up exercise: Sustain /i/ for as long as possible on the musical note (F) above middle (C) for females and boys, (F) below middle (C) for adult males. Placement of the tone should be in an extreme forward focus, almost, but not quite, nasal.
2. Stretching exercise: Glide from lowest note to highest note on the word "knoll." The word "knoll" encourages a forward placement of the tone as well as an expanded open pharynx. The client's lips are to be rounded and a sympathetic vibration should be felt on the lips.
3. Contracting exercise: Glide from highest note to lowest note on the word "knoll." The client is instructed to feel a half-yawn in the throat throughout the exercise. The client's lips are to be rounded and a sympathetic vibration should be felt on the lips.
4. Low-impact adductory power exercise: Sustain the musical notes (C-D-E-F-G) for as long as possible on the word "knoll" minus the "kn," The "oll" is produced with an open pharynx and constricted, sympathetic vibrating lips. The shape of the pharynx to the

lips is likened to an inverted megaphone. Each exercise is performed as softly as possible with engaged phonation.

Each exercise includes a form of vocal tract semi-occlusion, utilizing either the nasal or oral cavity. The SOVT posture is thought to be a key component of VFEs, but has not been systematically investigated.

Clinical Efficacy of SOVT

Many successful therapy techniques and programs are based on exercises that incorporate a SOVT. Some studies have even compared various SOVT approaches. In a randomized control trial, Kapsner-Smith et al. (2015) compared VFEs to phonation through flow-resistant tubes (FRT). The authors concluded that FRT was noninferior to VFEs in improving voice quality of life in people with dysphonia. Both exercise protocols incorporate a form of semi-occlusion, but also include a variety of other therapeutic elements. Thus, the specific role and contribution of the SOVT to the efficacy of each of these treatment protocols is not fully understood.

Statement of the Problem

While there is evidence to suggest that VFEs are efficacious in improving the disordered (Berg, Hapner, Klein, & Johns, 2008; Gelfer & Van Dong, 2013; Gillivan-Murphy, Drinnan, O'Dwyer, Ridha, & Carding, 2006; Gorman, Weinrich, Lee, & Stemple, 2008; Kaneko et al., 2015; Kapsner-Smith et al., 2015; Patel, Pickering, Stemple, & Donohue, 2012; Pedrosa, Pontes, Pontes, Behlau, & Peccin, 2016; Radhakrishnan & Scheidt, 2012; Roy et al., 2001; Sauder, Roy, Tanner, Houtz, & Smith, 2010; Sharma, De, Martin, & Pracy, 2009; Tanner, Sauder, Thibeault, Dromey, & Smith, 2010; Tay, Phyland, & Oates, 2012; Van Stan, Roy, Awan, Stemple, & Hillman, 2015;

Ziegler, Verdolini Abbott, Johns, Klein, & Hapner, 2014), normal (Ellis & Beltyukova, 2011; Sayles, 2003; Stemple et al., 1994), and well-trained voice (Guzman, Angulo, Munoz, & Mayerhoff, 2013; Sabol, Lee, & Stemple, 1995), the precise mechanism of change remains an open question. It is unclear whether the SOVT posture is an essential component of efficacy, or whether other vocal tract postures are capable of achieving similar results. Failure to systematically investigate components of the VFE treatment protocol presents difficulty in distinguishing between essential and nonessential aspects of the program. Consequently, it becomes difficult to improve the efficacy and efficiency of VFEs as a treatment approach and identify individuals for whom the treatment is most beneficial. Van Stan et al. (2015) argue that the field of rehabilitation is limited by incomplete descriptions of therapeutic processes that produce outcomes. This lack of specification hinders the field's ability to identify the active ingredients within treatments. The present study uses a dismantling approach, modifying and eliminating a single component of the VFE protocol (the SOVT posture), in order to determine its precise impact on efficacy. In doing so, this study begins to address the central issue of whether a SOVT posture is crucial to VFE efficacy.

Purpose of the Study

This study addressed the specific component of SOVT posture in VFEs, a physiologic voice therapy delivered by speech-language pathologists. Individuals with normal voice were chosen for this study for two reasons. First, voice quality exists on a continuum including the disordered, normal, and well-trained voice; thus, individuals with normal voice are capable of improving their voice production (Stemple, 2005). Second, because this is a pilot study and the first to systematically investigate the role of

the SOVT posture as part of the VFE protocol, it was pragmatic to begin with a normal population.

Three experimental groups completed VFEs using varying degrees of vocal tract occlusion. The first group used the traditional SOVT posture with greatest semi-occlusion; the second group used a modified /o/ posture with partial occlusion, lessened in comparison to the first group; the third group used a modified /a/ posture, without significant occlusion. The primary outcome measure was percent of maximum phonation time (MPT) goal attained. MPT is thought to approximate efficiency of vocal fold vibration; with greater efficiency of vibration, MPT increases (Stemple, 2005). The primary purpose of this study was to investigate the effects of varying degrees of vocal tract semi-occlusion on percent of MPT goal attainment.

Chapter Summary

Chapter one served to introduce the reader to the idea of the semi-occluded vocal tract and its application in voice treatment approaches. Chapter two will serve to review the relevant literature.

Chapter Two: Literature Review

Vocal Function Exercises (VFEs) is a physiologic approach to voice therapy which seeks to strengthen and rebalance the laryngeal musculature and restore balance among the three subsystems of voice: respiration, phonation, and resonance (Stemple et al., 1994). The therapy program is comprised of a series of four exercises, including warm up, stretching, contracting, and low impact power adductory exercises that are completed two times each, twice daily. Currently, a total of 27 studies have demonstrated that VFEs improve the normal, pathological, and well-trained voice in a variety of populations. This chapter will begin by discussing the key components of VFEs.

Semi-Occluded Vocal Tract Posture

One key component of VFEs is the incorporation of a semi-occluded vocal tract (SOVT) posture. The goal of using a SOVT is to achieve greater vocal output (efficiency), with less vocal fold stress and physical effort (economy) (Croake et al., 2016). The SOVT posture is similar to a whistling mouth posture with the lips tightly rounded, which creates a narrow and elongated labial aperture. The pharynx is expanded and, in combination with the labial posture, is likened to an inverted megaphone (Croake et al., 2016). Maxfield, Titze, Hunter, and Kapsner-Smith (2015) endorse the SOVT posture for voice therapy because it encourages the development of voice production that relies on heightened interaction between the source (glottis) and filter (supraglottic configuration), rather than vocal fold adductory stress which can be caused by supraglottic hyperfunction (Titze, 2006). When the lips are semi-occluded and the epi-larynx tube is narrowed, the vocal folds and the vocal tract work synergistically to reinforce easier vocal fold vibration (nonlinear source-filter coupling) (Titze, Riede, &

Popolo, 2008). Additionally, when the combination of supraglottal pressure and positive intraglottal pressure is maintained throughout the vibratory cycle, the mean positive pressure in the glottis keeps the vocal folds slightly separated (Titze, 2009). Parallel or nearly parallel positioning of the medial surfaces of the vocal folds results in lowest phonation threshold pressure, which decreases vocal fold adduction, thereby lessening the risk of injury to the vocal fold mucosa (Kapsner-Smith et al., 2015).

Vocal tract semi-occlusion is used for each of the four exercises in VFEs. In exercise one, a semi-occlusion is created through the nasal cavity. When sustaining /i/, the tone should have an extreme forward focus and be almost, but not quite, nasal (Stemple, 2005). Exercises two, three, and four are performed with the semi-occluded posture formed by expanding the pharynx and narrowing the labial aperture. The present study was designed to investigate the effect of changing the vocal tract posture traditionally utilized in VFEs. The next several sections will provide an overview of the efficacy of traditional VFEs employing a SOVT.

Traditional VFEs for Normal Voice

Stemple (2005) explained that vocal wellness exists on a continuum, which includes the disordered, normal, and well-trained voice. When a relative dynamic equilibrium among respiration, phonation, and resonance is maintained, not only the disordered but also the normal voice can be enhanced. Substantial evidence suggests that VFEs are efficacious in doing so. Stemple et al. (1994) investigated the efficacy of VFEs as a method for improving voice quality in individuals with normal voice. This double blind, placebo-controlled study included 35 female participants divided into three groups: experimental, control, and placebo. All participants underwent a four-week intervention

protocol. The experimental group performed VFEs as described above two times each, twice daily. Results indicated greatest improvement in the experimental group with significant changes in phonation volume (increased), flow rate (decreased), maximum phonation time (MPT) (increased), and phonational frequency range (increased).

Sayles (2003) studied a population of singing children with normal voice who performed VFEs for eight weeks. A significant increase in mean average weekly phonation times and improvement along several aerodynamic parameters including open quotient, maximum flow declination rate, and subglottal pressure were found.

Traditional VFEs for Aging Voice

Presbylaryngeus, or aging larynx, is well documented in the literature and is recognized to adversely affect vocal function and quality of life (Sauder et al., 2010). VFEs have been implemented in this population, resulting in increased MPT and sublglottic air pressure, improved jitter, shimmer, and noise-to-harmonic ratio, and decreased glottal airflow (Gorman et al., 2008; Kaneko et al., 2015; Tay et al., 2012). Tanner et al. (2010) observed increased mid-membranous and posterior glottal closure during laryngeal examination after four sessions of VFEs. In a study by Sauder et al. (2010), blinded-listeners rated statistically significant reductions in breathiness and strain, and participants reported significant reductions on VHI scores post-treatment. Comparably, significant improvements on the Grade, Roughness, Breathiness, Asthenia, Strain (GRBAS) scale and reduction of VHI scores were demonstrated in a retrospective study by Kaneko et al. (2015). In individuals with presbylaryngeus, VFEs have resulted in improvements measured objectively and subjectively along acoustic, aerodynamic, visual-perceptual, auditory perceptual, and self-report parameters.

Traditional VFEs for Pathological Voice

VFEs are also efficacious in improving disordered voice and have been compared to several voice treatments. A study by Roy et al. (2001) examined elementary and secondary teachers with self-reported voice problems. Participants were assigned to one of three groups: VFEs, vocal hygiene (VH), or a no-treatment control (NTC). The VFE group demonstrated improved Voice Handicap Index (VHI) scores, and self-reported overall vocal improvement, greater vocal clarity, and greater ease of speaking compared to the VH and NTC groups.

VFEs have also been compared to voice amplification (VA) and no treatment in teachers with behavioral dysphonia during a six-week therapy protocol (Teixeira & Behlau, 2015). Positive outcomes were found in the VFE group on measures of overall severity of dysphonia, self-perceived impact of dysphonia, and videolaryngoscopy, which demonstrated improved glottic closure. The authors concluded that VFEs are capable of treating behavioral dysphonia while VA is more useful prophylactically to prevent onset of voice disorders, and no intervention may worsen voice outcomes.

Pedrosa et al. (2016) compared VFEs to a new voice treatment program, the Comprehensive Voice Rehabilitation Program (CVRP) for treating functional dysphonia. The authors chose VFEs as a comparison treatment based on evidence of efficacy in the literature. Results indicated that in six weeks the two treatment protocols produced positive results without a significant difference in outcome measures along self-assessment, auditory-perceptual, and visual-perceptual parameters. Similarly, a randomized controlled trial by Kapsner-Smith et al. (2015) compared VFEs to phonation through flow-resistant tubes (FRT). Twenty participants with dysphonia were assigned to

one of four groups: immediate FRT, immediate VFE, delayed FRT, or delayed VFE; the delayed groups served as non-treatment control groups. The immediate FRT and VFE groups rated improvement on the VHI and the authors concluded that FRT was "noninferior" to VFEs in improving voice quality of life in people with dysphonia.

VFEs have also been studied as the sole therapy approach for disordered voice. In a case study by Patel et al. (2012), vocal fold vibration and voice production were evaluated in a single-subject before-after prospective study. A 51-year-old male with a unilateral contact granuloma performed VFEs for six weeks. Although stroboscopic, acoustic, aerodynamic, and audio-perceptual improvements were marginal, high-speed digital imaging measures provided physiologic and kinematic measures demonstrating post treatment improvement in vocal function. The authors concluded that using a semi-occluded vocal tract during VFEs provided a change in glottic configuration during phonation, thereby increasing vibratory motion and glottic closure while decreasing impact stress.

Finally, in a single-subject case study, Sharma et al. (2009) implemented VFEs for voice rehabilitation following laryngeal fracture secondary to a penetrating shrapnel injury. After performing VFEs for three months the subject's MPT doubled, indicating improved vocal function.

There is evidence to suggest that VFEs improve the disordered voice in individuals with self-reported dysphonia, behavioral dysphonia, unilateral contact granuloma, and laryngeal fracture. VFEs have also been implemented in conjunction with other therapy approaches to enhance the normal voice and treat the disordered voice.

Combined Modality Approaches

VFEs have proven to be efficacious when implemented independently to enhance the normal and the disordered voice. A number of studies have also investigated VFEs in conjunction with other therapy approaches. Guzman et al. (2013) investigated the effect of VFEs on voice quality when used in conjunction with vocal warms ups for pop singers with perceptually normal voice. When compared to a control group that only completed vocal warm ups, there were statistically significant improvements for the VFE group on acoustic parameters. The authors concluded that VFEs are advantageous as a vocal warm up because of the immediate effect on the spectrum of the voice.

A retrospective case-control study by Berg et al. (2008) used the Voice-Related Quality of Life (VRQoL) questionnaire to measure perceived vocal impairment before and after treatment for presbylaryngeus. The experimental group (EG) underwent four sessions of voice intervention including VH, resonant voice therapy (RVT), and VFEs. The EG demonstrated a statistically significant improvement on the VRQoL compared to a non-treatment control group.

VFEs have also been used in conjunction with a symptomatic voice treatment approach to assist in feminizing voices of male-to-female transgender (TG) clients (Gelfer & Van Dong, 2013). This prospective treatment study found that listeners continued to identify TG subjects as male when listening to voice samples, though listeners rated TG voices as significantly less masculine and more feminine after treatment. Furthermore, TG subjects reported benefitting from the addition of VFEs to their therapy protocol.

Finally, in a study by Gillivan-Murphy et al. (2006), VFEs were combined with VH (VFE +VH) and compared to a non-treatment control group in teachers with self-reported voice problems. There was a statistically significant improvement in the VFE+VH group as measured by the Voice Symptom Severity Scale (VoiSS), and this group also demonstrated a statistically significant increase in voice care knowledge.

There is evidence to suggest that VFEs improve the normal, pathological, and well-trained voice when used as part of a combined modality approach. However, it cannot be determined if the results of these studies should be attributed to the use of VFEs or to the additional treatments employed.

Modified VFE Protocol

The following studies have investigated VFEs with protocol modifications. A modified VFE protocol is defined here as any deviation from the exercise regimen described by Stemple et al. (1994).

Compliance. In a study by Ellis and Beltyukova (2011), 20 female graduate students performed the traditional VFE regimen for 28 days. Half of the participants were placed into the Monitored Compliance (MC) group and the other half into the Unmonitored Compliance (UC) group. The MC group was required to submit an audio or video recording of daily practice, while the UC group was not. Both groups improved; however, the MC group demonstrated greater increases in MPT and maximum frequency range. An important aspect of voice therapy is compliance to the prescribed protocol. The results underscore the value of monitored practice in improving overall compliance, which has important implications for overall voice outcomes.

Service-delivery model. Pasa, Oates, and Dacakis (2007) compared group VFE

training and group VH training for teachers with self-reported voice symptoms and phonotrauma. The authors found improvement in voice symptoms and reduction in phonotraumatic behaviors in the VH group only, over a 10-week intervention period. Ziegler, Gillespie, and Abbott (2010) suggested multiple explanations for the ineffectiveness of VFEs in the study by Pasa et al. (2007). One possible explanation is that individual VFE treatment would have benefitted teachers with voice problems, however group VFE treatment was less effective. Furthermore, the group service delivery format implemented by Pasa et al. (2007) decreased training time and involved fewer sessions with trained investigators, which may have limited participant knowledge and understanding of appropriate VFE technique. A final suggested explanation was that, when compared to the study by Roy (2001), which investigated VFEs in teachers with self-reported voice problems, the apparent difference in clinician uniformity and subject training may account for the inconsistency of outcomes.

Dosage. In a study by Bane, Angadi, Dressler, Andreatta, and Stemple (2016), three experimental groups completed a six-week VFE protocol and practiced twice daily. The low dose (LD) group performed each exercise once, the traditional dose (TD) group twice, and the high dose (HD) group four times. Results demonstrated that, at six weeks, all three groups significantly improved their MPT from pre-treatment, with greatest improvement in the high dosage group. However, the authors conclude that increased dosage may result in suboptimal voice outcomes by undermining compliance, since higher dosage increased participant withdrawal to 50%.

Vocal tract posture. Currently, there are two studies that have modified the traditional SOVT posture utilized in VFEs. The first was a retrospective, single-subject

case study by Radhakrishnan and Scheidt (2012), which evaluated VFEs in a participant with presbylaryngeus. The posture was modified from an SOVT to an /o/, lessening the degree of semi-occlusion by an unknown amount. Additionally, the participant had difficulty matching pitch and therefore exercise four was simplified by instructing the participant to ascend in pitch slightly with each trial. Despite modifications, post-treatment analysis resulted in improvement on VHI score, CAPE-V, MPT, perturbation measures, pitch range, and electroglottographic closed quotient following six weeks of therapy.

The second study was a single-blinded, randomized controlled clinical trial by Nguyen and Kenny (2009), which evaluated the treatment effects of VFEs on muscle tension dysphonia in two groups of tonal speakers. The "full exercise" (FE) group followed the traditional VFE protocol of practicing the four exercises two times each, twice daily. The "partial exercise" (PE) group completed only the first exercise two times each, twice daily. For both groups, the standard SOVT posture was modified by using Vietnamese vowels. In exercise one, the Vietnamese vowel /i/ as in "bee" was used. In exercises two, three, and four, the Vietnamese vowel /ô/ as in "spoke" was used, which is slightly higher than the English vowel /o/. The author states, "the change in vowel should meet two criteria: it should maintain the intentional vocal tract shape in the original exercise and be easy to follow" (Nguyen & Kenny, 2009, p. 274). It is unknown whether the /i/ was nasalized and whether true semi-occlusion of the /ô/ was utilized. Both groups completed the modified VFEs for four weeks. Significant improvements were found in perturbation, harmonics-to-noise ratio (HNR), perceived voice quality, and size and speed of pitch change for the FE group.

In summary, modifications to the traditional VFE protocol may undermine, maintain, or improve treatment efficacy. However, modifications to VFEs vocal tract posture have not been systematically implemented or studied. VFEs are thought to improve the relationship among the three subsystems of voice, but the mechanism underlying their efficacy remains an open question (Stemple, 2005). It is unclear whether the SOVT posture is an essential component of efficacy, or whether another vocal tract posture is capable of accomplishing similar results. Thus, at this time, it is unclear if use of an SOVT posture is essential, favorable, or superfluous. The purpose of this study is to investigate the efficacy of VFEs using three differing vocal tract postures, as measured by percent of MPT goal attained.

Research Hypotheses

1. Use of the traditional VFE protocol with an SOVT posture will result in greater percent of MPT goal attained compared to the /o/ and /a/ postures. This hypothesis is based on nonlinear source-filter coupling, which is theorized to increase vocal efficiency and vocal economy.

Chapter Summary

Chapter two served to review pertinent literature regarding efficacy of VFEs and protocol modifications. The ideal vocal tract posture remains an open question because it has not been thoroughly or systematically investigated. Chapter three will present the methods used to address the research question.

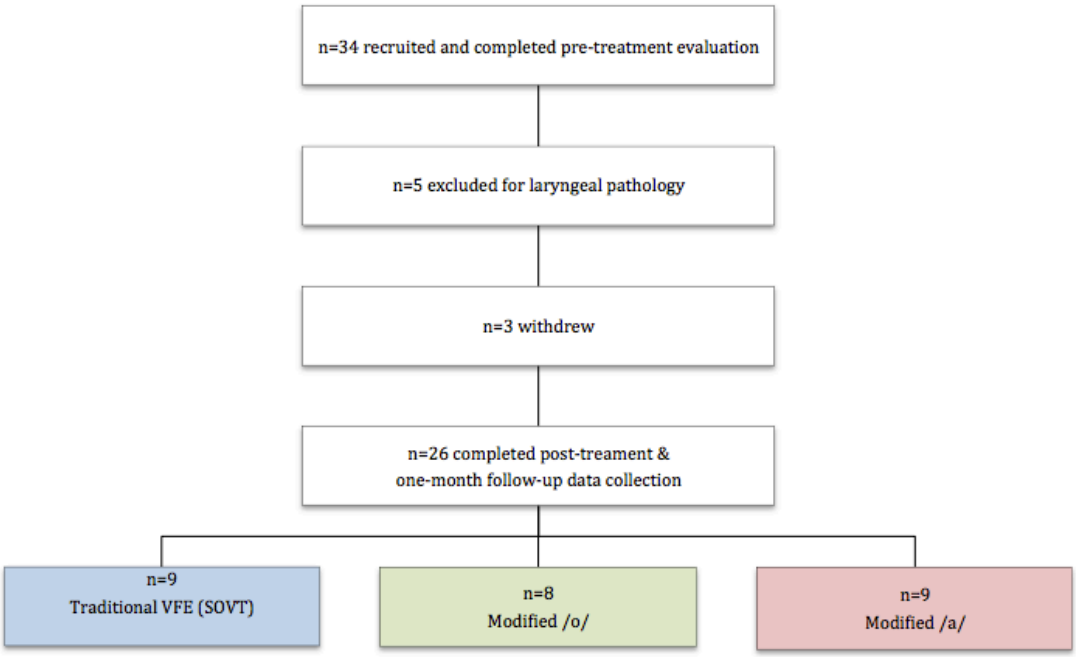
Chapter Three: Methodology

All recruitment, intervention, and data collection procedures were approved by the Institutional Review Board (IRB) at the University of Kentucky (UK).

Participants

A total of 34 female participants with normal voice were recruited from the University of Kentucky (Appendix A). A power analysis with an alpha of .05 and power set to 80% yielded N = 30. Participants met the following inclusion criteria: 18-45 years of age (>18 and <45), non-smokers, and hearing within normal limits. Functional hearing was not objectively screened; however, each participant was able to complete the consent process and participate in the experimental protocol. A history of uncontrolled asthma, a year or more of classical vocal training, and/or the presence of vocal fold pathology identified by laryngeal examination denoted exclusion from the study. Twenty-nine participants completed pre-treatment measures. Within the first three weeks, three participants withdrew from the study. A total of twenty-six participants completed post-treatment data collection and returned for the one-month follow-up. Please see Figure 3.1.

Figure 3.1– Consort Diagram



Training of Research Assistants

Four research assistants were trained prior to study initiation. Training included formal instruction by a specialist in voice disorders with extensive experience teaching and using Vocal Function Exercises (VFEs). The first training session established technique using a group format with opportunities for individual instruction. Technique was solidified in three subsequent training sessions with a speech-language pathologist. Additionally, research assistants participated in mock sessions to practice teaching the required technique for each vocal tract posture.

Pre-treatment Data Collection

During pre-treatment data collection, consent was obtained using forms approved by the UK IRB (Appendix B). All participants were briefly educated on vocally abusive behaviors and were provided with supplementary written information related to vocal

hygiene. All participants agreed to abstain from vocally abusive behaviors for the duration of the study, however compliance data for vocal hygiene was not collected.

Pre-treatment measures were obtained prior to intervention. A self-assessment instrument, the Voice Related Quality of Life (VRQoL), was administered to guarantee each participant began with what they considered a normal voice (Appendix H). A laryngeal examination to determine normal appearance of the vocal folds and the Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V) to determine normalcy of vocal quality were completed for each participant by a speech language pathologist blinded to group assignment (Appendix G). Maximum airflow volume (MAV) was obtained and used to calculate the participant's physiologic maximum phonation time (MPT) goal. Individual participant MPT goals were calculated by dividing MAV by an airflow rate of 80 mL/s (e.g. MPT goal = 4000/80 = 50s). All data was recorded on the study checklist (Appendix F)

Group Assignment

After study qualification was confirmed according to inclusion and exclusion criteria, participants were randomized into one of three groups, each with a distinct vocal tract posture to be used during VFEs. Trained research assistants taught the corresponding exercises to participants individually. Group one performed the traditional VFE vocal tract posture using a semi-occluded vocal tract (SOVT). Groups two and three learned a modified vocal tract posture using /o/ or /a/, respectively. The modified /o/ vocal tract posture provides partial occlusion due to the roundness of the lips, while the modified /a/ posture is produced without significant occlusion of the vocal tract. These sounds were chosen to demonstrate a possible change between the exercises performed

with and without the SOVT as prescribed in VFEs. Additionally, the first exercise was modified for Groups two and three by removing nasalization of /i/ to eliminate the semi-occluded vocal tract posture on all exercises.

Table 3.1 – Exercise Protocol by Group

Exercise	Group 1: Traditional VFE	Group 2: Modified /o/	Group 3: Modified /a/
1. Warm up exercise – sustain vowel /i/ as long as possible	Nasalized /i/	Open /i/	Open /i/
2. Stretching exercise – glide upward from the lowest to highest note	Forward focus with lip buzz (SOVT)	Open /o/	Open /a/
3. Contracting exercise – glide downward from highest to lowest note	Forward focus with lip buzz (SOVT)	Open /o/	Open /a/
4. Low impact adductory power exercise – Sustain the musical note C-D-E-F-G for as long as possible	Forward focus with lip buzz (SOVT)	Open /o/	Open /a/

Once each participant demonstrated appropriate technique with a trained research assistant, a speech-language pathologist joined the session to solidify and confirm technique and obtain pre-treatment MPT on the corresponding vocal tract posture. Participants were then provided with a hyperlink containing a practice video specific to their vocal tract posture. The video provided them with instructions, pitches, and guidance for home practice. Furthermore, each participant received home practice logs for recording daily practice (Appendix C). Each log was specific to group assignment. All groups were instructed to complete the VFEs two times each, twice daily for six weeks. Participants received reminders to practice twice a day via email.

Weekly Check-ins

Participants attended weekly check-ins with a trained research assistant for six weeks after learning the VFEs. During each session, the participant completed the VRQoL to monitor for potential self-reported adverse effects. These were monitored closely, particularly those of non-traditional vocal tract postures. The home practice logs were returned to research assistants weekly to monitor compliance of practice. At each check-in, a research assistant guided the participant through the VFE protocol with their assigned vocal tract posture and recorded MPTs. Technique was adjusted as necessary with the help of supervising clinicians. Twenty percent of all research assistant-conducted sessions were monitored by a SLP, and an additional 20% were monitored by a second year graduate student.

Post-treatment Data Collection

After six weeks, participants discontinued daily practice of exercises and weekly check-ins. At this time, post-treatment data were collected Measures collected at pre-treatment were repeated, including laryngeal examination, CAPE-V, VRQoL, and MPTs taken during VFEs with the appropriate vocal tract posture.

One- Month Follow-Up

Participants returned one month later to provide follow-up data. At this time, the VRQoL and CAPE-V were administered. MPTs taken during VFEs on the appropriate vocal tract posture were collected.

Table 3.2 – Outcome Measures Obtained by Week

	Pre-treatment	Week 1	Week 2	Week 3	Week 4	Week 5	Post-treatment (Week 6)	One-month follow-up
Laryngeal Examination	X						X	
CAPE-V	X						X	X
Maximum Airflow Volume	X							
Maximum Phonation Time	X	X	X	X	X	X	X	X
VRQoL	X	X	X	X	X	X	X	X

Chapter Summary

Chapter three outlined the methods used to answer the research question. Results are analyzed in chapter four.

Chapter Four: Results

Demographics

Following completion of informed consent, 29 female subjects between the ages of 18 and 45 were recruited from the University of Kentucky and enrolled in this study. Three participants discontinued participation and were unable to be replaced with new recruits due to semester time constraints; therefore a total of 26 subjects completed the study. In the traditional VFE group, ages ranged from 19-22; the mean was 20.89. In the modified /o/ group, ages ranged from 18-29; the mean was 20.38. In the modified /a/ group, ages ranged from 18-22; the mean was 19.33. One-way ANOVA indicated no significant difference in age between groups ($p = 0.340$).

Table 4.1: One-way ANOVA for Age

Group	Mean Age	Standard Deviation	p-value
Traditional VFE (SOVT)	20.89	1.167	.340
Modified /o/	20.38	3.583	
Modified /a/	19.33	1.322	

significant at $p \leq 0.05$

Additionally, a chi-square test indicated groups were not statistically different in distribution of ethnicity ($p = 0.565$).

Table 4.2: Distribution of ethnicity

	Group			p-value
Ethnicity	Traditional VFE	Modified /o/	Modified /a/	0.565
White	8	7	8	
African-American	0	1	1	
Biracial	1	0	0	

significant at $p \leq 0.05$

Participants were non-smokers with normal voice who had not received more than one year of vocal training. At pre-treatment, a laryngeal examination and the Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V) were completed for each participant by a speech-language pathologist blinded to group assignment. Additionally, a self-assessment instrument, the Voice Related Quality of Life (VRQoL), was completed by each participant to determine if they were experiencing vocal discomfort throughout the study. Maximum airflow volume (MAV) was obtained and used to calculate the participant's physiologic maximum phonation time (MPT) goal. Data was collected at three time points: pre-treatment, post-treatment, and one-month follow-up.

During the six-week intervention period, each participant completed home practice twice daily (morning and evening) using a practice log to record the VFE MPT results (Appendix C). The vocal tract posture used during home practice was determined by the participant's random group assignment. The traditional VFE group completed the exercises with a semi-occluded vocal tract (SOVT). Groups two and three completed the VFEs with a modified vocal tract posture, /o/ and /a/ respectively. Each subject attended a weekly check-in to monitor compliance, provide VFE MPTs, and return practice logs. Weekly average phonation times were calculated for each participant (Appendix E).

Groups. The traditional VFE group consisted of 10 participants, one of whom discontinued participation. The modified /o/ group consisted of nine participants, one of whom discontinued participation. The modified /a/ group consisted of 10 participants, one of whom discontinued participation. This resulted in a withdrawal rate of 10%, 11%, and 10% respectively; participants who withdrew from the study could not be replaced

because of semester time constraints. Attrition information by group is presented in Table 4.3.

Table 4.3: Vocal Tract Posture Assignments

Group	Initial No. of Participants	Discontinuing Participants	Final No. of Participants
Traditional VFE (SOVT)	n = 10	1/10 = 10%	n = 9
Modified /o/	n = 9	1/9 = 11%	n = 8
Modified /a/	n = 10	1/10 = 10%	n = 9

Withdrawal questionnaires. Upon discontinuation of this study, participants were asked to complete a questionnaire regarding rationale for withdrawal (Appendix D). Of the three participants who withdrew from the study, one completed and returned the questionnaire. The participant that responded was in the traditional VFE group. One of the questions probed the former participants' experience with laryngeal exam by asking degree of discomfort during laryngeal examination. The responding participant reported mild discomfort. The remainder of the questionnaire addressed the reason for withdrawal. The participant reported difficulty with the required technique and felt she was unable to achieve it independently.

Pre-treatment Measures

Normality of distribution for all dependent variables under study was tested prior to performing tests of comparison. Parametric and non-parametric tests of comparison were performed based on normality of distribution. All dependent variables under study were normally distributed with the exception of VRQoL scores. Additionally, a series of between subjects one-way ANOVAs demonstrated equivalence between groups at pre-

treatment for percent of MPT goal, and scores on CAPE-V overall severity and VRQoL self-rating.

A significance value of 0.05 (alpha = 0.05, power = 80%) was used based on a power analysis completed a priori. The resulting p-values for each of these variables are listed in Table 4.4, and indicate that groups were not significantly different.

Table 4.4: One-Way ANOVAs for Pre-treatment Measures

Variables	**p-value**
Percent of MPT Goal	0.927
CAPE-V- Overall Severity	0.437
VRQoL	0.242

significant at $p \leq 0.05$

Outcome Measures

Primary outcome measures. The primary purpose of this investigation was to examine a modified vocal tract posture used during VFEs and the subsequent effect on attainment of pre-established MPT goals in individuals with normal voice production. MPTs on corresponding vocal tract postures were collected at pre-treatment, weekly at check-ins for five weeks, post-treatment (week 6), and at one-month follow-up. Individual physiologic goals for VFE MPT were determined by dividing each participant's maximum airflow volume by 80 mL/s (e.g. MPT goal = 4000/80 = 50s). Average weekly VFE MPTs were calculated, following data collection. Percent of MPT goal attainment was calculated at pre-treatment, post-treatment (week 6), and one-month follow-up. Clinically, individuals who complete VFEs are typically discharged from therapy when they reach and maintain 80% of their MPT goal. Therefore, the number of participants in each experimental group who reached 80% of their goal was tabulated.

In the traditional VFE group, one of nine participants (11%) reached 80% of their physiologic goal, and this occurred on week 5. 80% goal was not maintained at post-treatment or at one-month follow-up. In the modified /o/ group, two of eight participants (25%) reached 80% of their physiologic goal, and this occurred on week six. One of the participants maintained improvement at one-month follow-up. In the modified /a/ group, one of nine participants (11%) achieved 80% of their physiologic goal, and this occurred on week six. 80% goal was not maintained at one-month follow-up.

Repeated measures ANOVA demonstrated that percent of MPT goal varied between groups. Post hoc paired sample t-tests using a Bonferonni correction ($p \leq 0.0056$) were applied to compare the difference in primary outcome measure between time points (pre-treatment, post-treatment, one-month follow-up). In the traditional VFE group, percent of MPT goal attained was significantly improved ($p = 0.000$) pre-treatment to post-treatment and pre-treatment to one-month follow-up ($p = 0.002$). The modified vocal tract posture groups did not demonstrate significant differences in percent of MPT goal attained between time points. Resulting means, standard deviations, and p-values from the analysis can be viewed in Tables 4.5 and 4.6.

Table 4.5: Means and Standard Deviations for Primary Outcome Measure

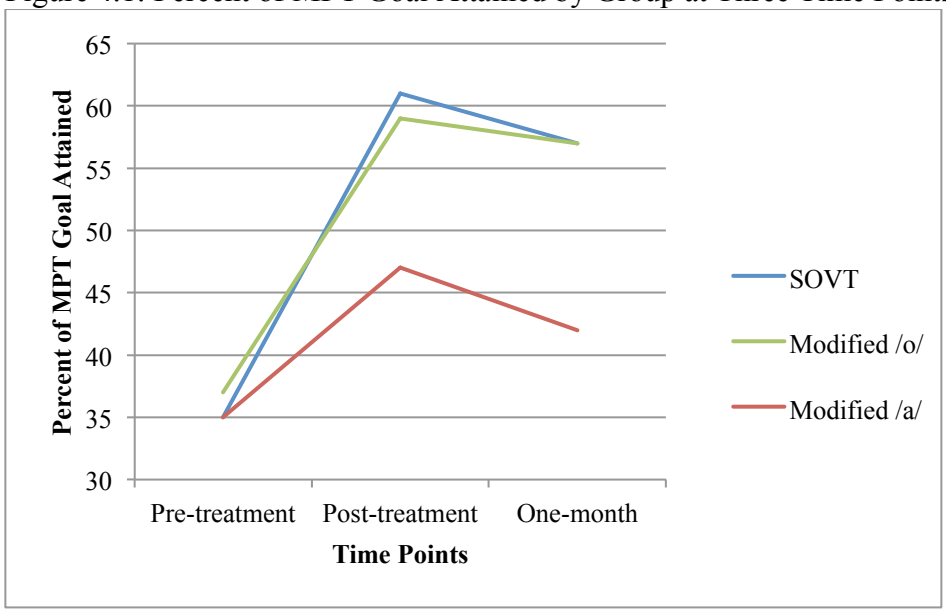
Percent of MPT goal – Traditional VFE					
Pre-treatment		Post-treatment		One-month follow-up	
Mean	SD	Mean	SD	Mean	SD
35.778	7.2419	61.111	10.6471	56.889	15.8307
Percent of MPT goal – Modified /o/					
Pre-treatment		Post-treatment		One-month follow-up	
Mean	SD	Mean	SD	Mean	SD
37.625	12.6710	59.750	19.3077	57.125	21.1757
Percent of MPT goal – Modified /a/					
Pre-treatment		Post-treatment		One-month follow-up	
Mean	SD	Mean	SD	Mean	SD
35.667	13.7113	47.333	19.9186	42.889	13.1856

Table 4.6: Paired Sample t-tests for Primary Outcome Measure

Traditional VFE	**Pre-post p-value**	**Post-month p-value**	**Pre-month p-value**
Percent of MPT goal	.000*	.096	.002*
Modified /o/	**Pre-post p-value**	**Post-month p-value**	**Pre-month p-value**
Percent of MPT goal	.015	.366	.018
Modified /a/	**Pre-post p-value**	**Post-month p-value**	**Pre-month p-value**
Percent of MPT goal	.081	.139	.127

*denotes statistically significant value ($p \leq 0.0056$)

Figure 4.1: Percent of MPT Goal Attained by Group at Three Time Points



Secondary Outcome Measures

This study evaluated two secondary outcome measures: VRQoL and CAPE-V overall severity. Each participant completed the VRQoL weekly, which allowed research assistants to monitor potential changes in scores. The VRQoL was administered primarily in order to assess potential discomfort, fatigue, or functional changes that may

result from hyperfunction. The rationale was that elimination of the SOVT posture may allow for greater hyperfunction during completion of vocal exercises, particularly those completed on /a/. The Shapiro-Wilk test of normality indicated that VRQoL scores were not normally distributed within groups; therefore, non-parametric testing, the Wilcoxon Signed Rank test, was completed to compare VRQoL scores between time points. There was no significant difference in VRQoL scores for any groups between time points.

The CAPE-V was completed at pre-treatment, post-treatment, and one-month follow-up by a speech-language pathologist blinded to group assignment. The Shapiro-Wilk test of normality indicated that CAPE-V overall severity scores were normally distributed within groups; Therefore, paired sample t-tests were performed to compare CAPE-V overall severity scores between time points for each group. For the traditional VFE group, there was a statistically significant increase in CAPE-V overall severity from pre-treatment to post-treatment ($p = 0.001$). There was no significant difference in CAPE-V scores for either of the modified groups at any time point. Despite the significant change in CAPE-V score from pre-treatment to post-treatment in the traditional VFE group, all CAPE-V scores remained within normal limits for normal voice throughout the duration of the study. Resulting means, standard deviations, and p-values from the analysis can be viewed in Table 4.7 and 4.8.

Table 4.7: Means and Standard Deviations for Secondary Outcome Measures

Mean	SD	Mean	SD	Mean	SD
2.000	2.9580	4.22	4.177	6.444	3.2447
VRQoL – Modified /a/					
Pre-treatment		Post-treatment		One-month follow-up	
Mean	SD	Mean	SD	Mean	SD
11.111	1.6159	10.333	.5000	10.222	.4410

Table 4.8: Data Analysis of Secondary Outcome Measures

Traditional VFE	**Pre-post p-value**	**Post-month p-value**	**Pre-month p-value**
CAPE-V	.001*	.938	.006
VRQoL	.180	.317	.180
Modified /o/	**Pre-post p-value**	**Post-month p-value**	**Pre-month p-value**
CAPE-V	.014	.200	.432
VRQoL	.010	.016	.317
Modified /a/	**Pre-post p-value**	**Post-month p-value**	**Pre-month p-value**
CAPE-V	.308	.059	.029
VRQoL	.317	.059	.059

*denotes statistically significant value ($p \leq 0.0056$)

Summary of outcome measures. One primary outcome measure (percent of MPT goal) and two secondary outcome measures (CAPE-V and VRQoL) were examined in this study at three time points.

Overall, the traditional VFE group was the only group to demonstrate statistically significant changes. Results indicated improvement on percent of MPT goal attained and a decline on CAPE-V overall severity between pre-treatment and post-treatment. Additionally, percent of MPT goal attained was significantly improved pre-treatment to one-month follow-up. The modified vocal tract groups did not result in significant differences on any primary or secondary outcome measures.

The hypothesis that the traditional VFE group would attain higher percent of MPT goal compared to the modified vocal tract groups is accepted.

Table 4.9: Number of Significant Changes in Outcome Measures

	Primary Outcome Measures (1 possible)	Secondary Outcome Measures (2 possible)	Subtotal (3 possible)	Total (9 possible)
Traditional VFE				
Pre-post	1	1	2	3 (2 improved, 1 declined)
Post-month	0	0	0	
Pre-month	1	0	2	
Modified /o/				
Pre-post	0	0	0	0
Post-month	0	0	0	
Pre-month	0	0	0	
Modified /a/				
Pre-post	0	0	0	0
Post-month	0	0	0	
Pre-month	0	0	0	

Compliance. Participant compliance with weekly check-ins was 99% overall. Only one participant failed to attend a check-in on one occasion due to illness. All home practice logs were returned with the exception of one log from one participant. Compliance was collected via home practice logs and tabulated in terms of number of practice sessions missed. The average number of missed practice sessions in the traditional VFE group was 10.22 and the median number of missed practice session was 1. Two participants in this group missed 17 or more practice sessions, indicating less than 80% compliance

The average number of missed practice session in the modified /o/ group was 9.75 and the median number of practice sessions missed was 8. Two participants in this group missed 17 or more practice sessions, indicating less than 80% compliance.

The average number of missed practice sessions for the modified /a/ group was 5.11 and the median number of practice sessions missed was 2. No participant in this group missed 17 or more practice sessions, which indicates that all participants were at least 80% compliant with the protocol. Compliance with home practice is described below in Table 4.10 by group.

Table 4.10: Home Exercise Compliance by Group

	Number of Practices Missed per Participant	Mean Practices Missed	Median Practices Missed	Participants missing ≥ 17 practices (< 80% compliant)
Traditional VFE group (SOVT)	0, 0, 0, 1, 1, 7, 11, 32, 40	10.22/84 = 12.17%	1	2
Modified /o/ group	0, 0, 6, 7, 9, 12, 21, 23	9.75/84 = 11.61%	8	2
Modified /a/ group	0, 0, 0, 0, 2, 4, 8, 16, 16	5.11/84 = 6.08%	2	0

Chapter Summary

Chapter four served to present the statistical results for the data analysis. Chapter five will discuss the significance of these findings, study limitations, and future directions for research.

Chapter 5: Discussion

Review of Purpose:

Vocal Function Exercises (VFEs) have been investigated in a variety of populations, implemented in combined modality approaches, and performed with a variety of protocol modifications. Although modifications to the Vocal Function Exercise protocol have been used previously, they were not systematically implemented and studied. Therefore, the essential and nonessential aspects of VFEs have yet to be determined.

The purpose of this study was to investigate the efficacy of VFEs performed with varying degrees of vocal tract occlusion and the effect on percent of maximum phonation time (MPT) goal attainment in individuals with normal voice. It is unclear whether the semi-occluded vocal tract (SOVT) posture is an essential component of efficacy, or whether another vocal tract posture, specifically, a simpler vocal tract posture with reduced vocal tract occlusion, is capable of accomplishing similar results. This study compared the efficacy of three groups: traditional VFE (SOVT), modified /o/ (partial occlusion), and modified /a/ (without significant occlusion). The primary outcome measure used to assess efficacy was percent of MPT goal attained. Additionally, two secondary outcome measures were evaluated: Consensus Auditory Perceptual Evaluation of Voice (CAPE-V) and the Voice Related Quality of Life (VRQoL). The three outcome measures were collected at three different time points: pre-treatment, post-treatment (week 6), and one-month follow-up.

Review of Methodology

A total of 26 female participants with normal voice were randomized into one of three vocal tract posture groups. All participants attended weekly check-ins and completed daily home practice of four exercises, two times each, twice daily, for six weeks. Group one performed the traditional VFE SOVT posture. Groups two and three performed VFEs using a modified vocal tract posture, either /o/ or /a/, respectively. After six weeks of exercise, VFE practice and weekly check-ins were discontinued. Participants returned one month later for follow-up.

Review of Results

Group homogeneity. A series of one-way ANOVAs demonstrated that the three experimental groups were not statistically different at pre-treatment for age, percent of MPT goal, CAPE-V overall severity, or VRQoL self-ratings. Additionally, a chi-square test indicated groups were not statistically different in distribution of ethnicity.

Summary of Outcome Measures. Only the traditional VFE group resulted in significant improvement in percent of MPT goal attained, which occurred between pre-treatment and post-treatment and between pre-treatment and one-month follow-up. A Bonferonni correction ($p \leq 0.0056$) was applied to make the statistical significance more rigorous and account for repeated measures error. The modified /o/ and /a/ vocal tract posture groups did not demonstrate significant change in percent of MPT goal attained.

The number of participants reaching 80% of MPT goal was tabulated in each group, since 80% of goal is a common clinical benchmark for improvement of voice production. The group with the most participants reaching 80% of MPT goal was the modified /o/ group; the traditional VFE and modified /a/ groups only had one participant

meet 80% of MPT goal. However, fastest 80% MPT goal attainment was achieved in the traditional VFE group.

The study hypothesis was that the traditional VFE (SOVT) posture would result in greater percent of MPT goal attainment compared to the modified /o/ and /a/ vocal tract postures; this hypothesis is accepted.

Secondary outcome measures for this study included scores from the VRQoL and the CAPE-V. As expected. scores on these measures remained within normal limits at all time points because participants began with normal vocal quality.

Compliance. After pre-treatment data collection, a total of three participants withdrew from the study. With regard to reported home practice compliance, the traditional VFE (SOVT) group reported lowest compliance (mean practices missed: 10.22); the modified /o/ group reported slightly better compliance (mean practices missed: 9.75); the modified /a/ group reported best compliance (mean practices missed: 5.11).

Significance of the Study

This study implemented a dismantling approach by modifying a single aspect of the VFE protocol in order to begin identifying elements of VFEs responsible for efficacy. Modification of single components of the exercise protocol yields evidence as to the precise contribution of the modified element, in this case, vocal tract posture. Through systematic modification of single components of VFEs, research will better be able to identify the active ingredient, or mechanism of change, within the treatment protocol. Identification of the mechanism of change is essential to improving the efficiency and efficacy of treatment when providing individualized care. This study modified vocal

tract posture in the normal voice, which is a preliminary step to research examining VFE vocal tract posture modification in the disordered voice.

Contribution to the Literature

A total of 27 outcome studies have demonstrated VFEs to be efficacious in improving the disordered, the normal, and the well-trained voice. This study is the first to systematically investigate VFEs performed with modified vocal tract postures. However, there have been two studies, presented in the literature review in chapter two, that have modified vocal tract posture in addition to a second component of the protocol.

Radhakrishnan and Scheidt (2012) evaluated VFEs in one participant with presbylaryngeus. The vocal tract posture was modified from an SOVT to an /o/, lessening the degree of vocal tract occlusion by an unknown amount. The researchers also made a second modification: exercise four was simplified due to the participant's difficulty matching pitch. Despite the protocol modifications, the participant demonstrated improved MPT following six weeks of therapy.

Additionally, Nguyen and Kenny (2009) evaluated treatment effects of VFEs on muscle tension dysphonia in two groups of Vietnamese tonal speakers. The traditional training gestures were modified to Vietnamese vowels /i/ and /ô/. Although the author states that the vowel should have preserved the intended vocal tract shape in the original protocol, the degree of occlusion is unknown. The researchers also made a second modification: a "full exercise" (FE) group was compared to a "partial exercise" (PE) group. The FE group followed the traditional VFE protocol of practicing four exercises two times each, twice daily. The PE group completed only exercise one, the warm up

exercise, two times each, twice daily. This study did not collect MPT as an outcome measure, however several acoustic improvements were identified in the FE group.

The studies by Radhakrishnan and Scheidt (2012) and Nguyen and Kenny (2009) provide examples of VFE protocols using a modified vocal tract posture in conjunction with an additional protocol modification. Due to the additional protocol modification, it is difficult to identify the precise contribution of the modified vocal tract posture to VFE efficacy. Additionally, since neither of the two studies utilized a control group, improvements in the VFE groups cannot be compared to a control. However, both studies resulted in significant improvements on various outcome measures. The Radhakrishnan and Scheidt (2012) and Nguyen and Kenny (2009) studies may have used a form of vocal tract occlusion that approximated the vocal tract posture used by the modified /o/ group in the present study. The present study supports use of a modified /o/ vocal tract posture for increasing MPT, however use of a modified /o/ vocal tract posture may not yield improvements in MPT commensurate with the traditional VFE posture.

Clinical Implications

While the present study examined VFEs in normal voice, the results may offer limited clinical implications. As a speech-language pathologist (SLP) creates an individualized plan of care for each client, he or she must consider factors such as prognosis, client goals, client-ability, and client buy-in, all of which may affect treatment outcomes.

Although only the traditional VFE group demonstrated significant improvement, increased MPT in the modified /o/ group may be clinically, though not statistically, significant. A voice clinician may elect the modified /o/ vocal tract posture as an

appropriate alternative for select individuals who are unable to achieve the SOVT posture. While the data suggests that the traditional VFE posture leads to more efficient attainment of MPT goal, the modified /o/ posture may improve likelihood of goal attainment. If appropriate, the modified /o/ vocal tract posture could be combined with other modifications to improve efficiency of treatment, for example extending treatment time or increasing dosage (Bane et al., 2016). The eventual ability to tailor treatment protocols to specific individuals is a central aspect of the significance of this study.

The modified /o/ vocal tract posture may be easier to achieve for certain individuals, which may minimize frustration, promote self-efficacy and motivation, and therefore improve adherence. Previous studies on voice therapy adherence have found that clients struggle to understand and execute voice techniques independently during home practice, resulting in decreased adherence (van Leer and Connor (2010). Based on the present study's results, a clinician might consider using a modified vocal tract such as /o/ to increase the patient's confidence in their ability to correctly produce the posture for protocol completion outside of therapy. Conversely, because the modified /o/ group proved to be less efficacious and less efficient than the traditional SOVT posture, the clinician must also consider potential risks of non-adherence as a result of delayed goal attainment.

In the present study, it appears groups with simpler vocal tract postures (the modified /o/ and /a/ groups) demonstrated superior compliance. Confidence in the assigned vocal tract posture technique may have influenced motivation to comply with the exercise protocol. Interestingly, although the modified /a/ group reported best compliance, the modified /a/ group improved least on MPT. VFEs performed without

significant occlusion does not appear efficacious despite high compliance; compliance is necessary but insufficient for MPT goal attainment. In fact, while the traditional VFE group demonstrated lowest reported compliance, it is the only group that demonstrated significant improvement in MPT. The finding that compliance is necessary but not sufficient for improved outcomes is consistent with literature investigating the effects of other voice therapy techniques, such as Lee Silverman Voice Treatment (LSVT©). In a study comparing LSVT to Respiratory Effort Treatment (RET), compliance and treatment intensity did not guarantee efficacy (Baumgartner, Sapir, & Ramig, 2001). While the LSVT group demonstrated significant improvement, the RET group did not. It is clear that treatment efficacy depended not only upon compliance to intense treatment schedules but also on unspecified active ingredients within the LSVT protocol. Similarly, the present study supports the idea that daily practice alone is not sufficient for improving outcome. Improvement on measures of MPT also requires an active ingredient or combination of active ingredients within VFEs. This study suggests that the traditional VFE SOVT is an active therapeutic agent. When the active agent is eliminated, as demonstrated by the modified /a/ group, minimal improvements can be expected.

Currently, clinicians rely largely on experience in order to modify treatment protocols for patients because there is a lack of systematic research to guide treatment modifications. By investigating a single component of the VFE protocol, treatment elements supportive of efficacy may be identified. Similarly, treatment elements that hinder treatment efficacy can also be identified and avoided in future research and in clinical settings. Systematic investigation of individual elements of the VFE protocol

informs clinicians about how they might customize treatments for individualized patient care.

Limitations and Delimitations

The present study contains several limitations, one of which is that self-reported home practice could not be verified by the researcher. Non-compliance with a home practice protocol can significantly alter an individual's improvement (Bane et al., 2016). To address the limitation of unverified compliance to home practice, certain aspects of the methodology were specifically incorporated. First, home practice logs were provided to each participant to record MPT data for each practice session; these were returned weekly and stored in each participant's folder. Second, participants were reminded to practice twice daily via email. Third, compliance was emphasized to each participant during the consent process, and participants verbally stated understanding. Finally, each participant was provided with practice videos to guide and facilitate home practice on the assigned vocal tract posture.

A second limitation is that research assistants provided guidance and recorded data for weekly check-ins rather than speech-language pathologists. Although research assistants were instructed on each vocal tract posture and trained to provide feedback to participants, the inexperience and lack of expertise with the exercises and postures may have diminished the quality of instruction. Several aspects of the study's design addressed the use of research assistants. First, research assistants received training from a speech-language pathologist and expert in voice prior to the study. Technique was then reviewed individually on two separate occasions. Additionally, all research assistants participated in mock sessions and provided adequate feedback to establish each vocal

tract posture. Second, upon initially teaching VFEs or modified VFEs to each participant, voice clinicians with extensive experience using and teaching VFEs confirmed technique with each participant and collected MPT pre-treatment data. Third, 20% of all weekly check-ins were supervised by experienced voice clinicians, and an additional 20% were monitored by a second year graduate student with experience teaching and using VFEs.

A number of delimitations were present in this study. First, the population under investigation included individuals with normal voice; conclusions regarding efficacy of vocal tract posture modification with pathological populations cannot be drawn. Second, time constraints limited this study to a small sample size, which only permits use of these data for preliminary purposes. Third, only three varying degrees of vocal tract occlusion were investigated, therefore conclusions about various other vocal tract postures cannot be drawn. Fourth, there was no attrition component to this study. Because data was collected during the fall semester, upper respiratory infections and allergies could not be prevented. Fifth, although participants were educated regarding harmful vocal behaviors and agreed to abstain from harmful vocal behaviors, vocal hygiene could not be tracked and was not reported. Finally, no tapering schedule was used despite clinical recommendations following the VFE protocol. Clinically, as described by Stemple (2005), once a client has reached the predetermined therapy goal (physiologic MPT), a tapering maintenance program should be implemented to gradually reduce practice intensity while maintaining 85% of the patient's peak MPT. In this study, exercises were discontinued after six weeks because the estimated time of completion of the VFE program is between six and eight weeks (Stemple, 2005). A tapering program was not implemented because this would require all participants to meet their physiologic MPT

goal during the study period. Since a tapering program was not used, one-month follow-up data should be interpreted with caution, as the absence of a maintenance program affects percent of MPT goal maintained at follow-up.

Implications for Future Research

Further investigation is required to determine the most efficacious vocal tract posture to be implemented in VFEs in normal voice. One potential research design would be to use the modified /o/ posture with increased treatment time (> 6 weeks). The modified /o/ group demonstrated significant improvement in percent of MPT goal attained prior to application of the Bonferonni correction. This means that the improvement made by the modified /o/ group was statistically significant at p=.05, but did not remain significant after a more rigorous analysis. Although the modified /o/ group improved less than the traditional VFE group in 6 weeks, the modified /o/ group may eventually make comparable improvements with extended treatment. Improvement using a modified /o/ vocal tract posture may not be as efficient as improvement using an SOVT. Second, one could consider implementing the modified /o/ posture with a higher dosage. A study by Bane et al. (2016), determined that a higher dosage of VFEs (each exercise four times each, twice daily) with the traditional VFE SOVT posture resulted in greater MPT improvement compared to the traditional VFE dosage (each exercise two times each, twice daily). A higher dosage of the modified /o/ posture might improve MPT goal attainment, but could also undermine MPT goal attainment since higher dosage may decrease compliance and increase participant withdrawal (Bane et al., 2016).

Another potential avenue for future research includes varying vocal tract semi-occlusion. Since this study demonstrated greater vocal tract occlusion to be associated

with improved outcomes, future research might examine the effects of increased vocal tract occlusion or alternate forms of achieving a SOVT. For example, the nasal consonant /m/ could be used to achieve a semi-occluded vocal tract posture. The /m/ is produced through the nasal cavity which provides a degree of vocal tract occlusion that has yet to be investigated in the VFE protocol.

In future research, participant compliance should be monitored, if possible. Ellis and Beltyukova (2011) found that a compliance-monitored group performing the traditional protocol of VFEs improved significantly more than an unmonitored VFE group. The participants in the monitored group were asked to submit audio or video recording of exercises. Future studies might incorporate an interactive web-based application that has the capability of providing videos of appropriate technique and recording MPT audio samples for reporting compliance to the principle investigator.

Conclusions

In summary, varying the degree of vocal tract occlusion used during VFEs alters MPT goal attainment in normal voice. The traditional VFE SOVT posture may be most efficacious and efficient, however the modified /o/ posture may increase the likelihood of goal attainment by easing patient frustration and increasing compliance. The modified /a/ posture may prevent individuals from reaching MPT despite protocol compliance. It appears greater vocal tract occlusion improves efficacy of VFEs in enhancing normal voice.

Chapter Summary

Chapter five served to discuss the results of this study, their significance, and their clinical implications. Limitations and delimitations, as well as directions for future research were outlined in this chapter.

Appendix A: Recruitment Flyer

University of Kentucky Research

Volunteers Needed for a Study of Voice Production

Researchers at the University of Kentucky, College of Health Sciences are inviting you to Participate in a study on voice production. Testing involves detailed throat examination and voice quality measures. The study requires 8 visits lasting approximately for one hour each.

You may be able to participate if you:

- Are between 18-45 years old
- Are female
- Are a non-smoker
- Have not had a year or more of classical vocal training
- Do not have a history of uncontrolled asthma

Appendix B: Consent Form

Combined Consent and Authorization to Participate in a Research Study

Vocal Function Exercises for Normal Voice: With and Without Semi-Occlusion

WHY ARE YOU BEING INVITED TO TAKE PART IN THIS RESEARCH?
You are being invited to take part in a research study that will examine how your voice responds to vocal exercises performed in different ways, for example, using different shapes with your mouth or by using acoustical resonators like drinking straws. You are being invited to take part in this research study as a volunteer in one of three groups. Your group assignment will be determined randomly. If you volunteer to take part in this study, you will be one of around 30 people to do so.

WHO IS DOING THE STUDY?
The person in charge of this study is Megan S. Brown of the University of Kentucky, Department of Communication Sciences & Disorders (CSD). Megan S. Brown is a Masters graduate student in the CSD program. She is being guided in this research by faculty advisors Joseph Stemple, Ph.D., CCCSLP and Daniel J. Croake, CCC-SLP. Dr. Stemple is a Professor in CSD and Mr. Croake is a doctoral candidate in rehabilitation sciences. There may be other people on the research team assisting at different times during the study.

WHAT IS THE PURPOSE OF THIS STUDY?
With this study, we hope to gain insight about the role of differing mouth postures and how they affect the successfulness of exercises used in voice therapy.

ARE THERE REASONS WHY YOU SHOULD NOT TAKE PART IN THIS STUDY?
You should not take part in this study if you smoke, have had formal singing training of greater than one year, or if you have a history of asthma or other respiratory issues. This study is limited to female participants. You should not take part in this study if you are younger than 18 or older than 45 years old.

WHERE IS THE STUDY GOING TO TAKE PLACE AND HOW LONG WILL IT LAST?
The research procedures will be conducted in room 106C of the Charles T. Wethington building and in the University of Kentucky Academic clinic in room 110 of the Charles T. Wethington Building. You will be asked to attend treatment or assessment sessions a total of 8 times, and each visit will take approximately one hour, with the exception of the initial assessment which will last around 90 minutes.
The treatment sessions will take place over a 6-week period and each participant will be asked to return one month after treatment to complete a follow-up assessment. In addition, you may be asked to do exercises at home in the morning and in the evening for 10 minutes each. The total duration of the study will be 11 weeks.

WHAT WILL YOU BE ASKED TO DO?
At your arrival, we will assess your voice at its current (baseline) state, which will include:
• Voice self-assessment: You will be asked to fill out a questionnaire on your voice quality.
• Visual imaging of the appearance and movements of vocal/laryngeal structures: An endoscope attached to a digital camera and recorder will be placed into your mouth and a recording will be made of the vocal folds as they vibrate. This examination is noninvasive and will take about 10 minutes.
• Audio-visual recordings of your voice: These measures will be obtained while you vocalize or breathe into a microphone and an airflow mask placed on your face over your nose and mouth. Researches will then measure the air pressure and airflow out of your mouth that you use during voice production. Voice samples and airflow measures may be taken several times to ensure consistency.
• Audio-perceptual rating: A speech-language pathologist who specializes in voice will listen to your speaking voice and rate it's audible quality and characteristics.

Clinic Visit Schedule:

Visit	Purpose	Procedures
1	Pre-Treatment Data Collection	Full voice assessment; learn Vocal Function Exercises (VFEs)
2	Week 1	VFEs; complete questionnaire
3	Week 2	VFEs; complete questionnaire
4	Week 3	VFEs; complete questionnaire
5	Week 4	VFEs; complete questionnaire
6	Week 5	VFEs; complete questionnaire
7	Post-treatment Data Collection (Week 6)	Full voice assessment
8	One-Month Follow-Up Data Collection	Full voice assessment

At Home Exercises: You will be assigned to one of three groups randomly. Each group will be asked to do the same exercises however with differing mouth postures. The exercises will be performed at each session and also independently at home, monitored by a daily log sheet (Appendix III). See the group descriptors and the list of exercises below:

Group	Mouth Posture during VFEs
1	VFEs with basic mouth posture (SOVT)
2	VFEs with open vowel /o/
3	VFEs with open vowel /a/

Exercise	Description
1	Warm up exercise – sustain "eee" for as long as possible
2	Stretching exercise – glide from your lowest note to your highest note
3	Contracting exercise – glide from your highest note to your lowest note
4	Low impact adductory power exercise – sustain the musical note C-D-E-F-G for as long as possible

WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS?
During assessment and data collection, an endoscope will be passed into your mouth to view your vocal folds. There is a chance of stimulating a gag reflex during this examination, in which case the scope will be removed. If your vocal folds show any visible abnormalities, you will be referred to an Ear, Nose and Throat physician in the Kentucky Clinic or another ENT doctor of their choice. Occasionally individuals demonstrate a hyper-gag reflex, precluding the completion of the stroboscopic examination. Should this occur, you will not be able to continue in the study. There are no known risks associated with audio recording or measuring airflow coming out of your mouth during speech. There is always a chance that any medical treatment can negatively affect you, and the procedures in this study are no different. Possible minor and reversible side effects of VFEs include edema to the vocal fold mucosa and muscular soreness. This may result in a temporary decrease in vocal quality, for example hoarseness. In addition to the risks listed above, you may experience a previously unknown risk or side effect.

DO YOU HAVE TO TAKE PART IN THE STUDY?
If you take part in this study, it should be because you really want to volunteer. You will not lose any benefits or rights you would normally have if you choose not to volunteer. You can stop at any time during the study and still keep the benefits and rights you had before volunteering. As a student, if you decide not to take part in his study, your choice will have no effect on your academic status or grade in any of your classes.

IF YOU DON'T WANT TO TAKE PART IN THE STUDY, ARE THERE OTHER CHOICES?
If you do not want to take part in this study, at this time there are no other choices.

WHAT WILL IT COST YOU TO PARTCIPATE?
There is no cost to you or your insurance company for you to participate in this study since these procedures are part of a research study at the University of Kentucky.

WHO WILL SEE THE INFORMATION THAT YOU GIVE?
We will keep private all research records that identify you to the extent allowed by law. Your information will be combined with information from other people taking part in the study. When we write about the study to share it with other researchers, we will write about the combined information we have gathered.
You will not be personally identified in these written materials. We may publish the results of this study; however, we will keep your name and other identifying information private. We will make every effort to prevent anyone who is not on the research team from knowing that you gave us information, or what that information was. Your personal information will be accessible only to the research personnel. Officials at the University

of Kentucky may look at or copy pertinent portions of records that identify you.

CAN YOUR TAKING PART IN THE STUDY END EARLY?
If you decide to take part in the study you will still have the right to decide at any time that you no longer want to continue. You will not be treated differently if you decide to stop taking part in the study. Any identifiable research information resulting from your participation in this research study prior to the date that you formally withdraw your consent may continue to be used and disclosed by the investigators for the purposes described in the previous section.

ARE YOU PARTICIPATING OR CAN YOU PARTICIPATE IN ANOTHER RESEARCH STUDY AT THE SAME TIME AS PARTICIPATING IN THIS ONE?
You may take part in this study if you are currently involved in another research study. It is important to let the investigator know if you are in another research study. You should also discuss with the investigator before you agree to participate in another research study while you are enrolled in this study.

WHAT HAPPENS IF YOU GET HURT OR SICK DURING THE STUDY?
If you believe that you have gotten sick or hurt as a result of participation in this study, you should contact Megan S. Brown at megan.brown22@uky.edu and Joseph Stemple Ph.D. at jcstem2@uky.edu. In case an abnormality of your voice is found during the assessment you will be referred to the UK Voice and Swallow Clinic. Should you choose to proceed with treatment, you and/or your insurance company will be responsible for the costs of all care and treatment. It is important for you to understand that the University of Kentucky does not have the funds set aside to pay for the cost of any care or treatment that might be necessary because you get sick or hurt while taking part in this study. Also, the University of Kentucky will not pay for any wages you may lose if you are negatively affected by this research. Depending on your insurance, your care costs may be paid by Medicare or Medicaid if you have coverage (If you have questions regarding Medicare/Medicaid coverage you may contact Medicare by calling 1-800-633-4227 or Medicaid at 1-800-635-2570. A co-payment/deductible from you may be required by your insurer or Medicare/Medicaid even if your insurer or Medicare/Medicaid has agreed to pay the costs. The amount of this copayment or deductible may be substantial. You do not give up your legal rights by signing this form.

WILL YOU RECEIVE ANY REWARDS FOR TAKING PART IN THIS STUDY?
You will not receive any rewards or payment for taking part in the study.

WHAT IF YOU HAVE QUESTIONS, SUGGESTIONS, CONCERNS, OR COMPLAINTS?
Before you decide whether to accept this invitation to take part in the study, please ask any questions that you might come to mind now. Later, if you have questions, suggestions, concerns or complaints about the study, you can contact the investigator, Megan S. Brown, at 859-948-7601. If you have any questions about your rights as a volunteer in this research, contact the staff in the Office or Research Integrity at the

University of Kentucky between the business hours of 8am and 5pm EST, Mon-Fri at 859-257-9428. You will be given a signed copy of this consent form to take with you.

WHAT IF NEW INFORMATION IS LEARNED DURING THE STUDY THAT MIGHT AFFECT YOUR DECISION TO PARTICIPATE?

You will be informed if the researcher learns of any new information in regards to this study that might change your willingness to stay in this study. You may be asked to sign a new informed consent form if the information is provided to you after you have joined the study.

POTENTIAL FUTURE USE

Contacting Research Subjects for Future Studies: Do you give your permission to be contacted in the future by Megan S. Brown and/or Dr. Joseph Stemple regarding your willingness to participate in future research studies about how to prevent, detect, or treat voice disorders?

o Yes o No Initials_____

WHAT ELSE DO YOU NEED TO KNOW?

There is a possibility that the data collection from you may be shared with other investigators in the future. If that is the case the data will not contain information that can identify you unless you expressly give your consent/authorization or the UK Institutional Review Board (IRB) approves the research. The IRB is a committee that reviews ethical issues, according to federal, state and local regulations on research with human subjects, to make sure the study complies with these regulations before approval of a research study is issued.

As a student in the College of Health Sciences, should you feel coerced in any way during the conduct of this research, you are encouraged to contact Anne Olson Ph.D., Division Chair of Communication Sciences and Disorders. Email: Aolso2@uky.edu Phone: (859) 323-1100

Your participation or non-participation in this research study will have no effect on your class standing or grade in any of your courses.

AUTHORIZATION TO USE OR DISCLOSE YOUR IDENTIFIABLE HEALTH INFORMATION

The privacy law, HIPAA (Health Insurance Portability and Accountability Act), requires researchers to protect your health information. The following sections of the form describe how researchers may use your health information.

Your health information that may be accessed, used and/or released includes:

• Your name, date of birth, and telephone number
• Visual images from the stroboscopic exam
• Averages, time of goal attainment, and data related to Vocal Function Exercise performance at home and during sessions
• Audio-visual recordings of your voice
• Questionnaire and auditory-perceptual ratings regarding your voice.

The Researchers may use and share your health information with:

• University of Kentucky's Institutional Review Board/Office of Research Integrity
• Only the research personnel participating in the present study. A list of personnel is listed below:
• Megan S. Brown, B.H.S., graduate student, Principal Investigator
• Joseph Stemple, Ph.D., CCC-SLP, Faculty Advisor
• Richard Andreatta, Ph.D.
• Daniel J. Croake, CCC-SLP, Co-investigator

The researchers agree to only share your health information with the people listed in this document. Should your health information be released to anyone that is not regulated by the privacy law, your health information may potentially be shared with others without your permission; however, the use of your health information would be still regulated by applicable federal and state laws. Electronic data will be deleted according to University guideline. Dates for data collection are from: August 2016- August 2017. You will not be allowed to participate in the research study if you do not sign this form. If you decide not to sign the form, it will not affect your:
• Current or future healthcare at the University of Kentucky
• Current or future payments to the University of Kentucky
• Ability to enroll in any healthcare plans (if applicable)
• Eligibility for benefits (if applicable)

After signing the form, you can change your mind and NOT let the researcher(s) collect or release your health information (revoke the Authorization). If you revoke the authorization:

• You will send a written letter to: Megan S. Brown, B.H.S. at 900 South Limestone, Suite 120, Lexington, KY 40503 to inform her of your decision.
• Researchers may use and release your health information already collected for this research study.
• Your protected health information may still be used and released should you have a bad reaction (adverse event).
• The use and sharing of your information has no time limit.

If you have not already received a copy of the Privacy Notice, you may request one. If you have any questions about your privacy rights, you should contact the University of Kentucky's Privacy Officer between the business hours of 8am and 5pm EST, Mon-Fri at: (859) 323-1184.

You are the subject. You have read this information, and you will receive a copy of this form after it is signed.

Signature of person agreeing to take part in the study

_____ Date: _____

Printed name of person agreeing to take part in the study

_____

Name of [authorized] person obtaining informed consent

_____ Date: _____

Signature of Principal Investigator or Sub/Co-Investigator

_____

Appendix C: Home Practice Log

THE UNIVERSITY OF KENTUCKY

Vocal Exercise Practice Record **TARGET: _____seconds**

Week 1		Day	1st	2nd	3rd	4th	5th	6th	7th
		DATE							
AM	**1**	**Traditional VFE** *Sustain the vowel "ee" for as long as you can. Placement should be extremely forward, almost but not quite nasal. Do this as soft as possible, but not breathy. Engage the voice. This is a warm-up. Time this exercise. Record times for 2 attempts below.* **Modified /o/** *Sustain the vowel "ee" for as long as you can. Do this as soft as possible, but not breathy. Engage the voice. This is a warm-up. Time this exercise. Record times for 2 attempts below.* **Modified /a/** *Sustain the vowel "ee" for as long as you can. Do this as soft as possible, but not breathy. Engage the voice. This is a warm-up. Time this exercise. Record times for 2 attempts below.*							
			/	/	/	/	/	/	/
	2	**Traditional VFE** **Glide from your lowest note to your highest on "knoll."** *You may also choose to use "woo" or "whoops". Check off 2 attempts at this exercise, but you do not need to time or measure the pitch. The goal is no voice breaks, with buzzing in the lips.* **Modified /o/** **Glide from your lowest note to your highest on the sound /o/.** *Check off 2 attempts at this exercise, but you do not need to time or measure the pitch. The goal is no voice breaks.* **Modified /a/** **Glide from your lowest note to your highest on the sound /a/.** *Check off 2 attempts at this exercise, but you do not need to time or measure the pitch. The goal is no voice breaks.*							
			☐☐	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐

	3	**Traditional VFE** **Glide from a comfortable high pitch to your lowest pitch on "knoll."** *You may also choose to use "woo" or "whoops". Check off 2 attempts at this exercise, but you do not need to time or measure the pitch. The goal is no voice breaks, with buzzing in the lips.* **Modified /o/** **Glide from a comfortable high pitch to your lowest pitch on the sound /o/.** *Check off 2 attempts at this exercise, but you do not need to time or measure the pitch. The goal is no voice breaks.* **Modified /a/** **Glide from a comfortable high pitch to your lowest pitch on the sound /a/.** *Check off 2 attempts at this exercise, but you do not need to time or measure the pitch. The goal is no voice breaks.*							
		☐☐	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐	
	4	**Traditional VFE** **Sustain the following 5 ascending pitches** *for as long as possible on the sound "ooooo". This should also feel buzzy in the lips. If you place a finger in front of your mouth you feel a narrow stream of air for as long as you voice.* **Modified /o/** **Sustain the following 5 ascending pitches** *for as long as possible* **on the sound /o/.** **Modified /a/** **Sustain the following 5 ascending pitches** *for as long as possible* **on the sound /a/.**							
		Pitch 1	/	/	/	/	/	/	/
		Pitch 2	/	/	/	/	/	/	/
		Pitch 3	/	/	/	/	/	/	/
		Pitch 4	/	/	/	/	/	/	/
		Pitch 5	/	/	/	/	/	/	/
PM	1	"Eee"	/	/	/	/	/	/	/
	2	Up glide	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐
	3	Low glide	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐
	4	Pitch 1	/	/	/	/	/	/	/
		Pitch 2	/	/	/	/	/	/	/
		Pitch 3	/	/	/	/	/	/	/
		Pitch 4	/	/	/	/	/	/	/
		Pitch 5	/	/	/	/	/	/	/

Appendix D: Withdrawal Questionnaire

Vocal Function Exercises for Normal Voice: With and Without Semi-Occlusion Withdrawal Questionnaire

Please complete the questionnaire honestly. You will not be subject to any penalty or repercussion as a result of withdrawal from this study. We would like to know the reason for withdrawal as it may have implications for our results, data analysis, and continuation of the study.

Please rate how difficult/ uncomfortable your stroboscopic examination (visualization of the vocal folds/ imaging of the larynx) was (circle one):

No discomfort Mild discomfort Moderate discomfort Extreme discomfort

Please check all that apply:

□ I feel that I experienced fatigue, pain, soreness, or discomfort as a result of the exercise practices that I completed.
□ I felt discouraged by the required technique and was not able to achieve it independently.
□ Another personal matter prevented my full participation.
□ I do not wish to give a reason but will not continue my participation.
□ Other (please elaborate):

Please return to Megan S. Brown at megan.brown22@uky.edu

Appendix E: Weekly Average MPT

Group	Participant #	Pre	Week 1	Week 2	Week 3	Week 4	Week 5	Post	Follow-up
1	1	13.3	17.6	15.3	23.3	31	36.5	33.6	33
1	7	15.5	16.3	21	25.3	27.3	28.7	28	26
1	11	21	35	34	27.8	33.5	37.8	34.5	37
1	14	12.5	17.5	17.5	17.6	20.8	27.5	27.5	23
1	18	14.3	8.2	8.8	13.3	12.5	13	15.5	12
1	25	22.5	25.2	23.2	26.7	26.8	28	30.3	31
1	27	15	13.2	16.2	19.3	22	22.3	22	22
1	29	14.6	21	25.3	28	25	30.6	31.2	22
1	30	12.2	12.8	15.5	19	22.6	25.2	25.2	25
2	3	25	30.5	29.5	22.6	25.1	31.6	25.7	28
2	5	14.5	16.8	22.2	23.3	28.6	33	42	36
2	6	9.8	15.5	17.6	17.5	18.5	16.8	21.6	20
2	9	19.6	25.2	27	28	Sick	28.3	24.8	27
2	16	15.8	14.8	15.6	16.5	17.8	20.5	21.6	18
2	21	25.2	30.5	35.5	36.3	38.5	50.8	51.2	54
2	22	14.6	15.16	20.7	19.2	23.5	21.3	25.83	20
2	23	15.3	12.8	12.8	13.1	14.5	15.5	15.8	16
3	2	16	15.7	18	17.3	15.6	18.6	20.5	21
3	10	33	27.6	28.6	27.2	24.8	25.8	26.5	23
3	12	19.8	20.5	21.5	25.8	29.6	39	45.6	34
3	13	16.3	14.3	13.5	13	12.5	13	14.6	16
3	15	17.3	21.5	21.6	22	20	21.2	20.3	21
3	19	12.3	14.3	14.1	14.8	17	17.5	16.2	15
3	20	13.3	13.5	13.2	15.1	16.5	18.5	20.1	19
3	24	10.3	11	12.5	14	11.8	11.8	12.6	12
3	28	22	15.16	17.5	19.1	19.5	20	22.6	20

Appendix F: Study Checklist

Study Checklist

DATE:

Please circle 'yes' for each item that has been completed

Participant #_____

Informed consent: Yes / No

VRQoL: Yes / No **Score (10-50)**: _____ **Overall Voice Quality:** _____

CAPE-V: Yes / No

Overall quality (> 29 disqualifies)	

Aerodynamics: Yes/No

Vital capacity	

Laryngeal Examination : Yes/No
0= Normal / 1= Abnormal

If abnormal: *(select one)*

Glottic closure	
Mucosal wave	
Supraglottic hyperfunction	
Phase symmetry	

If other, please identify:_____

Appendix G: Consensus Auditory Perceptual Evaluation of Voice

Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V)

Name:_____ **Date:**_____

The following parameters of voice quality will be rated upon completion of the following tasks:

1. Sustained vowels, /a/ and /i/ for 3-5 seconds duration each.
2. Sentence production:
   a. The blue spot is on the key again.
   b. How hard did he hit him?
   c. We were away a year ago.
   d. We eat eggs every Easter.
   e. My mama makes lemon muffins.
   f. Peter will keep at the peak.
3. Spontaneous speech in response to: "Tell me about your voice problem." or "Tell me how your voice is functioning."

Legend: C = Consistent I = Intermittent
MI = Mildly Deviant
MO = Moderately Deviant
SE = Severely Deviant

				SCORE
Overall Severity	_____ MI MO SE	C	I	/100
Roughness	_____ MI MO SE	C	I	/100
Breathiness	_____ MI MO SE	C	I	/100
Strain	_____ MI MO SE	C	I	/100
Pitch	(Indicate the nature of the abnormality): _____ _____ MI MO SE	C	I	/100
Loudness	(Indicate the nature of the abnormality): _____ _____ MI MO SE	C	I	/100
_____	_____ MI MO SE	C	I	/100
_____	_____ MI MO SE	C	I	/100

COMMENTS ABOUT RESONANCE: NORMAL OTHER (Provide description):_____

_____

ADDITIONAL FEATURES (for example, diplophonia, fry, falsetto, asthenia, aphonia, pitch instability, tremor, wet/gurgly, or other relevant terms):

Clinician:_____

Appendix H: Voice Related Quality of Life

Otolaryngology Associates, P.C.
Voice Related Quality of Life (V-RQOL)

Name: _____ **Date:** _____

We are trying to learn more about how a voice problem can interfere with your daily activities. On this paper, you will find a list of possible voice-related problems. Please answer all questions based upon what your voice has been like over the past 2 weeks. There are no "right" or "wrong" answers.

Considering both how severe the problem is when you get it, and how frequently it happens, please rate each item below on how "bad" it is (that is, the amount of each problem you have). Use the following scale for rating the amount of the problem.

1 = None, not a problem
2 = A small amount
3 = A moderate (medium) problem
4 = A lot
5 = Problem is "as bad as it can be"

Because of my voice:	**How much of a problem is this?**
1. I have trouble speaking loudly or being heard in noisy situations.	1 2 3 4 5
2. I run out of air and need to take frequent breaths when talking.	1 2 3 4 5
3. I sometimes do not know what will come out when I begin speaking.	1 2 3 4 5
4. I am sometimes anxious or frustrated (because of my voice).	1 2 3 4 5
5. I sometimes get depressed (because of my voice).	1 2 3 4 5
6. I have trouble using the telephone (because of my voice).	1 2 3 4 5
7. I have trouble doing my job or practicing my profession (because of my voice).	1 2 3 4 5
8. I avoid going out socially (because of my voice).	1 2 3 4 5
9. I have to repeat myself to be understood.	1 2 3 4 5
10. I have become less outgoing (because of my voice).	1 2 3 4 5

The overall quality of my voice during the last two weeks has been (please circle):

Poor Fair Good Very Good Excellent

Hogikyan ND, Sethuraman G. Validation of an instrument to measure voice-related quality of life (V-RQOL). Journal of Voice. 1999. 13:557-569.

LPV 3/10

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