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Effects of Fitzmaurice Voicework® on the voice of graduate student actors

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EFFECTS OF FITZMAURICE VOICEWORK®
ON THE VOICE OF GRADUATE STUDENT ACTORS

by

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CERTIFICATE OF APPROVAL

MASTER'S THESIS

This is to certify that the Master's thesis of

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has been approved by the Examining Committee for
the thesis requirement for the Master of Arts degree
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To my dear mentor and friend, Donna Snow, who introduced me to Fitzmaurice Voicework® and encouraged me to pursue a career in both theatre and speech-language pathology

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ABSTRACT

The vocal demands placed on actors are higher than those of the typical speaker. Actors' livelihood is predicated on their ability to consistently perform at peak levels, many times in conditions that are not optimal for vocal efficiency (e.g. theaters with poor acoustics). Further, many actors perform after spending the day at a second job to ensure they have a sufficient income to support themselves. Despite challenges, the hallmark of the strong actor is to strive for peak performance. To do so, many actors implement some form of theatre voice training.

One popular method is Fitzmaurice Voicework®. Fitzmaurice Voicework® is comprised of two phases: Destructuring and Restructuring. Destructuring is based in decreasing tension through relaxation and tremoring. Restructuring focuses on maximizing voice function with the least amount of effort needed. This study specifically looked at the effect of Fitzmaurice Voicework® training on the voice, as it has little more than anecdotal evidence to support its effect. Six graduate student actors enrolled in a theatre voice course based on Fitzmaurice Voicework® completed pre and post training measures examining the changes in maximum phonation time, average loudness and loudness range, fundamental frequency and frequency range, jitter, shimmer, and noise to harmonic ratio, and perceptual measures of vocal quality (e.g. strain, breathiness, and roughness) on the CAPE-V.

Despite no statistically significant findings due to the small sample size and noted variability between individual subjects, trends of more efficient performance post training were present for individuals without a history of voice problems.

PUBLIC ABSTRACT

The vocal demands placed on actors are higher than those of the typical speaker. Actors' livelihood is predicated on their ability to consistently perform at peak levels, many times in conditions that are not optimal for vocal efficiency (e.g. theaters with poor acoustics). Further, many actors perform after spending the day at a second job to ensure they have a sufficient income to support themselves. Despite challenges, the hallmark of the strong actor is to strive for peak performance. To do so, many actors implement some form of theatre voice training.

One popular method is Fitzmaurice Voicework®. Fitzmaurice Voicework® is comprised of two phases: Destructuring and Restructuring. Destructuring is based in decreasing tension through relaxation and tremoring. Restructuring focuses on maximizing voice function with the least amount of effort needed. This study specifically looked at the effect of Fitzmaurice Voicework® training on the voice, as it has little more than anecdotal evidence to support its effect. Six graduate student actors enrolled in a theatre voice course based on Fitzmaurice Voicework® completed pre and post training measures examining the changes in how long the individuals could sustain a note on one breath, average loudness and loudness range, average pitch and pitch, and vocal quality (e.g. strain, breathiness, and roughness), as well as several other measures common in scientific voice analysis.

Despite no mathematically significant changes being present and noted variability between individual subjects, trends of more efficient performance post training were present for individuals without a history of voice problems.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE: INTRODUCTION

Actors use their voices at a heightened level, which calls for voice training to maximize the effectiveness of vocal expression, as well as to maintain healthy vocal production during the extended demands of performance. They must navigate their character's journey through the production, which is typically a journey with levels of intense emotions and trying circumstances, project their voice so it can be heard by the audience, without sounding artificial and forced, and make the words in the script come across as new and their own. For stage actors, these demands must be met consistently show after show (Rodenburg, 2000). Despite some actors attempting to meet these demands without training, most dedicated actors employ a number of various voice training methods, as voice training is essential to the sustained livelihood of a performer (Williams, 1988). One specific method is Fitzmaurice Voicework® (Meier, 2010).

Fitzmaurice Voicework® involves three levels of training, with 281 trained teachers practicing in 35 states, 24 countries, and five continents. Of these teachers, there are 13 Master Teachers who have undergone extensive work with Catherine Fitzmaurice and have extended experience teaching the technique; 237 Associate Teachers who have received certification in the technique with both Catherine Fitzmaurice and Master Teachers and have experience teaching the technique; and 31 Assistant Teachers who have undergone the certification program (Fitzmaurice Voicework®). Fitzmaurice Voicework® Teachers at all levels teach in MFA acting programs, such as Yale School of Drama, Harvard University/American Repertory Theatre's Institute for Advanced Theatre Training, New York University's graduate acting program, University of California-Irvine, Temple University, and University of Iowa. The use of the technique in programs across the US attests to its popularity in the theatre community (Fitzmaurice Voicework®).

Fitzmaurice Voicework® was developed by Catherine Fitzmaurice. Fitzmaurice studied with Cicely Berry and Clifford Turner at the Central School of Speech and Drama in London, where she learned classical British voice training. These techniques consisted of things such as Turner's "rib-reserve", in which the actor is taught to maintain an expanded lower ribcage and use the movement of the abdominal muscles to support speech (Watson & Nayak, 2014). As she began to work with students, she noticed that many appeared to be holding habitual tension throughout the body, in places such as the abdomen, neck, pelvis, or shoulders, and that tension inhibited their voice use, by causing unnecessary muscular strain and inefficient vocal productions. Fitzmaurice hypothesized that this habitual tension restricted the actors from a natural, relaxed, uninhibited breathing pattern. By restricting the breath with tension, the actors were decreasing the efficiency of their lung capacity and were unable to embody their characters, because their habitual breathing patterns constrained the ability to live the text (Fitzmaurice Voicework®). As she developed Fitzmaurice Voicework®, she began to draw from her knowledge of not only theatre voice training, but also from the study of different psychological, physical, and spiritual training methods. In doing so, she integrated the Bioenergetic work of Alexander Lowen and body-based disciplines and energy work, such as yoga, into the foundation of her voice training method (Morgan, 2012).

Fitzmaurice Voicework® is comprised of two phases: Destructuring and Restructuring. Destructuring "promotes awareness of the body, spontaneous and free breathing, vocal expressivity, and presence" through relaxation and tremoring

(Fitzmaurice Voicework®). A main component of destructuring is a tremor sequence. Tremors are taken from the Bioenergetics work of Lowen and use modified yoga positions. Tremors are created by gently stretching or contracting various muscles until the body naturally vibrates in response to the tension. The vibration is then used to relax the tension by allowing the vibration to increase amplitude and extend to other parts of the body (Snow, 2015; Nest, 2015). It can be thought of as similar to a Parkinsonian tremor that may begin by only affecting the hand, but as the disease progresses, the tremor becomes larger and involves multiple parts of the body. Another aspect is "drapes" in which the actor drapes themselves over a ball or other object, allowing them to stretch the back and release tension, so as to become more aware of the sensation of breath moving throughout the body, specifically in the expansion of the ribcage along the spine (Nest, 2015). Restructuring on the other hand is about using the voice economically to maximize its function with the least amount of effort needed. The main components of restructuring are strengthening muscles that will promote breath support in performance (Snow, 2015; Nest, 2015).

Fitzmaurice claims that training in her technique increases kinesthetic and proprioceptive awareness of how the voice and breath are used, increases the ability to communicate thoughts and feelings in conjunction with theatrical demands (e.g. the character's emotional and the need to project to the a large theatre), reduces vocal strain, increases vocal range, and improves vocal expression (Fitzmaurice Voicework®).

Unlike other well known theatre voice training methods, (e.g. Lessac Method or the Alexander Technique), there has been little to no research examining the effects of Fitzmaurice Voicework® on the voice. One study by Watson and Nayak (2014) investigated whether Fitzmaurice training resulted in acoustic changes in the voice. Pre and post training measures of maximum phonation time, jitter, shimmer, and noise to harmonics ratio were obtained. A "moderate" increase in maximum phonation time was seen in 70% of the participants (despite an insignificant *p*-value, effect size *d* was .48). There was no change found in jitter or noise to harmonics ratio, but a slight decrease in shimmer was observed (Watson & Nayak, 2014). An important caveat in interpreting these findings is that the subject group consisted entirely of participants enrolled in the Fitzmaurice Voicework® certification program, which indicates that they possessed prior training in theatre voice techniques.

The purpose of the present study was to examine the effects of training in Fitzmaurice Voicework® on acoustic and perceptual features of voice. We analyzed voice in variety of ways. First, because the Fitzmaurice approach is based on the relationship between breath and voice production (Fitzmaurice, 1997), we measured maximum phonation time to determine the relationship between respiratory modification and coordination of the subsystems of respiration and phonation. We hypothesized that uninhibited breathing patterns and increased breath management as a result of training would lead to an increased maximum phonation time. Second, we examined expressivity of the voice through measures of pitch and loudness from participant's oral reading of two standard passages, "The Rainbow Passage" and "Goldilocks and the Three Bears". As Fitzmaurice claims that her approach increases vocal expressivity, we hypothesized that there would be differences in the post measures of both passages, but more noticeable on the "Goldilocks and the Three Bears" passage, as participants are instructed to read it as if reading to a group of children, which hypothetically involves a more dramatic reading with more variation of pitch and loudness. Third, we used the CAPE-V to perceptually assess voice quality, specifically vocal strain. We hypothesized that consistent with program claims we would see an overall decrease in perception of vocal strain. Finally, we compared pre- and post-training acoustic measures of jitter, shimmer, noise to harmonic ratio, fundamental frequency, and pitch range to assess the acoustic changes present in the voice after training. We hypothesized that consistent with program claims we would see an increase in pitch range. We also hypothesized, based upon anecdotal reports, that there would be a decrease in fundamental frequency. We hypothesized a decrease in the perturbation measures of jitter and shimmer, as well as a decrease in the noise to harmonic ratio, as this would imply a more stable, uninhibited vocal production.

Statement of the Problem

The vocal demands placed on actors are higher than those of the typical speaker. Their livelihood is predicated on their ability to consistently perform at peak levels, many times in conditions that are not optimal for vocal efficiency (e.g. theaters with poor acoustics). Further, many actors perform after spending the day at a second job to ensure they have a sufficient income to support themselves. Despite these challenges, the hallmark of the strong actor is to strive for peak performance (Raphael, 2005). Theatre voice training has been shown to be an effective way to maximize vocal efficiency and to keep the actor's voice healthy despite the large level of demand and strain on their voice. It has also been shown to be beneficial with disordered populations as a way to rehabilitate their voices (Freed, Raphael, & Sataloff, 2005). Theatre voice training has been shown to have an effect on the pitch and loudness ranges of actors. It has also been shown that more pleasing voices show higher intensity in the level of the actor's formant. However, many of the studies on theatre voice training do not clearly specify what training method the actors in the study used. With multiple training methods available, it is pertinent to know which method will be most efficacious to an actor by knowing the expected effect of training in that method. This study specifically looked at the effect of the Fitzmaurice Voicework® training method on the voice, as it is popular training method in the theatre field, but has little more than anecdotal evidence to support its effect. Watson and Nayak (2015) began looking at this and found some developing trends, but due to a small sample, they did not find any statistically significant findings. This study set out to see if these trends are also present in the population of graduate student actors and addresses two questions:

1.) What is the physiological response to training with Fitzmaurice Voicework®, as measured by maximum phonation time, loudness range, pitch range, fundamental frequency, jitter, shimmer, and noise to harmonic ratio?

2.) Are there perceptual differences in the voices of a speaker pre and post training with Fitzmaurice Voicework®, as measured by the CAPE-V?

CHAPTER TWO: REVIEW OF THE LITERATURE

The following literature review is organized into three main sections. The first is an extended background on Fitzmaurice Voicework® and its influences. This will include destructuring, restructuring, perceived benefits of Fitzmaurice Voicework®, and expectations of the voice after training. The second is a review of the literature on the vocal physiology and perceptual differences in the voices of actors' pre and post training (as well as compared to those of non-actors) associated with other theatre voice training methods. This section will include pitch range, loudness range, and the presence of higher harmonics/actor's formant. The final section will provide a description of the measures used in this study and rationale for each.

Fitzmaurice Voicework®

Fitzmaurice Voicework® was developed by Catherine Fitzmaurice. Fitzmaurice began acting at a young age, and by ten-years-old she had already began studying voice. Fitzmaurice studied with Cicely Berry and Clifford Turner at the Central School of Speech and Drama in London, where she learned classical British voice training, such as Turner's "rib-reserve", in which the actor is taught to maintain an expanded lower ribcage and use the movement of the abdominal muscles to support speech (Watson & Nayak, 2014). As she began to work with students, she noticed that many appeared to be holding habitual tension throughout the body that inhibited their voice use, by causing unnecessary muscular strain and inefficient vocal productions. Fitzmaurice hypothesized that this habitual tension restricted the actors from a natural, relaxed, uninhibited breathing pattern. By restricting the breath with tension, the actors were decreasing the efficiency of their lung capacity and were unable to embody their characters, because their habitual breathing patterns constrained the ability to live the text (Fitzmaurice Voicework®). As a result, she developed Fitzmaurice Voicework®. She drew from her knowledge of not only theatre voice training, but also from the study of different psychological, physical, and spiritual training methods by integrating the Bioenergetic work of Wilhelm Reich and body-based disciplines and energy work, such as yoga, into the foundation of her voice training method (Morgan, 2012).

Fitzmaurice Voicework® is comprised of two phases: Destructuring and Restructuring. Destructuring "promotes awareness of the body, spontaneous and free breathing, vocal expressivity, and presence" through relaxation and tremoring (Fitzmaurice Voicework®). Restructuring on the other hand is about using the voice economically to maximize its function with the least amount of effort needed (Snow, 2015; Nest, 2015).

Destructuring

Destructuring is a process used to remove habitual muscular tensing and holding patterns that may be inhibiting breathing and voice production (Danford, 2016). A main component of destructuring is the "tremor sequence". Tremors are created by gently stretching or contracting various muscles while in modified yoga positions until the body naturally vibrates, or shakes, in response to the tension (Watson & Nayak, 2014). The vibration is then used to release tension through increasing amplitude and expanding to other parts of the body (Snow, 2015). It can be thought of as similar to a Parkinsonian tremor that may begin by only affecting the hand, but as the disease progresses, the tremor becomes larger and involves multiple parts of the body. The tremors are intended to free, or relax, the torso and make breathing easy and unforced by decreasing unnecessary physical tension (Nest, 2015). Reportedly, tremoring also allows the actor to mentally relax, release "emotional baggage", and be more connected with those emotions (Snow, 2015). The emotional release related to tremoring is based in the work of psychotherapist, Wilhelm Reich and the Bioenergetic work of his student, Alexander Lowen (Morgan, 2012). Fitzmaurice studied with Alexander Lowen, who was a student of Wilhelm Reich. Reich's work viewed focusing on sexual health as a way to manage psychiatric neurosis. From this Lowen developed Bioenergetics, which is a therapeutic technique intended to get the participant in tune with and aware of their body and its basic functions, such as sexuality, breathing, moving, feeling, and self-expression. These basic functions are fundamental to the actor in creating a realistic performance onstage (Morgan, 2012). Bioenergetics seeks to decrease tension in the body caused by the opposing forces of sexuality and anxiety. This anxiety, which is manifested in tension, is claimed to be released in Fitzmaurice Voicework® through tremoring by activating the autonomic nervous system and decreasing the "fight or flight" response (Morgan, 2012; Danford, 2016). While tremoring may not directly involve the laryngeal structures, an argument can be made that if tremoring accomplishes what it claims, then it could have a potential effect on laryngeal function.

The autonomic nervous system can be activated by moments of stress, anxiety, fear, and pain. In subjects with functional vocal pathologies, such as individuals with muscle tension dysphonia, it is hypothesized that these stressors can be an underlying component of the pathology, as the activation of the autonomic nervous system has been shown to cause increased activation of intrinsic laryngeal muscles (Helou, et al., 2013). If tremoring activates the autonomic nervous system, as claimed, it could cause increased laryngeal tension, which would be counterproductive to destructuring causing relaxation. However, when looked at from the view of Bioenergetics, this activation would be targeting the release of the emotional stressors that are thought to be the underlying cause of these stressors (Morgan, 2012). With the release and acceptance of these stressors, one could, in theory, reduce the adverse psychological tension that is causing autonomic nervous system activation and learn to cope with it (Morgan, 2012). It is also known that body posture and tension throughout the body can indirectly affect phonation and cause voice difficulty (Kooijman, et al., 2005). With this in mind, even if the psycho-emotional stressors intended to be addressed through the Bioenergetics aspect of tremoring are not relieved, the stretching and tremoring that causes a release of physical tension in varying parts of the body, could indirectly affect the individual's phonatory abilities (Kooijman, et al., 2005). With both the potential for psycho-emotional and physical tension to be released through tremoring, one can hypothesize that through continued use, tremoring could play a role in changing laryngeal capabilities.

Destructuring also includes "drapes" which are done by hanging over a large ball or another object in various positions to open up the ribcage and lower back, and lower the position of the diaphragm (Nest, 2015). Performing both de- and restructuring techniques using modified yoga positions is essential in that the positions naturally drive the breath. By attending to the release of tension, the actor is able to more efficiently manage breath, making it easy and unforced (Morgan, 2012).

Restructuring

Restructuring is the process that introduces only the essential muscular effort needed to produce sound, without excess tension or effort (Danford, 2016). Restructuring leads to mental, physical, and emotional balance (Morgan, 2012). Restructuring incorporates a bel canto four-part breath—inhale ribcage belly, exhale making sound, activate the transversus muscles, and subglottal pressure—to create ease and control in the breath (Nest, 2015; Danford, 2016). The use of the transverse and psoas muscles is crucial to supporting the breath (Snow, 2015). The third part of restructuring is the so-called "focus line". Focus line refers to the process of imagining the breath beginning in the abdomen and move up to the pelvis, back, neck, and around the head, finally coming out of the mouth. The concept is meant to encourage full body engagement (Nest, 2015). Nest (2015) describes restructuring as challenging work that requires intentional focus followed by a period of release in which one reduces the degree of focus and ultimately "lets it go." She compares it to doing exercises at the ballet bar where you think intently on technique, but the thought goes away and it becomes second nature in performance. This is the goal of restructuring (Nest, 2015). Snow (2015) agrees that the process of restructuring requires dedication and commitment, but once the muscles are trained, the work is effortless.

Outcomes of Fitzmaurice Voicework®: Anecdotal

One perceived benefit of Fitzmaurice Voicework® is that it does not require a teacher to guide the work after it is trained (Snow, 2015; Nest, 2015). Many techniques require (or at least have better results) when a teacher is providing images. However, with Fitzmaurice Voicework®, a teacher can guide or suggest images, but the actor can create their own images to help the technique resonate with them (Snow, 2015). The technique also allows actors to incorporate other theatre techniques, as nothing in Fitzmaurice Voicework® would directly contradict other training (Snow, 2015). Another benefit is that tremoring rapidly and efficiently opens breath (Nest, 2015). The full Fitzmaurice Voicework® sequence opens the body, warms resonance, and connects the actor to their emotions, though this connecting to emotions is not the intent, but a byproduct of the work (Nest, 2015; Danford, 2016). Restructuring allows the actor to perform with a free sound that is powerful, but has minimal effort (Danford, 2016).

Snow (2015) stated that before she was introduced to Fitzmaurice Voicework®, she would regularly lose her voice before shows and her vocal pitch would increase. However, after she began doing the work, she did not lose her voice again from theatrical demands and her pitch would lower after her warm-up. This lowering of the voice took her fundamental frequency to a more natural place, as she shared that while completing undergraduate work in Seattle, her first acting teacher told her, "That's not your real voice." He had her stand against the wall and go up and down in pitch and found that her voice was more resonant at a frequency much lower than the one she had been speaking at (Snow, 2015). This lowering of the voice from Fitzmaurice Voicework® is not something that Snow has only experienced in herself. She recounted acting in New York City with a male actor who had a very high voice that sounded feminine, especially on the phone. Snow taught him some exercises and the technique seemed to "click" for this actor and his voice lowered. Snow has also had students tell her that they have gone home over breaks and have had friends or family mention that their voice sounds lower

(Snow, 2015). Snow says she practices Fitzmaurice Voicework® exercises religiously and over the years has taught many students in the technique, incorporating aspects of several other techniques or acting skills, but remains relatively true to the work she was taught by Catherine Fitzmaurice (Snow, 2015).

Snow discusses the training as something that brings extraordinary relaxation, a feeling of being "centered", being able to access the uninhibited relaxed performance that you can give when alone in the bedroom, and being able to access different "colors" with the voice without manufacturing them (Snow, 2015). Danford describes the physical release from destructuring as a huge benefit with the "potential to go deeper than muscles" and allows a more resonant sound (Danford, 2016). Snow also stated that the combination of Fitzmaurice Voicework®, which included Catherine's yoga, an additional yoga class, and an Alexander technique class increased her amount of physical flexibility the most in her life, despite years of ballet training (Snow, 2015).

Nest (2015) described her personal experience with Fitzmaurice Voicework® and stated that the method provides a clear language for instruction and yields better control of her body, mind, and voice, while also opening up her singing voice. She said that in her students, she has noticed the work give a better connection between the voice and the breath and open up their body to be more present onstage. However, she said that in students this greatly varies based on their level of maturity and their commitment to practicing the work on their own (Nest, 2015). Nest also claims that the work is not for everyone, but she says of the tremoring aspect of destructuring that if you "just show up and do it, it will teach you." (Nest, 2015). Danford (2016) states that allowing the breath the respond to the tremor assists in managing the breath when faced with other stresses (such as being onstage).

Expectations on the Voice After Training

Nest (2015) states that a well trained voice should exhibit vocal variety, range, an open resonance, and have a connection of the voice with emotional life. Snow (2015) states that the well trained voice will show a decrease in tension. She states that in class, it is clear that a student is “not getting” the technique when the voice sounds like it is being controlled from the back of the tongue or that they haven’t released tension in their throat or core. She states that these students may tremor in the legs, but they’re still holding their stomach. This is why she encourages students to practice at home, where inhibition is lower and they are not concerned with other students. In performance, she says if an actor is not employing technique, then their voice may be heard but it is not centered or expressing feeling, but she also warns that this could be a by-product of poor acting skills and not merely a lack of voice skills. So if it is working, the actor’s voice would be projecting throughout the theatre, but still being true to the emotions of the character (Snow, 2015). Danford (2016) similarly states that when it is working, the voice sounds free and “not trapped in the throat”. She states that the breath is full and effortless and students will not run out of air easily or lose their voices in times of frequent or extreme use. She also states that there is noticeable engagement in the lower part of the transverse muscles on the initiation of sound and the ribcage and chest do not squeeze or collapse (Danford, 2016).

Vocal Training and Voice Physiology

Pitch and Loudness Range

The voice range profile is a common measure obtained to determine a speaker's frequency and loudness range, however as it is calculated through sustained tones, it is not functional to measure the frequency and loudness range of an actor onstage. To do this, a speech range profile is more appropriate. The speech range profile works much like a voice range profile, but it is obtained through the use of text from a play (Emerich, Titze, Švec, Popolo, & Logan, 2005).

In a study by Emerich et al. (2005), a voice range profile and a speech range profile were obtained from eight actors. The examiners proposed that there was a limited range of pitch and intensity that the vocal system could sustain for an extended amount of time, such as that required by a performance. Due to this, they hypothesized that to maximize vocal efficiency, actors would stay in the midrange of their voice range profile parameters and only exceed this midrange momentarily. Emerich et al. (2005) found that of the four male actors that 60-90% of the voice range profile was used in the speech range profile and the intensity levels used exceeded those of the voice range profile in three of the four male actors. In the four female actors, they found that 50-90% of the voice range profile was used in the speech range profile, but the actresses exceeded their lower frequency voice range profile limit by three to six semitones. Also, as was seen with the males, three of the four actresses exceeded their intensity limit of the voice range profile in their speech range profile (Emerich et al., 2005).

Ferrone, Galgano, and Ramig (2011) studied the La MaMa Experimental Theatre's voice work and the effect it had on actors' voices. Their vocal training includes the use of yoga and sipping breaths while using visualization. The La MaMa actors undergo sustained voice use ranging from 46-2000 Hz at levels between 90-108 dB (30 cm microphone to mouth distance) for three to four hours at a time. The examiners hypothesized that due to this increased demand on the voice, the actors were at a high risk for possible vocal disorders. However, the examiners found that measures taken on the actors' pre and post performance were statistically stable, or in some cases the measures improved post performance. They found an increase in maximum phonation time in seven of the eight actors and an increase in maximum phonation range in seven of the eight actors. There was an increase in sound pressure level in six of the eight actors. They also found a decrease in perturbation in the fundamental frequency of seven of the eight actors as well as a decrease in jitter in seven of eight actors and a decrease in shimmer in six of eight actors. There was no change in the noise to harmonic ratio, which would indicate stability in vocal quality (Ferrone, Galgano, & Ramig, 2011). Recordings of the actors were taken pre-training and post-training, as well as pre- and post- performance. Perceptually 74% of raters rated post-training recordings as better or equal to pre-training recordings and 71% of raters rated post performance recordings as better or equal to pre-performance recordings (Ferrone, Galgano, & Ramig, 2011).

Harvey, Feudo, Jr., and Aronson (1989) gathered actors and found their frequency range used in speech and compared it to their frequency range used in an acting scenario by determining the percentage of time in which they remained within their frequency range used in typical speech. To do this, they had the actors complete a reading task, a performance of a prepared monologue, and a cold reading performance. For the males in the study, the average frequency range used for speaking was 100-140 Hz. For the females in the study, the average frequency range was 190-240 Hz. The researchers found a significant increase in frequency range usage during acting tasks for both males and females. In the reading task, the actors remained within their average frequency ranges for 60-90% of the duration of the task, however for the acting task, they only remained in this frequency range for 40-60% of the time. This shows a significant increase in range during acting tasks (Harvey, Feudo, Jr., & Aronson, 1989). These authors then chose to look at the effect of training on these measures in a future study.

Feudo, Jr., Harvey, and Aronson (1992) gathered forty-four actors from a pool of eighty four actors and took pre- and post- training measures. Post-training, the actors were noted to have an 8.3 second increase in sustained /s/, a 10.0 second increase in sustained /z/, and a 2.0 semitone increase in range. This shows that training increased maximum phonation time, as well as range. They also had the actors complete tasks as in the previous study (Harvey, Feudo, Jr., & Aronson, 1989) and found that the actors decreased the amount of time spent in their habitual speaking frequency range by 12% in reading tasks and 20% in scripted acting tasks. This shows that training increased the variability in the actors' use of pitch range. Intensity levels increased by an average of 6 dB in scripted tasks and 7 dB in monologue tasks and the peak intensity in the monologue task increased an average of 9 dB. The mean frequency reading increased by an average of 1.4 semitones (Feudo, Jr., Harvey, & Aronson, 1992).

Walzak, McCabe, Madill, and Sheard (2008) took 9 male and 9 female students in a three year acting program and assessed them at the beginning of the program and after one year of training. They found that there was an increase in shimmer for both males and females. For females, they found an increase in pitch range with a significantly lower mean frequency (Walzak, McCabe, Madill, & Sheard, 2008). Another study of students after 18 months of training in classical voice techniques employed by English voice teachers, such as Berry and Rodenburg, showed better GRBAS scores and increase in singing pitch range in females. However, it showed no significant increase in maximum phonation time (Timmermans, De Bodt, Wuyts, & Van de Heyning, 2004). A third study that compared acting students and non-acting students found that male acting students had significantly lower average deviation for their fundamental frequency (indicating that they had a very stable fundamental frequency) and a higher harmonic to noise ratio for female actors (Varošanec-Škarić, 2008). This shows that female actors had a higher level of harmonic activity than noise activity when compared to their non-acting peers.

These studies are not always specific on what training approach is utilized by the actors, but a general increase in intensity and pitch range has been shown. A study on the effects of Linklater voice training (Wessendarp, 2012) showed that this specific approach increased maximum phonation time and decreased the mean phonation quotient. Many studies have shown that voice training is beneficial to actors in maximizing the ranges of their voices.

Higher Harmonics/Actor's Formant

Many people have studied the "singer's formant", or the increased intensity between 2,000 and 8,000 Hz in the spectrograms of singers, specifically males and how it is considered more pleasing to a listener. Leino, Laukkanen, and Radolf (2011) studied this phenomenon in the actor. They found that a higher intensity peak between 3,000 and

4,000 Hz is found in male actors. This "actor's formant" or "speaker's formant" was studied on a Finnish actor after completing a thirty minute vocal warm-up based on Kuukka exercises (a Finnish theatre voice training technique that focuses on the use of nasal sounds). Measures were taken before and after the warm-up during a text reading at a habitual loudness level, a soft level, a loud level, and with sustained vowels. The actor's intensity level was found to remain constant, but there was a stronger peak around 3.5 kHz on all vowels due to the clustering of F4 and F5. They also found that this increased resonance around 3.5 kHz is perceptually more pleasing across languages (Leino, Laukkanen, & Radolf, 2011).

Master, de Biase, Chiari, and Laukkanen (2008) looked at the actor's formant in Brazilian male actors. They gathered eleven male actors and ten male non-actors to see if there was a difference in the vocal projection strategies of actors, while looking for the actor's formant and looking at the long term average spectrum. The subjects were asked to read an extended text at a habitual, moderate, and loud level. The actors showed a greater alpha ratio (the difference between the average sound pressure level between 1,000-5,000 Hz and 50-1,000 Hz). This shows that there was greater intensity in the region of the proposed actor's formant (3,000-4,000 Hz). This also caused recordings of the actors to be perceptually rated as having higher projection and loudness, despite there being no significant acoustic difference between the sound pressure level of the actors and non-actors. There was also no mean formant frequency range difference between groups. The researchers noted that as fundamental frequency increased, loudness increased as well. Examiners also noted no significant difference in perceived tension between groups. However, they noted a less tilted spectral slop in the long term average spectrum of actors due to suspected favorable, glottal adjustment, which provides faster glottal closing (Master, de Biase, Chiari, & Laukkanen, 2008).

Having found the proposed actor's formant in male actors, Master, de Biase, and Madureira (2012) studied this phenomenon in the voices of females. They gathered thirty actresses and thirty female non-actresses and had all subjects read a 40 second text at habitual and loud levels. The examiners measured sound pressure level and the speaking fundamental frequency of both groups. They found that fundamental frequency of actresses was significantly lower than that of non-actresses by an average of 15 Hz. They also noted a lower intensity level of the first and second formant in actresses, possibly making a case that, while there was not a specific increase in the 3,000-4,000 Hz range, the lower amplitude of the fundamental and first harmonic allows higher harmonics to potentially be perceived as louder (Master, de Biase, & Madureira, 2012).

Raphael and Scherer (1987) studied the spectrum of two male and two female actors during the use of the Lessac "call" technique, of which they had a great understanding. They were asked to produce the word "Hello" five times in normal speech and five times using the Lessac call technique. In the female actors, spectrums yielded a higher second, seventh, and eighth harmonic and lower third and tenth harmonic in the Lessac "call" mode than in normal speech. Overall, the examiners noted an enhancement in the intensity of speakers in the mid-frequency range. The spectrums showed lower energy between 700-1000 Hz and a higher F2 in three of the four actors (Raphael & Scherer, 1987).

Measuring Perceptual and Acoustic Voice Changes

CAPE-V

Kempster, Gerratt, Verdolini Abbott, Barkmeier-Kraemer, and Hillman (2009) discussed the development of the Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V). The tool was developed out of conversations of ASHA Special Interest Division 3, Voice and Voice Disorders. SID 3 felt that the field called for a standardized protocol for quantifying perceptual voice quality measures. The CAPE-V tasks consist of sustained vowels (/a/ and /i/), repeated sentences, and conversation. A modified version now includes reading "Goldilocks and the Three Bears" as if reading to children. The productions from these tasks are rated for different qualities (overall severity, roughness, breathiness, strain, pitch, and loudness) by making a tick mark on a 100 mm line. The far left side of the line is considered normal and by measuring with a ruler, the tick mark is given a numerical rating, with a rating of 0 being normal and 100 being severely deviant. The tasks on the CAPE-V serve different purposes. The sustained vowels allow the rater to hear phonation without the interference of articulatory movement. The six sentences each have different consonant/vowel conditions. "The blue spot is on the key again" allows the rater to hear the voice influenced by coarticulation on the vowels /a, i, u/. "How hard did he hit him" allows the rater to listen to soft glottal attacks and the speaker's transition from voiceless to voiced sounds. "We were away a year ago" includes all voiced phonemes. "We eat eggs every Easter" includes multiple vowel initial sounds to listen for glottal attacks. "My mama makes lemon muffins" includes many nasal consonants, while "Peter will keep at the peak" contains no nasals consonants.

Karnell, Melton, Childes, Coleman, Dailey, and Hoffman (2007) found that there is a high level agreement between the "Grade" rating on the GRBAS scale and the "Overall Severity" rating of the CAPE-V. They stated, however, that the CAPE-V is more sensitive to smaller changes. With four raters who worked in the same facility, Karnell et al. (2007) found the overall severity rating of the CAPE-V to reliability rating of greater than .80. Zraick et al. (2011) found that reliability is greater among ASHA certified speech-language pathologists who specialize in working with voice disorders when using the CAPE-V than when using the GRBAS scale. The study gathered 21 raters who listened to 74 samples separated by 3 seconds of silence. Of the samples, 11 were repeated samples and 4 were used for training purposes. All samples were of conversational speech and played to the raters in a free-field. Eleven of the raters rated samples first with the GRBAS and the other ten raters rated samples with the CAPE-V first. Intra-rater reliability on CAPE-V measures ranged from .82 for breathiness to .35 for strain. Inter-rater reliability on CAPE-V measures ranged from .76 for overall severity to .28 for pitch. Fourteen of the twenty-one raters had intra-rater reliability ratings of more than .70 on three of the six CAPE-V categories (breathiness, roughness, and pitch) compared to only eight of the twenty-one raters having greater than .70 intra-rater reliability on at least three GRBAS parameters. When the four comparable measures on the GRBAS and CAPE-V (Grade/Overall Severity, Roughness, Breathiness, and Strain) were compared, inter-rater reliability was slightly higher on CAPE-V measures.

Overall, auditory-perceptual measures are an important aspect of judging vocal quality, especially in disordered voices (Oates, 2009). Despite the importance of these measures, research has shown variability between and within raters, especially on measures of strain. There are many confounding variables that affect the reliability and validity of auditory-perceptual measures, such as listener fatigue, rater training in perceptual measures, type of voice sample, and type of rating scale (Oates, 2009).

Clinical Laboratory Measures

Heuer, Hawkshaw, and Sataloff (2005) discuss one of the key tools in a voice laboratory is the KayPentax computerized speech lab. This program can take a recorded speech sample (such as a sustained /a/) and calculate many acoustic analyses using the MultiDimension Voicing Profile (MDVP) (Heuer, Hawkshaw, & Sataloff, 2005). Among these measures are the fundamental frequency, jitter, shimmer, and frequency range. The fundamental frequency is the number of vibrations per second of the vocal folds. Jitter is a frequency perturbation measure that describes the variability of the fundamental frequency between cycles. Shimmer is an intensity perturbation measure that describes the variability in amplitude of the fundamental frequency between cycles (Jacobson, 1994). Jitter and shimmer can be obtained by sustaining a vowel, such as /a/ for about five seconds. The analog signal delivered to the microphone is converted to a digital signal and analyzed by running the sample through an algorithm that provides the jitter and shimmer measures (Horii, 1980). The frequency range (or maximum phonational range) is the highest and lowest frequency a speaker makes, when elicited by a glide up and down (Jacobson, 1994).

CHAPTER THREE: METHODOLOGY

Participant Voice Training

The data for this study were collected at the beginning and middle of the semester on first year MFA acting students enrolled in THTR: 6150--Vocal Technique at the University of Iowa. This course is a graduate level voice class that all enrolled MFA acting students must take as part of their training. All voice training was conducted in this course via the course instructors, Associate Fitzmaurice Teachers Anne Marie Nest and Kris Danford. The first semester of work in this course was focused on training in Fitzmaurice Voicework®. The course met twice a week for the duration of the Fall semester and each meeting lasted 140 minutes. Some meetings were all voice focused, but meetings were typically split between Fitzmaurice Voicework® and speech work (e.g. International Phonetic Alphabet transcription and text work). This course introduced the entire Fitzmaurice Voicework® destructuring sequence and introduced the basics of restructuring as the semester progressed. Several additional exercises of physical release were taught in the course from other voice training methods, such as Roy Hart and Feldenkrais. The typical structure of voice portion of the course began with floor work (e.g. yoga poses and stretches) on mats, draping over zafus, doing chest or rib opening stretches, and taking time to focus on their breath. After doing these exercises, they would continue to tremor exercises in multiple positions to allow tremors in various parts of the body (e.g. legs, pelvis, or chest) and full sequences, or a structured order of exercises to be done as a warm-up. Students were expected to practice Fitzmaurice Voicework® outside of class time at least three hours a week, increasing to five hours by the end of the semester. At the time of post measures, Restructuring had just been introduced to the graduate actors.

Participants

For the present study, data were collected from six participants (originally eight participants agreed to participate, but two were lost to follow-up). All participants were enrolled in THTR: 6150-Vocal Technique at the University of Iowa. All participants were first year MFA acting students. Participants included four females and two males with an average age of 26.33 years (range: 22-31, SD=3.615). No participant reported speech or language problems, but four of the six reported voice problems of either losing their voice or reflux. Four of the six participants had previous singing training (range: about 6 months to 20 years), with one participant receiving a weekly 30 minute singing lesson during the duration of the study. Four of the six participants had previous training in Fitzmaurice Voicework®, as well as other theatre voice training methods. More specific demographic breakdowns by subject can be seen in the Appendix in Figure A.1 with each subject's individual pre and post measures in Figures A.2-A.7.

Methods

All study measures were collected at the Wendell Johnson Speech and Hearing Center. At the initial visit to the Wendell Johnson Speech and Hearing Center, participants answered several questions related to their voice: "Do you have a history of speech or language problems?", "Have you had any formal singing training? If so, how long?", "Have you had any formal theatre voice training? If so, how long and what method?", "Are you currently taking any voice training lessons other than Theatre 6150? If so, please describe." "Do you have a history of voice problems?" During both visits, each participant completed eight tasks (a) sustained an /a/ for as long as they could three times (Heuer, Hawkshaw, & Sataloff, 2005), (b) sustained an /a/ for 3-5 seconds (Kempster, Gerratt, Verdolini Abbott, Barkmeier-Kraemer, & Hillman, 2009), (c) sustained an /i/ for 3-5 seconds (Kempster, Gerratt, Verdolini Abbott, Barkmeier-Kraemer, & Hillman, 2009), (d) repeated the six CAPE-V sentences (Kempster, Gerratt, Verdolini Abbott, Barkmeier-Kraemer, & Hillman, 2009), (e) read the "Rainbow Passage" (Watson & Nayak, 2015), (f) read "Goldilocks and the Three Bears" as if reading to a group of children, (g) sustained an /a/, (h) glided up to the highest pitch they could produce and then glided down to the lowest pitch they could and then match several pitches within the range and at the extreme ends to verify these pitches being part of their range (Jacobson, 1994). Measure (a) allowed the examiner to obtain maximum phonation time. Measures (b-f) were recorded to be used for CAPE-V perceptual measures. Measures (a, e, f) allowed the examiner to obtain the loudness range for each participant. Measure (g) allowed the KayPENTAX CSL Model 4150B in the MDVP mode to provide fundamental frequency, jitter, shimmer, and noise to harmonic ratio. Measure (h) allowed the KayPENTAX CSL Model 4150B in the Voice Range Profile mode to provide participants' full frequency range.

Measures

Maximum phonation time was taken during task (a). The examiner instructed the participants to "hold out an /a/ for as long as they could at a comfortable pitch and loudness” and then began a stopwatch on his iPhone at the beginning of each sustained /a/ and stopped at the end of the duration of the /a/ and recorded on a sheet of paper. The participant’s highest of the three scores was recorded as their maximum phonation time (Heuer, Hawkshaw, & Sataloff, 2005).

Professor Ann Fennell, an ASHA certified speech-language pathologist who specializes in treating voice disorders, provided CAPE-V measures for recordings of tasks (b) - (f). Each participant’s pre- and post- training performances were included on PowerPoint slides in a randomized order. Fennell recorded her perceptual judgments by making marks on the visual-analogue scale on a CAPE-V record form. The marks were then measured by the examiner and translated into numerical ratings. Six recordings were included twice to check intra-rater reliability (Zraick et al., 2011).

The examiner recorded the participant’s loudness level in dB SPL using a sound pressure level meter placed three feet from the participant’s mouth during tasks (a), (e), and (f). The range was given by taking the highest and lowest reading and an average was taken by summing all readings in a task and dividing by the total number of data points for that task.

For task (g), the sustained /a/ was recorded using the KayPENTAX CSL Model 4150B in the MDVP program with subjects holding a microphone two finger widths from their lips and was elicited as in the previous sustained /a/ tasks. The computer program then analyzed the sound signal and provided measures for fundamental frequency, jitter, shimmer, and noise to harmonic ratio.

For task (h), the participants’ voice glides were recorded using the KayPENTAX CSL Model 4150B in the Voice Range Profile Mode. The computer program then analyzed the sound signal and provided the participant's highest and lowest note produced and the semitone range.

CHAPTER FOUR: RESULTS

The results will be discussed in three sections. First, the statistical findings for the full subject group will be discussed. Second, raw pre-post difference trends for the full subject group will be discussed by measure: maximum phonation time, loudness range and average, fundamental frequency and vocal range, jitter, shimmer, and NHR, and CAPE-V measures. Finally, raw pre-post difference trends by demographic category will be discussed by measure: maximum phonation time, loudness range and average, fundamental frequency and vocal range, jitter, shimmer, and NHR, and CAPE-V measures.

Group Results: Statistical Findings

Paired t-tests were run for each measure for the full sample of participants. No changes between pre and post testing were statistically significant for the subjects as a whole, as can be expected with the small sample size. Results are presented in Table 1. Despite not being statistically significant, the raw pre-post difference trending scores for the group are discussed below.

	Pre Average	Post Average	*t*	*p*
MPT Avg.	12.955 seconds	11.935 seconds	-0.6291	0.5569
dB MPT Avg.	71.025 dB	72.065 dB	0.4955	0.6412
dB Rainbow Avg.	68.815 dB	69.655 dB	1.0304	0.3501
dB 3 Bears Avg.	71.065 dB	73.623 dB	2.227	0.0765
Fundamental Freq.	187.49 Hz	199.4005 Hz	2.0823	0.0918
Jitter	0.5845	0.6943	0.5587	0.6005
Shimmer	2.996	3.3935	0.4253	0.6883
NHR	0.116	0.124	0.7469	0.4887
Semitone Range	34.33	34.33	0	1
CAPE-V Overall	13.667	14.25	0.2158	0.8377
CAPE-V Roughness	12.25	14.083	0.6689	0.5332
CAPE-V Breathiness	0	0	0	1
CAPE-V Strain	0.333	0.833	1.4639	0.2031
CAPE-V Pitch	0.083	0.333	1	0.3632
CAPE-V Loudness	0.5	0.417	-0.1832	0.8618

Table 1.1 p-values for All Variables were p>.05, Indicating Changes Overall were Not Statistically Significant

Group Results: Raw Difference Trends

Due to the small sample size, raw differences of the pre-post scores were examined for the sample. There was a large amount of variability in performance across subjects. For individual subject measures, see Figures 1.1-1.6 in the Appendix.

Change in Maximum Phonation Time

The average change in maximum phonation time was -1.02 seconds (range: -6.71 to 4.36 seconds), which goes against our hypothesized increase of maximum phonation time. However, 50% of the subjects increased their MPT as expected (range: 0.13 to 4.36 seconds), however the other 50% showed a decreased MPT (range: -0.47 to -6.71s).

Change in Loudness Range and Average

The average change in average dB level for MPT was 1.04 dB (range: -6.94 to 6.16dB) with an average change in the dB range of -2dB (range: -11 to 3dB). For the average dB level of MPT, 67% increased their loudness and 50% decreased the range of dB levels showing more stability in the sustained /a/. This would be expected with voice training, as the overall increase in dB would be expected with training and the decrease in range would show less variability during the sustained vowel.

The average change in average dB level for the Rainbow Passage was 0.84dB (range: -2.18 to 3.11dB), with an average change in dB range of 1.83dB (range: 0 to 6dB). For the average dB level during the Rainbow Passage, 67% increased their loudness and 67% increased the range of dB levels showing some increased expressivity in terms of loudness for this reading passage, as was hypothesized.

The average change in average dB level for the Three Bears reading passage was 2.55833dB (range: 0.32 to 7.85dB), with an average change in dB range of 1.3333dB (range: -1 to 5dB). For the average dB level during the Three Bears reading, 100% increased their loudness and 50% increased the range of dB levels showing more expressivity during this performance style reading passage. The increased loudness is expected, as this is a more performance based task, however, it was hypothesized that there would be more change in the dB range in the Three Bears passage than the Rainbow Passage, as it was more of a performance passage, requiring increased expressivity.

Change in Fundamental Frequency and Vocal Range

The average change in fundamental frequency was 11.9105Hz (range: -6.507 to 29.77Hz). For fundamental frequency, 83% of subjects showed an increase in habitual pitch on sustained /a/. It was hypothesized, based on anecdotal reports that there would be a decrease in fundamental frequency, which was not seen in a majority of subjects. The average change in vocal range was 0 semitones (-6 to 6 semitones), with an average change in maximum frequency produced of -6.0466Hz (range: -186.89 to 294.66Hz) and an average change in minimum frequency produced of 1.335 (range: -8.73 to 24.75Hz). These averages show a decrease in the maximum frequency produced and an increase in the minimum frequency produce, implying a potential loss of range. In terms of vocal range, 50% of subjects showed an increase in their maximum pitch, 50% showed a decrease in their minimum pitch, and 50% showed an increase in overall range. Only half of the participants showed the hypothesized increase in range that Fitzmaurice claims.

Change in Jitter, Shimmer, and NHR

The average change in jitter was 0.109833 (range: -0.401 to 0.944). The average change in shimmer was 0.397167 (range: -2.379 to 4.49). The average change in noise to harmonic ratio was 0.008166 (range: -0.015 to 0.057). For jitter, shimmer, and noise to harmonic ratio, 50% of subjects showed an increase on these measures. It was hypothesized that a decrease would be seen in these measures.

CAPE-V Intra-rater Reliability

Intra-rater reliability was determined for the six samples that were included twice. Ratings were counted as in agreement if they were within 2 points between both rating forms on the 100 point scale. In terms of ratings on the full CAPE-V, intra-rater agreement was at 88.89%. For the Overall rating and Roughness rating, intra-rater agreement was at 66.67%. For Breathiness, Strain, Pitch, and Loudness ratings, intra-rater agreement was 100%.

Change in CAPE-V Measures

In terms of perceptual measures on the CAPE-V, a decrease in rating shows a move towards normal vocal quality. The average pre CAPE-V ratings were as follows: Overall 13.667 (range: 0-30), Roughness 12.25 (range: 0 to 28), Breathiness 0 (range: 0), Strain 0.333 (range: 0-2), Pitch 0.083 (range: 0-0.5), and Loudness 0.5 (range: 0-2). The average post CAPE-V ratings were as follows: Overall 14.25 (range: 0-24), Roughness 14.083 (range: 0-24), Breathiness 0 (range: 0), Strain 0.833 (range: 0-4), Pitch 0.333 (range: 0-2), and Loudness 0.417 (range: 0-1.5). The average change in CAPE-V ratings was as follows: Overall 0.583 (range: -7.5 to 8), Roughness 1.833 (range: -6.5 to 10), Breathiness 0 (Range: 0), Strain 0.5 (range: 0-2), Pitch 0.25 (range: 0-1.5), and Loudness -0.083 (range: -2 to 1.5). For the Overall rating, 33% of subjects showed a decrease, however 50% showed an increase on this measure. For the Roughness rating, 33% showed a decrease, however 50% showed an increase on this measure. No change was noted in Breathiness ratings across all subjects, as no breathiness was found present in any sample. For the Strain rating, 33% of subjects increased in this measure. For the

Pitch rating, 17% of subjects showed an increase on this measure. For the Loudness rating, 17% of subjects showed an increase and 17% of subjects showed a decrease on this measure. These findings are not consistent with our hypothesis, as the average change was expected to be a negative number (or zero) on all measures to show that they are moving closer to zero, or within normal limits.

The most important measure in terms of Fitzmaurice's claims was strain. There was not a large amount of strain noted in the samples overall, and when it was noted, it was typically during the Baby Bear voice of the Three Bears passage. However, the vocal quality feature that was most noted in the samples was roughness, which affected overall ratings as well. This roughness was characterized by glottal fry, specifically at the ends of phrases. Glottal fry was noted in the pre and post measures of five of the six participants.

Individual Results by Participant Characteristics: Raw Difference Trends

Raw differences for the pre-post averages for females (N=4), males (N=2), singers (N=4), non-singers (N=2), previous theatre voice experience (N=4), no previous theatre voice experience (N=2), history of voice problems (N=4), and no history of voice problems (N=2) were examined for each measure. The following discusses the directional trends related to the varying subgroups.

Changes in Maximum Phonation Time

For maximum phonation time, the previous theatre voice training and no voice problems subgroups increased their MPT as expected, however the other subgroups showed a decreased MPT. Averages and differences for each demographic category can be found in Table 2.1.

MPT	Pre (seconds)	Post (seconds)	Difference (seconds)
Total	12.955	11.935	-1.02
Females	11.76	8.53825	-3.22175
Males	15.345	14.17	-1.175
Singers	13.0075	12.5575	-0.45
Non-Singers	12.85	10.69	-2.16
Theatre Voice	12.115	12.38	0.265
No-Theatre Voice	14.635	11.045	-3.59
Voice Problems	12.9625	10.46	-2.5025
No-Voice Problems	12.94	14.885	1.945

Table 2.1 Maximum Phonation Time Averages and Raw Differences Among Subgroups in Seconds

Changes in Loudness Range and Average

For the average dB level of MPT, all subgroups increased their loudness except for the singers, no previous theatre voice training, and no voice problems subgroups and all subgroups, except for the gender subgroups decreased the range of dB levels showing more stability in the sustained /a/. For the average dB level during the Rainbow Passage, all subgroups except for the no previous theatre voice training increased their loudness and all subgroups increased the range of dB levels showing some increased expressivity in terms of loudness for this reading passage. For the average dB level during the Three Bears reading, all subgroups increased their loudness and all subgroups except for the history of voice problems increased the range of dB levels showing more expressivity during this performance style reading passage. Averages and differences for each demographic category can be found in Tables 2.2-2.4.

dB Average MPT	Pre (dB)	Post (dB)	Range Difference (dB)	Avg. Difference (dB)
Total	71.025	72.065	-2	1.04
Females	71.9475	72.235	-3.75	0.2875
Males	69.18	71.725	1.5	2.545
Singers	72.5175	71.2875	0.25	-1.23
Non-Singers	68.04	73.62	-6.5	5.58
Theatre Voice	66.535	68.7925	-2	2.2575
No-Theatre Voice	80.005	78.61	-1	-1.395
Voice Problems	69.035	72.095	-2.25	3.06
No-Voice Problems	75.005	72.005	-1.5	-3

Table 2.2 dB Level Averages and Raw Difference for dB Level of Maximum Phonation Time Among Subgroups

dB Average Rainbow	Pre (dB)	Post (dB)	Range Difference (dB)	Avg. Difference (dB)
Total	68.815	69.655	1.83	0.84
Females	69.635	69.87	2.25	0.235
Males	67.175	69.24	1	2.065
Singers	68.4375	68.725	2	0.2875
Non-Singers	69.57	71.53	1.5	1.96
Theatre Voice	67.6125	68.99	0.75	1.3775
No-Theatre Voice	71.22	71	4	-0.22
Voice Problems	68.92	70.135	1.25	1.215
No-Voice Problems	68.605	68.71	3	0.105

Table 2.3 dB Level Averages and Raw Difference for dB Level of Rainbow Passage Among Subgroups

dB Average 3 Bears	Pre (dB)	Post (dB)	Range Difference (dB)	Avg.Difference (dB)
Total	71.065	73.623	1.333	2.558
Females	72.0125	73.435	1	1.4225
Males	68.95	74.18	2	5.23
Singers	71.09	73.8775	2	2.7875
Non-Singers	70.795	73.295	0	2.5
Theatre Voice	68.965	72.3675	0.75	3.4025
No-Theatre Voice	75.045	76.315	2.5	1.27
Voice Problems	71.16	73.0325	-0.25	1.8725
No-Voice Problems	70.655	74.985	4.5	4.33

Table 2.4 dB Level Averages and Raw Difference for dB Level of Three Bears Among Subgroups

Changes in Fundamental Frequency and Vocal Range

For fundamental frequency, all subgroups showed an increase in habitual pitch on sustained /a/. In terms of vocal range, the male, singer, no previous theatre voice training, and no voice problems subgroups showed an increase in their maximum pitch, the singers, no previous theatre voice training, and no voice problems subgroups showed a decrease in their minimum pitch, and the male, singers, no previous theatre voice training, and no voice problems subgroups showed an increase in overall range. Averages and differences for each demographic category can be found in Tables 2.5-2.6.

Average Fundamental Freq.	Pre (Hz)	Post (Hz)	Average Difference (Hz)
Total	187.49	199.4005	11.9105
Females	226.14	238.71575	12.57575
Males	110.19	120.77	10.58
Singers	159.485	170.59075	11.10575
Non-Singers	243.5	257.02	13.52
Theatre Voice	201.82	207.19575	5.37575
No-Theatre Voice	158.83	183.81	24.98
Voice Problems	200.335	210.51575	10.18075
No-Voice Problems	161.8	177.17	15.37

Table 2.5 Fundamental Frequency Averages and Raw Difference Among Subgroups in Hz

Semitone Range	Pre (Hz and semitones)	Post (Hz and semitones)	Difference (semitones)
Total	115.878-843.593 (34.33 semitones)	117.213-837.5467 (34.33 semitones)	0
Females	139.1675-1003.3275 (34 semitones)	141.1125-962.165 (33 semitones)	-1
Males	69.30-524.125 (35 semitones)	69.415-588.31 (37 semitones)	2
Singers	110.2475-775.7275 (34 semitones)	106.0625-834.7625 (36 semitones)	2
Non-Singers	127.14-979.325 (35 semitones)	139.515-843.115 (31 semitones)	-4
Theatre Voice	117.6025-921.92 (35.5 semitones)	122.76-824.0625 (33.25 semitones)	-2.25
No-Theatre Voice	112.43-686.94 (32 semitones)	106.12-864.515 (36.5 semitones)	4.5
Voice Problems	117.6025-906.7975 (35 semitones)	120.7575-807.0925 (33.25 semitones)	-1.75
No-Voice Problems	112.43-717.185 (33 semitones)	110.125-898.455 (36.5 semitones)	3.5

Table 2.6 Semitone Range Averages and Raw Difference Among Subgroups in Hz and Semitones

Jitter, Shimmer, and NHR

For jitter, all subgroups showed an increase except for the previous theatre voice and no voice problems subgroups. For shimmer, all subgroups showed an increase except for the no previous theatre voice training and history of voice problems subgroups. For noise to harmonic ratio, all subgroups except for the non-singer and no previous theatre voice training subgroups showed an increase on these measures. Averages and differences for each demographic category can be found in Tables 2.7-2.9.

Average Jitter	Pre	Post	Difference
Total	0.5845	0.6943	0.1098
Females	0.52025	0.54925	0.029
Males	0.713	0.9845	0.2715
Singers	0.6625	0.79975	0.13725
Non-Singers	0.4285	0.4835	0.055
Theatre Voice	0.57275	0.569	-0.00375
No-Theatre Voice	0.608	0.945	0.337
Voice Problems	0.50775	0.84025	0.3325
No-Voice Problems	0.738	0.4025	-0.3355

Table 2.7 Jitter Averages and Raw Difference Among Subgroups

Average Shimmer	Pre	Post	Difference
Total	2.996	3.3935	0.3975
Females	2.54875	2.61675	0.068
Males	3.8915	4.947	1.0555
Singers	3.2295	3.74275	0.51325
Non-Singers	2.53	2.695	0.165
Theatre Voice	2.5495	3.60525	1.05575
No-Theatre Voice	3.89	2.97	-0.92
Voice Problems	3.08725	2.42575	-0.6615
No-Voice Problems	2.8145	5.329	2.5145

Table 2.8 Shimmer Averages and Raw Difference Among Subgroups

Average NHR	Pre	Post	Difference
Total	0.116	0.124	0.008
Females	0.104	0.1145	0.0105
Males	0.1405	0.144	0.0035
Singers	0.12	0.1355	0.0155
Non-Singers	0.1085	0.102	-0.0065
Theatre Voice	0.10725	0.123	0.01575
No-Theatre Voice	0.134	0.127	-0.007
Voice Problems	0.114	0.122	0.008
No-Voice Problems	0.1205	0.129	0.0085

Table 2.9 Noise to Harmonics Ratio Averages and Raw Difference Among Subgroups

CAPE-V Measures

In terms of perceptual measures on the CAPE-V, a decrease in rating shows a move towards normal vocal quality. For the Overall rating, males, non-singers, and the history of voice problems subgroups showed a decrease on this measure. For the Roughness rating, males and non-singers showed a decrease on this measure. No change was noted in Breathiness ratings across all subgroups, as no breathiness was found present in any sample. For the Strain rating, only males (who were rated as normal) showed the expected decrease or normal rating. For the Pitch rating, males, non-singers, previous theatre voice training, and history of voice problems subgroups showed a decrease on this measure. For the Loudness rating, total population, females, singers, no previous theatre voice training, and no voice problems subgroups showed a decrease on this measure. Averages and differences for each demographic category can be found in Tables 2.10-2.15.

CAPE-V Overall Rating Avg	Pre	Post	Difference
Total	13.667	14.25	0.583
Females	18.5	21.25	2.75
Males	4	0.25	-3.75
Singers	8	10.125	2.125
Non-Singers	25	22.5	-2.5
Theatre Voice	15.5	16.25	0.75
No-Theatre Voice	10	10.25	0.25
Voice Problems	17.5	16.375	-1.125
No-Voice Problems	6	10	4

Table 2.10 CAPE-V Overall Ratings Averages and Raw Difference Among Subgroups

CAPE-V Roughness Rating Avg	Pre	Post	Difference
Total	12.25	14.083	1.833
Females	16.25	20.625	4.375
Males	4.25	1	-3.25
Singers	6.875	10	3.125
Non-Singers	23	22.25	-0.75
Theatre Voice	13.5	15.625	2.125
No-Theatre Voice	9.75	11	1.25
Voice Problems	15.625	16.125	0.5
No-Voice Problems	5.5	10	4.5

Table 2.11 CAPE-V Roughness Ratings Averages and Raw Difference Among Subgroups

CAPE-V Breathiness Rating Avg	Pre	Post	Difference
Total	0	0	0
Females	0	0	0
Males	0	0	0
Singers	0	0	0
Non-Singers	0	0	0
Theatre Voice	0	0	0
No-Theatre Voice	0	0	0
Voice Problems	0	0	0
No-Voice Problems	0	0	0

Table 2.12 CAPE-V Breathiness Ratings Averages and Raw Difference Among Subgroups

CAPE-V Strain Rating Avg	Pre	Post	Difference
Total	0.333	0.833	0.5
Females	0.5	1.25	0.75
Males	0	0	0
Singers	0.5	1	0.5
Non-Singers	0	0.5	0.5
Theatre Voice	0	0.25	0.25
No-Theatre Voice	1	2	1
Voice Problems	0	0.25	0.25
No-Voice Problems	1	2	1

Table 2.13 CAPE-V Strain Ratings Averages and Raw Difference Among Subgroups

CAPE-V Pitch Rating Avg	Pre	Post	Difference
Total	0.083	0.333	0.25
Females	0.125	0.5	0.375
Males	0	0	0
Singers	0.125	0.5	0.375
Non-Singers	0	0	0
Theatre Voice	0	0	0
No-Theatre Voice	0.25	1	0.75
Voice Problems	0	0	0
No-Voice Problems	0.25	1	0.75

Table 2.14 CAPE-V Pitch Ratings Averages and Raw Difference Among Subgroups

CAPE-V Loudness Rating Avg	Pre	Post	Difference
Total	0.5	0.417	-0.083
Females	0.75	0.25	-0.5
Males	0	0.75	0.75
Singers	0.5	0.375	-0.125
Non-Singers	0.5	0.5	0
Theatre Voice	0.25	0.625	0.375
No-Theatre Voice	1	0	-1
Voice Problems	0.25	0.25	0
No-Voice Problems	1	0.75	-0.25

Table 2.15 CAPE-V Loudness Ratings Averages and Raw Difference Among Subgroups

CHAPTER FIVE: DISCUSSION

Statistical analysis did not yield significant results, yet the raw data note some form of change in varying direction based on the subject. While the small sample size made it highly unlikely that significant results would be possible, the minor changes within subjects should not be fully dismissed. In a population that relies on the voice for their livelihood and employment, even a small change may be "significant" to the individual. A minute decrease in vocal ability could feel almost debilitating to someone whose profession demands peak performance and the same could be said about a minimal increase in vocal ability being the subtle difference between just having a great audition and actually getting the part.

Despite not producing statistically significant changes on any of the measures studied and including noted variability between subjects, several trends can be seen when looking at the raw differences of pre and post performance. First, we discuss the potential effects on maximum phonation time. Second, we discuss the potential effects on loudness range and average. Third, we discuss the potential effects on fundamental frequency and vocal range. Fourth, we discuss the potential effects on jitter, shimmer, and NHR. Finally, we discuss the potential effects on perceptual CAPE-V measures. After the potential effects are discussed, we discuss the limitations to the current study, followed by directions for future research.

Potential Effects of Fitzmaurice Voicework®

Maximum Phonation Time

Before the observed changes in maximum phonation time are discussed, it should be noted that pre and post measures for maximum phonation time were below, the average norms for healthy adults for a majority of data points. This could potentially be due to the concept of conserving energy and using minimal effort that was consistently being discussed with the actors. Due to this concept of using minimal effort and the instruction given to use "a comfortable pitch and loudness", it is possible that despite being asked to sustain an /a/ for as long as they could, actors may have cut off early to conserve energy. It was hypothesized that maximum phonation time would increase with training in Fitzmaurice Voicework®, as was seen by Watson and Nayak (2015). Despite an increase only being present in 50% of the subjects, it is possible to hypothesize that maximum phonation time may increase more often in individuals with previous theatre voice training and individuals without a history of voice problems after training with Fitzmaurice Voicework®. For those who have had previous theatre voice training, this change may be due to the advancement of previously established skills from previous voice training. For those without a history of voice problems, the increase may be attributed to the vocal system functioning efficiently with the absence of voice problems. It was noted in the demographics of the subjects that four of the six participants reported some history of voice problems. While actors are at a higher risk for developing voice problems due to the increased use of their voice, to fully maximize the effect of voice training, eliminating potential pathologies prior to training appears to be more efficacious in terms of the habilitation, such as increasing maximum phonation time, that is expected to be provided through voice training.

Loudness Range and Average

Fizmaurice claims that after training, actors exhibit more expressivity in their voice. One hypothesized form of increased expressivity was a more diverse loudness range in the Three Bears reading passage, as it was the closest task to a theatrical performance. While all participants showed an increase in the average loudness level for the Three Bears reading passage, only half of participants showed an increase in loudness range. However, when broken into demographic categories, the only group that did not show an increased loudness range on the Three Bears passage was those participants with a history of voice problems. So similar to the previous hypothesized effects of training on maximum phonation time, to increase the expressivity in the voice in terms of loudness range, it is also important to try and eliminate potential pathologies prior to training.

Fundamental Frequency and Vocal Range

Based on anecdotal reports, it was hypothesized that there would be a decrease in fundamental frequency after training with Fitzmaurice Voicework®. However, to the contrary, 83% of participants showed an increase in fundamental frequency after training. Fitzmaurice claims that after training, actors exhibit more expressivity in their voice. One hypothesized form of increased expressivity was the ability to produce a larger range of frequencies. An increased frequency range was noted in 50% of participants and may be more noticeable in males, singers, individuals without previous theatre voice training, and individuals without a history of voice problems after training with Fitzmaurice Voicework®. In males, this change may be due to males beginning with a less expressive range. In singers, this change may be related to singers already increasing the demands on their vocal range by music calling for a larger vocal range than speaking. For individuals without previous theatre voice training, it would be logical to assume that learning techniques and methods that are intended to increase the abilities of the voice when there was no previous knowledge on the subject would produce a positive outcome. For individuals without a history of voice problems, this change can come from the vocal system functioning efficiently with the absence of voice problems. This finding, again, matches with the findings for the effect of training on maximum phonation time and average loudness and loudness range, in that, it appears that it is more efficacious to habilitate a voice that is without pathology.

Jitter, Shimmer, and NHR

It was hypothesized that there would be a decrease in measures of jitter, shimmer, and NHR. Watson and Nayak (2015) saw a decrease in the raw difference of shimmer, but relatively no change in jitter and NHR. In the present study, an increase was seen in 50% of subjects on each of these measures. For jitter, the measure of frequency perturbation, all subgroups showed an increase except for the previous theatre voice and no voice problems subgroups. Like previous effects, this could be explained as expanding upon previous skills and working with a non-pathologic vocal system. For shimmer, the measure of amplitude perturbation, all subgroups showed an increase except for the no previous theatre voice training and history of voice problems subgroups. This finding does not coincide with Watson and Nayak (2015) and does not have an obvious physiological explanation, so it is most likely due to chance and the small sample size. For noise to harmonic ratio, all subgroups except for the non-singer and no previous theatre voice training subgroups showed an increase on these measures. This finding also does not have an obvious physiological explanation, so it is most likely due to chance and the small sample size.

CAPE-V Measures

Fitzmaurice claims that training with Fitzmaurice Voicework® will decrease strain in the actor's voice. It was hypothesized that after training, actors would show a decrease across vocal qualities approaching a normal voice. To the contrary, the averages for the full sample showed an increase in all CAPE-V ratings, except for Breathiness (which was within normal limits for all participants) and Loudness (which showed a slight decrease towards more normal). However, it should be noted that in all cases the change in measures was relatively negligible, in that all changes were less than 2 points on the 100 point scale. Strain was not that prevalent in pre or post measures for the participants, however there was notable roughness in some of the participants. It was also noted that glottal fry was present at the end of phrases of five of the six participants, even after training. A decrease in abnormal voice quality on perceptual measures may be more noticeable in males, non-singers, and individuals with a history of voice problems after training with Fitzmaurice Voicework®. This change in males may be due to males having a less demanding fundamental pitch (less cycles per second) than females. This less demanding pitch puts the male at a lower risk of developing an abnormal vocal quality or pathology, despite the extended voice use of acting. The decrease in abnormal vocal qualities of non-singers may be related to non-singers having less demanding vocal use than singers, putting them at lower risk of developing an abnormal voice quality or pathology, despite the extended voice use of acting. Having a history of voice problems allows the largest change possible on CAPE-V measures, as they are beginning with a voice that is starting off as abnormal. These measures are the only measures that appear to have a positive effect for actors with a history of voice problems. Despite this change being present, it still appears to be more advisable to try and eliminate abnormality and potential pathology prior to attempting to habilitate the voice with theatre voice training.

When these trends are combined, the most notable message that can be concluded from the findings is that Fitzmaurice Voicework® is more beneficial when there is a negative history for voice problems. Due to the vocal demands on an actor, they are at a greater risk for developing pathologies, so it is understandable that four of the six participants noted some history of voice problems. However, the trends in this study make a case that voice training appears to be more beneficial when pathologic tendencies are not present. Due to this finding, it would be beneficial for incoming graduate actors to undergo a voice evaluation to determine if they have a potential pathology that should be addressed by the appropriate medical professionals (e.g. a speech-language pathologist or otolaryngologist) prior to/or in conjunction with their theatre voice training, so the theatre voice training is more efficient.

Limitations

There are many limitations to this study. The most important limitation to note is the timeline for the study. The timeline did not allow a lot of time for the actors to make significant changes, as was noted by Fitzmaurice Voicework® professors. Also, with the course beginning with Destructuring and then only adding Restructuring as the semester progressed, the students had very little training in Restructuring before their post measures were taken. With this is mind, the study was more so a look at Destructuring, rather than Fitzmaurice Voicework® as a whole.

Another limitation is that the time of day for pre and post measures was not consistent for each subject. Subjects were not required to warm-up with their Fitzmaurice Voicework® warm-up before taking post measures, as it was intended to measure if there was an overall change in voice with the theatre voice training. Subjects were also not required to track how much they practiced outside of class time, as it was assumed they would be practicing on their own. They were also not required to track what else could be affecting their vocal production. While data was not collected for all participants, it was noted that subject 3's post measures were collected in the evening, after she had day of classes and had just finished teaching an acting course. The subject had also just finished the run of production the week prior to post measures and had noted during pre measure collection that she often experiences loss of her voice around the time of productions. With this in mind, this subject's post measures could have been greatly affected by this other, non-tracked, factors and the same could be said for other subjects as well.

In terms of data collection, the microphone used for the CAPE-V recordings included a lot of background noise which did not remain constant across recordings. The quality of this microphone also included too much noise to allow additional information to be taken from these recordings using other software.

Future Direction for Research

Future research on Fitzmaurice Voicework® is warranted as there is little research on the technique, but many theatre practitioners use it and have found benefits to it. One way future research could be beneficial is to follow the MFA actors over their three year program and intermittently take measures. Another way is to take measures immediately after the Theatre Voice class concludes, as everyone will have had the same warm-up. Measures could also be taken at varying lengths of time after the course to see how long the effect of a warm-up lasts on the voice (which would be beneficial in determining if it will sustain an actor through a performance and if it would be a potential method of rehabilitation for disordered voices). It could also be beneficial to do perceptual ratings in a theatre during rehearsals with Fitzmaurice Voicework® teachers and at times have them complete their warm-up and other times go on cold to see if there is a noticeable perceptual difference by an SLP in the audience. It would also be beneficial to have theatre voice practitioners rate the voice as well to see if the theatre professionals and speech-language pathologists are listening for similar things. Qualitative research with students about their perceived benefits from completing Fitzmaurice Voicework® exercises could also provide insight for future research.

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APPENDIX

Subjects	Gender	History of Voice Problems	Singing Training	Theatre Voice Training	Additional Voice Lessons
1	F	Occasional loss of voice from shouting, sore throats	No	Yes, 1 semester Fitzmaurice	No
2	F	Reflux	Yes, 20 years	Yes, 4 years, Linklater and musical theatre voice	Yes, 30min 1x/wk
3	F	Loses voice around seasonal changes and before a show opens	No	Yes, 1 year Fitzmaurice	No
4	M	GERD-9 years ago but controlled for past 3-4 years, infrequent PPIs	Yes, 6 months	No	No
5	M	No	Yes, 1 year	Yes, 5 years, Fitzmaurice, Alexander, Linklater	No
7	F	No	Yes, 2 years	No	No

Figure A.1 Demographic Breakdown by Subject

Subject 001	Pre	Post	Difference
MPT	9.00 seconds	9.13 seconds	.13 seconds
dB MPT avg	67 dB	72 dB	5 dB
dB MPT range	65-70 dB	70-73 dB	-2 dB
dB Rainbow Avg	66.08 dB	66.89 dB	.81 dB
dB Rainbow Range	65-68 dB	65-70 dB	2 dB
dB 3 Bears Avg	66.77 dB	68.52 dB	1.75 dB
dB 3 Bears Range	60-72 dB	63-76 dB	1 dB
Avg Fundamental	252.85 Hz	258.31 Hz	5.46 Hz
Jitter	0.37	0.536	0.166
Shimmer	2.275	2.981	0.706
NHR	0.106	0.108	0.002
Max Range	783.99 Hz	698.46 Hz	-85.53 Hz
Min Range	123.47 Hz	123.47 Hz	0
Semitones in Range	32 semitones	30 semitones	-2 semitones
CAPE-V			
Overall	30	24	-6
Roughness	28	24	-4
Breathiness	0	0	0
Strain	0	0	0
Pitch	0	0	0
Loudness	0	0	0

Figure A.2 Raw Data for Subject 001

Subject 002	Pre	Post	Difference
MPT	9.11 seconds	10.13 seconds	1.02 seconds
dB MPT avg	65.88 dB	62.81 dB	-3.07 dB
dB MPT range	65-68 dB	59-65 dB	3 dB
dB Rainbow Avg	66.75 dB	65.92 dB	-.83 dB
dB Rainbow Range	63-69 dB	63-69 dB	0 dB
dB 3 Bears Avg	69.71 dB	70.03 dB	.32 dB
dB 3 Bears Range	62-78 dB	62-77 dB	-1 dB
Avg Fundamental	207.12 Hz	200.613 Hz	-6.507 Hz
Jitter	0.591	0.867	0.276
Shimmer	2.322	1.725	-0.597
NHR	0.085	0.142	0.057
Max Range	1174.66 Hz	987.77 Hz	-186.89
Min Range	146.83 Hz	138.59 Hz	-8.24
Semitones in Range	36 semitones	34 semitones	-2 semitones
CAPE-V			
Overall	12	20	8
Roughness	8	18	10
Breathiness	0	0	0
Strain	0	0	0
Pitch	0	0	0
Loudness	0	0	0

Figure A.3 Raw Data for Subject 002

Subject 003	Pre	Post	Difference
MPT	16.70 seconds	12.25 seconds	-4.45 seconds
dB MPT avg	69.08 dB	75.24 dB	6.16 dB
dB MPT range	62-79 dB	72-78 dB	-11 dB
dB Rainbow Avg	73.06 dB	76.17 dB	3.11 dB
dB Rainbow Range	70-76 dB	72-79 dB	1 dB
dB 3 Bears Avg	74.82 dB	78.07 dB	3.25 dB
dB 3 Bears Range	66-82 dB	71-86 dB	-1 dB
Avg Fundamental	234.15 Hz	255.73 Hz	21.58 Hz
Jitter	0.487	0.431	-0.056
Shimmer	2.785	2.409	-0.376
NHR	0.111	0.096	-0.015
Max Range	1174.66 Hz	987.77 Hz	-186.89 Hz
Min Range	130.81 Hz	155.56 Hz	24.75 Hz
Semitones in Range	38 semitones	32 semitones	-6 semitones
CAPE-V			
Overall	20	21	1
Roughness	18	20.5	2.5
Breathiness	0	0	0
Strain	0	1	1
Pitch	0	0	0
Loudness	1	1	0

Figure A.4 Raw Data for Subject 003

Subject 004	Pre	Post	Difference
MPT	17.04 seconds	10.33 seconds	-6.71 seconds
dB MPT avg	74.18 dB	78.33 dB	4.15 dB
dB MPT range	72-77 dB	75-81 dB	1 dB
dB Rainbow Avg	69.79 dB	71.53 dB	1.74 dB
dB Rainbow Range	68-72 dB	68-74 dB	2 dB
dB 3 Bears Avg	73.34 dB	75.15 dB	1.81 dB
dB 3 Bears Range	66-81 dB	68-83 dB	0 dB
Avg Fundamental	107.22 Hz	127.41 Hz	20.19 Hz
Jitter	0.583	1.527	0.944
Shimmer	4.967	2.588	-2.379
NHR	0.154	0.142	-0.012
Max Range	493.88 Hz	554.37 Hz	60.49 Hz
Min Range	69.30 Hz	65.41 Hz	-3.89 Hz
Semitones in Range	34 semitones	37 semitones	3 semitones
CAPE-V			
Overall	8	0.5	-7.5
Roughness	8.5	2	-6.5
Breathiness	0	0	0
Strain	0	0	0
Pitch	0	0	0
Loudness	0	0	0

Figure A.5 Raw Data for Subject 004

Subject 005	Pre	Post	Difference
MPT	13.65 seconds	18.01 seconds	4.36 seconds
dB MPT avg	64.18 dB	65.12 dB	.94 dB
dB MPT range	60-68 dB	61-71 dB	2 dB
dB Rainbow Avg	64.56 dB	66.95 dB	2.39 dB
dB Rainbow Range	61-68 dB	64-71 dB	0 dB
dB 3 Bears Avg	65 dB	72.85 dB	7.85 dB
dB 3 Bears Range	59-74 dB	64-83 dB	4 dB
Avg Fundamental	113.16 Hz	114.13 Hz	.97 Hz
Jitter	0.843	0.442	-0.401
Shimmer	2.816	7.306	4.49
NHR	0.127	0.146	0.019
Max Range	554.37 Hz	622.25 Hz	67.88 Hz
Min Range	69.30 Hz	73.42 Hz	4.12 Hz
Semitones in Range	36 semitones	37 semitones	1 semitone
CAPE-V			
Overall	0	0	0
Roughness	0	0	0
Breathiness	0	0	0
Strain	0	0	0
Pitch	0	0	0
Loudness	0	1.5	1.5

Figure A.6 Raw Data for Subject 5

Subject 007	Pre	Post	Difference
MPT	12.23 seconds	11.76 seconds	-0.47 seconds
dB MPT avg	85.83 dB	78.89 dB	-6.94 dB
dB MPT range	81-91 dB	76-81 dB	-5 dB
dB Rainbow Avg	72.65 dB	70.47 dB	-2.18 dB
dB Rainbow Range	70-76 dB	65-77 dB	6 dB
dB 3 Bears Avg	76.75 dB	77.12 dB	.37 dB
dB 3 Bears Range	67-89 dB	67-94 dB	5 dB
Avg Fundamental	210.44 Hz	240.21 Hz	29.77 Hz
Jitter	0.633	0.363	-0.27
Shimmer	2.813	3.352	0.539
NHR	0.114	0.112	-0.002
Max Range	880.00 Hz	1174.66 Hz	294.66 Hz
Min Range	155.56 Hz	146.83 Hz	-8.73 Hz
Semitones in Range	30 semitones	36 semitones	6 semitones
CAPE-V			
Overall	12	20	8
Roughness	11	20	9
Breathiness	0	0	0
Strain	2	4	2
Pitch	0.5	2	1.5
Loudness	2	0	-2

Figure A.7 Raw Data for Subject 007