

2018-01-01

Changes In Fundamental Frequency Of Voice In A Group Of Transwomen Following Voice Modification Therapy

Emily Marquez

University of Texas at El Paso, emdalt55@gmail.com

Follow this and additional works at: https://digitalcommons.utep.edu/open_etd

 Part of the [Health and Medical Administration Commons](#), [Other Education Commons](#), [Speech and Hearing Science Commons](#), and the [Speech Pathology and Audiology Commons](#)

Recommended Citation

Marquez, Emily, "Changes In Fundamental Frequency Of Voice In A Group Of Transwomen Following Voice Modification Therapy" (2018). *Open Access Theses & Dissertations*. 1477.
https://digitalcommons.utep.edu/open_etd/1477

CHANGES IN FUNDAMENTAL FREQUENCY
OF VOICE IN A GROUP OF TRANSWOMEN
FOLLOWING VOICE
MODIFICATION
THERAPY

EMILY ANN MARQUEZ

Master's Program in Speech Language Pathology

APPROVED:

Patricia Lara, PhD, CCC-SLP, Chair

Connie Summers, PhD, CCC-SLP

Kathryn Schmidt, PhD, LMSW

Charles H. Ambler, Ph.D.
Dean of the Graduate School

CHANGES IN FUNDAMENTAL FREQUENCY
OF VOICE IN A GROUP OF TRANSWOMEN
FOLLOWING VOICE
MODIFICATION
THERAPY

By

Emily Ann Marquez, B.S.

Presented to the Faculty of the Graduate School of
The University of Texas at El Paso
in Partial Fulfillment
of the Requirements
for the Degree of
MASTER OF SCIENCE

Department of Rehabilitation Sciences
THE UNIVESITY OF TEXAS AT EL PASO

Acknowledgements

I would like to begin by thanking my mentor, Dr. Patricia Lara, for guiding me step by step through this process and for always being someone I could talk to about my fears, my aspirations, and life itself. We have had many laughs and long discussions and those memories have made my graduate school experience a blessing. I would also like to thank Dr. Lara for helping me recognize my passion for research and for working with the LGBTQ population. Additionally, I would like to thank Dr. Connie Summers for her guidance during my first semester of graduate school and Dr. Kathryn Schmidt for supporting me in this endeavor. I would like to extend my sincerest gratitude towards the participants in my study. Thank you for being flexible with schedules, for being patient, for telling your stories, and for your willingness to participate in research that will help others find who they are. Last but not least, I would like to thank my parents for their never-ending support, love, and guidance throughout my educational career. Over the years, they have taught me to persevere in difficult situations, to dedicate myself to something I love, and to always look on the bright side of things. A special shout-out goes to my mother, who encouraged me to become a speech language pathologist, despite my stutter. Thank you mom for always believing in me and for providing endless laughs and words of encouragement throughout my graduate school experience.

Abstract

The term transgender refers to an individual that identifies with a gender that is different to the one given at birth. Individuals that are transgender experience conflict between the gender the individual identifies with and the sex they are born with. Individuals that are transgender may elect to go through a transition process so that their outward appearance is congruent with their gender identity. Part of the transition process may include voice modification therapy.

Transgender individuals may seek voice modification therapy so that the outward appearance matches the voice. However, there is limited information regarding the efficacy of traditional voice therapy for transgender individuals. Therefore, the purpose of this study is to examine voice outcomes in a group of transwomen following traditional voice therapy. The results of this study show a mean increase of 40 Hz in fundamental frequency in this group of transwomen. These results suggest that traditional voice therapy is effective in increasing the fundamental frequency in this group of transwomen.

Keywords: transgender individuals, voice, fundamental frequency, traditional voice modification therapy, female-to-male, pitch, transgender, gender dysphoria, transition

Table of Contents

Acknowledgements.....	iii
Abstract.....	iv
Table of Contents.....	v
List of Tables.....	vi
List of Figures.....	vii
Chapter 1: Introduction.....	1
Chapter 2: Literature Review.....	3
2.1 Voice Modification Therapy.....	3
Chapter 3: Methods.....	8
3.1 Participants.....	8
3.2 Research Design.....	8
3.3 Baseline Procedures.....	9
3.4 Treatment Procedures.....	9
Chapter 4: Data Collection.....	11
4.1 Data Analysis.....	11
Chapter 5: Results.....	12
Chapter 6: Discussion.....	14
6.1 Limitations.....	15
6.2 Future Direction.....	15
References.....	17
Appendix.....	20
Curriculum Vita.....	21

List of Tables

Table 1.0. Pre- and Post- Fundamental Frequencies of Participants.....	11
Table 2.0 Participant Self Rating of Voice.....	13

List of Figures

Figure. 1.0. Two-Tailed T-Test.....	12
-------------------------------------	----

Chapter 1: Introduction

Transgender (TG) is an umbrella term used to describe individuals that identify with a gender that is different from the sex they were assigned at birth. These individuals go through a physical transition process, which includes a change in voice and physical appearance, due to endocrine therapy. Endocrine therapy is the use of hormones to alter the body's chemistry and hormonal levels in order to change an individual's physical appearance (Granados, 2014). The goal of endocrine therapy in a male to female transition is to alter the male physical appearance to a more feminine appearance. Endocrine therapy and voice therapy may increase satisfaction with voice in these individuals. Satisfaction with the physical transition can result in a more successful transition process to the identified gender. However, if an individual gets misgendered due to their voice or appearance, it may decrease that satisfaction and result in a less successful transition process (Adler, 2012).

The human voice is used to communicate wants, needs, emotions and expresses our individuality. The human voice encompasses multiple features including pitch, intonation, and resonance. Gestural language and articulation styles influence voice as well. All of these features combined makes our voice unique, personal, and influences how we are perceived by others. Pitch, measured in Hz (fundamental frequency), is especially important as it is perceptually used to differentiate between femininity and masculinity. Factors that influence pitch include vocal fold mass, tension, and length (Zhang, 2016). In transmen, endocrine therapy alters the mass of the vocal folds, causing the pitch to drop. For transwomen, endocrine therapy does not affect the vocal fold mass and this may be one of the reason these individuals choose to receive voice modification therapy (Granados, 2014). Changes in voice may affect a person's quality of life, since it is unique to every individual (Hancock, Krissing, & Owen, 2011). Therefore, voice

modification therapy is an important part of the transition process for transgender individuals (Adler, 2012). Transwomen are more likely to elect to receive voice therapy, in order to match the pitch to the identified gender. Satisfaction with the voice creates self-confidence, while being misidentified can result in feelings of social isolation and a lack of confidence (Adler, 2012). Therefore, voice modification therapy significantly contributes to a complete and successful transition (Hancock & Haskin, 2015). However, research that examines voice therapy efficacy in transgender individuals is limited (Davies, Papp, & Antoni, 2015). Results of this study will assist in filling some of the gaps that exist in the evidence base of voice modification treatments for transwomen.

The purpose of this study is to examine the efficacy of traditional voice therapy on voice modification outcomes in a group of transwomen. This study will examine changes in fundamental frequency (pitch) and examine changes in levels of satisfaction with voice following traditional voice therapy treatment.

Chapter 2: Literature Review

Transgender is an umbrella term used to describe those individuals who identify as a different sex than the one they were assigned at birth. According to Flores, Herman, Gates, & Brown (2016) an estimated 0.6% or 1.4 million adults in the United States identify as transgender. This figure has doubled since the last survey completed in 2011 which put the estimate at 0.3% of the U.S. population identifying as transgender (Flores et. al., 2016). The number of individuals that identify as transgender is increasing and therefore there is a need to provide appropriate transgender health care services, which include efficacious voice modification therapy (Conway, 2001).

2.1 *Voice Modification Therapy*

Voice modification therapy helps transgender individuals create a voice that better represents and reflects the identified gender. Voice modification therapy consists of changing an individual's fundamental frequency (pitch) to reflect the identified gender (Gelfer, 1999). Pitch is what a listener perceives when listening to another person's voice. Fundamental frequency is measured in hertz (Hz) and is used as a vocal measurement for differentiation between males and females. Pitch is influenced by vocal fold tension, length, and mass. The vocal folds in males are shorter in length and have more mass, while female vocal folds are long and thin (Zhang, 2016). The mass of the vocal folds is what determines how high or low the pitch will be. A larger mass will cause the vocal folds to vibrate at a slower pace, thereby producing a low pitch. In contrast, a smaller mass will cause the vocal folds to vibrate faster, thus producing a high pitch (Zhang, 2016). This results in males having a low pitch and females having a high pitch. There are specified fundamental frequency (pitch) ranges that correlate to whether an individual is

perceived as male or female. The male fundamental frequency (pitch) averages range from 100-150 Hz, while for females it can range from 150-250 Hz. Gender neutral is considered to be in the range of 155-185 Hz (King, Brown & McCrea, 2012).

Since fundamental frequency plays a direct role in gender identification, the main goal of voice modification therapy is to help the transgender individual reach the desired vocal range. It is important for individuals that are transgender to have a voice that matches the identified gender in order to avoid misgendering. For example, an unfamiliar listener may assume that a transwoman is male, based on the perception of the voice.

According to Davies, Papp, and Antoni (2015), there are a limited number of studies that investigate the effectiveness of voice and communication treatments for individuals that are transgender. As a result, finding effective voice treatments to manage voice modification in individuals that are transgender is a challenge (Hancock & Garabedian, 2012).

With the recent interest in transgender care issues including management of voice, researchers within the field of speech language pathology are beginning to focus on this important area in order to improve the care of individuals that are transgender. For example, Gelfer and Schofield (2000) examined the differences in speaking fundamental frequency (SFF) in fifteen transwomen. They found that those individuals who were perceived as female by naïve listeners exhibited a higher SFF than those identified as male. The findings from Gelfer and Schofield (2000) study suggest that fundamental frequency is the main acoustic indicator used by listeners to discern between femininity and masculinity. In another study, Gelfer and Mikos (2004) investigated whether unfamiliar listeners could identify the gender of a speaker from expressive production of vowels in transgender and cisgender individuals. Cisgender is a term used to denote an individual whose sense of gender identity is congruent with the sex assigned at birth.

The findings from this study are similar to those found previously by Gelfer and Schofield (2000). Both of these studies show that fundamental frequency is the primary perceptual measure used by unfamiliar listeners to differentiate between feminine and masculine voice. The authors suggest that transwomen should target increasing fundamental frequency (pitch) so that it falls within the average female pitch range. For example, King, Brown and McCrea (2012) investigated at which point in the fundamental frequency range unfamiliar listeners would identify male to female transgender veterans as female. The results show that an average fundamental frequency of greater than 180 Hz and a range from 140-300 Hz would result in male to female transgender individual being identified as female by unfamiliar listeners (King et al., 2012). The results from this study suggest an acceptable target fundamental frequency range for transwomen to be perceived as female. To further support this point, Gelfer and Tice (2013) examined the perceptual outcomes of voice therapy for transwomen following voice therapy and at 15-months follow-up session. Gelfer and Tice (2013), found that the participants were 50.8% more likely to be identified as female after 8 weeks of voice therapy using fundamental frequency. However, this percentage dropped to 33.1% at the 15-month follow-up post-test. These results suggest that follow-up voice therapy sessions may be crucial for transwomen to maintain the increased fundamental frequency (pitch) obtained post-treatment.

Soderpalm, Larsson and Almquist (2004) conducted a study that assessed changes in fundamental frequency in 22 male to female transgender individuals. The participants were divided into two groups. One group of participants had vocal fold surgery and one did not. Both groups received traditional voice therapy. Both groups of participants were followed for a period of 10 years. Soderpalm et al., (2004) found that 21 of the participants had increased the fundamental frequency by 20 Hz and maintained a fundamental frequency at or above 155 Hz at

follow-up. In addition, Soderpalm et al., (2004) found that those individuals that received a greater number of therapy sessions had a greater increase in fundamental frequency at post-treatment. Furthermore, both groups continued to increase fundamental frequency by 7 Hz by follow-up.

In addition to the results found by Soderpalm et al., (2004) regarding the support for targeting fundamental frequency in voice modification treatment for transwomen, this study is significant in that it is one of the few studies with what would be considered a large sample size. In addition, this study further supports the use of traditional voice therapy to increase fundamental frequency in male to female transgender individuals. However, much of the evidence that exists on the efficacy of voice modification for transwomen is in the form of single case studies. For example, Bralley, Bull, Gore and Edgerton (1978) examined fundamental frequency in a 49-year-old male to female transgender individual post vocal cord surgery. The results show changes in fundamental frequency from 145 Hz pre-vocal cord surgery to 165Hz post-vocal cord surgery. In addition, the participant reported increased satisfaction with voice post-surgery and therapy. While the study by Bralley et al., (1978) investigated satisfaction with voice following vocal cord surgery in addition to behavioral voice treatment, it supports the use of targeting fundamental frequency in the management of voice modification in transwomen. Additionally, a study by Meszaros, Vitez, Szabolcs, Goth, Kovacs, Gorombej, and Hacki (2005) examined changes in fundamental frequency from pre-to post traditional voice therapy in three transwomen. Meszaros et al., (2005) found that the three participants increased their fundamental frequency by an average of 22.3 Hz at the follow-up session. The findings from this study support the use of “traditional” voice therapy to manage voice in transwomen.

In contrast, only one study in the literature review found that “traditional” voice management did not achieve the desired results of increasing the fundamental frequency to be gender neutral or in the female range. Kaye, Bortz, and Tuomi (1993) examined the changes in fundamental frequency in one male to female transgender participant following “traditional” voice therapy. In this study, the participant’s starting fundamental frequency was measured and found to be at 100 Hz. The participant was provided with 12 weeks of traditional voice treatment. Post treatment, the participant’s fundamental frequency was measured. The participant’s ending fundamental frequency was 135 Hz. Although the participant increased the fundamental frequency by 35 Hz, 135 Hz is not considered to fall within the gender neutral or female fundamental frequency ranges.

While only one study in the literature review showed that traditional voice therapy did not result in the desired fundamental frequency, as a whole the available literature suggests that traditional voice therapy is effective in managing voice in male to female transgender individuals. However, the evidence is weak as much of this evidence is in the form of single case studies. The results of this study will add to the evidence that currently exists on voice modification for transgender individuals.

Chapter 3: Methods

The purpose of the current study is to examine the outcomes of traditional voice therapy treatment in a group of English speaking transwomen. Specifically, we examined changes in fundamental frequency (pitch) from pre to post-treatment. This study was approved by the UTEP IRB Committee.

3.1 Participants

Participants included a group of five English speaking transwomen with a mean age of thirty-five years. All participants were recruited from the El Paso area community via physician, community, and self-referral. None of the participants reported using puberty blockers. All participants reported taking medically supervised endocrine therapy.

Inclusion criteria included:

- a. Male to Female Transwoman
- b. Passed a hearing screening according to ASHA standards at 1000 Hz, 2000 Hz, and 4000 Hz using 25dB HL in both ears (ASHA, 2003)
- c. 18 years of age or over
- d. All participants reported speaking English to communicate daily
- e. No self-reported history of mental health issues

Exclusion criteria included:

- a) Refusal to participate in the study
- b) Self-reported history of mental health issues

3.2 Research Design

This study is a quasi-experimental design because no random assignment was made. All participants were provided with the same intervention approach. The dependent variable is

fundamental frequency (pitch). The independent variable is traditional voice modification therapy.

3.3 Baseline Procedures

The following procedures were completed on all participants. The participants were asked to read The Rainbow Passage (Appendix A) three times to establish a stable baseline. The Rainbow passage was chosen as one of the baseline measures because it is a phonetically balanced passage that is used to evaluate an individual's ability to produce connected speech (Fairbanks, 1960). The Rainbow Passage was used a standard measure across participants because it uses all the sounds found in the English language (Fairbanks, 1960). PRAAT (2016) software was utilized to record, measure, and analyze the participant's fundamental frequency while the participant read the Rainbow Passage. PRAAT (2016) is a free downloadable software that is used to measure fundamental frequency (pitch) and intonation. PRAAT (2016) also provides an in-depth analysis of speech and speech patterns.

3.4 Treatment Procedures

1. Participants were treated from Sept. 2016-Nov. 2017. Except for P001, who started receiving therapy prior to the start of the study in June 2016. All participants received 1-2 weekly treatment sessions that were 60 minutes in length. Therefore, participants attended therapy for 19- 25 sessions with a mean length of attendance of 22.5 sessions.
2. Voice modification therapy includes education regarding vocal hygiene (i.e. hydration, throat clearing techniques, vocal irritants) and decreasing vocally abusive behaviors (i.e. shouting, smoking, talking at a loud volume). The vocal hygiene program is a program that is used with individuals who suffer from voice disorders, that focuses on decreasing the use of phonotraumatic behaviors.

3. Participants were taught a breathing protocol outlined by the Centers for Disease Control and Prevention, Chronic Obstructive Pulmonary Disease (COPD). Breathing protocol was completed at the beginning of each treatment session. The breathing protocol is a program designed to educate and teach individuals about the proper breathing patterns used during speech production. The breathing protocol was used in order to increase the participant's ability to sustain phonation during the session, as it focuses on appropriate breathing patterns and increasing breath support which is essential for phonation.
4. A progressive relaxation protocol outlined by Adler, Hirsch, and Mordaunt (2012) was completed following the breathing protocol in order to decrease laryngeal tension.
5. Following the education, breathing and progressive relaxation protocols, a pitch matching exercise was implemented. Pitch matching consists of having the participant match their vocal pitch to a specific frequency using an electric keyboard for reference. Pitch matching exercises began at the syllable level and increased in complexity to mono-syllabic, multi-syllabic words, to 2-3-word phrases, 5-8-word sentences, and finally conversation. Fundamental frequency (pitch) was recorded and analyzed at each treatment session using PRAAT (2016). All treatment was provided by speech language pathology graduate students closely supervised by faculty of the UTEP Speech Language Pathology Program.

The participants were asked informal questions at the post-treatment session. The participants were asked to rate their voice on a Likert Scale of 1-3, 1 being male, two being gender neutral, and 3 being female. The participants were also asked if voice modification therapy was helpful and if it increased their satisfaction with voice following the treatment.

Chapter 4: Data Collection

Fundamental frequencies for every participant were recorded and analyzed using PRAAT software (2016). Participants were asked to read the Rainbow Passage three times at the beginning, midway point, and end of treatment to track changes in fundamental frequency (pitch) during reading tasks. Table 1.0 shows the pre and post-treatment measures for each of the five participants.

Table 1.0

Participants	Pre-Treatment Fundamental Frequency (Hz)	Post-Treatment Fundamental Frequency (Hz)
P001	161.33 Hz	208.50 Hz
P002	114.5 Hz	163.80 Hz
P003	118.73 Hz	166.56 Hz
P004	116.6 HZ	139.10 Hz
P005	158 Hz	197 Hz

4.1 Data Analysis

A statistical analysis was run using SPSS version 23. The pre and post fundamental frequencies (pitch) were analyzed using a paired sample t-test. The level of significance was set at .05. The participants in the study were transwomen (N=5) with a mean age of thirty-four years.

Chapter 5: Results

The purpose of this study was to examine changes in the outcomes of traditional voice therapy as a treatment to increase fundamental frequency (pitch) in a group of transwomen (N=5). We found that the participants increased fundamental frequency by an average of 41.16 post-treatment. The standard deviation was 11.17 and the standard error mean was 4.99. The degree of freedom (df) was determined to be 4 and the *p*-value was .001. Effect size was calculated using Cohen's *d* and found to be -3.7, which is considered a large effect size. Furthermore, a correlation between the pre and post treatment measures were positively correlated ($r=.918$). Figure 2.0 shows the descriptive statistics summarizing the data including the *p* value.

Figure 2.0

Paired Sample T-Test					
Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
41.16	11.17	4.99	-8.234	4	.001

All participants reported that voice modification was helpful post-treatment. The participants further reported that their satisfaction with voice increased following treatment. The participants were asked to rate their voice on a Likert Scale of 1-3, 1 being male, 2 being gender neutral, and 3 being female. Table 2.0 shows the results for each participant post-treatment.

Table 2.0

Participant	Post-Treatment Voice Rating
P001	2 (gender neutral)
P002	2
P003	2
P004	2
P005	2

Chapter 6: Discussion

The purpose of this study was to examine the efficacy of traditional voice therapy on voice modification outcomes in a group of transwomen. The aims of the study were to examine changes in fundamental frequency (pitch) from pre-to post-treatment and to examine changes in levels of satisfaction with voice following voice modification treatment. We found a statistically significant difference from pre to post treatment measures ($p=.001$). The effect size was determined to be -3.7 , which is considered a large effect size. The results of this study suggest that the treatment used in this study to modify voice in this group of transwomen was effective. The results found in this study are similar to those found by Solderpalm et al., (2004) in which a traditional voice therapy approach increased fundamental frequency in a group of transwomen. The participants in our study had a mean fundamental frequency increase of 41 Hz at post-treatment. All participants in the study ($N=5$) increased fundamental frequency at post-treatment. The post-treatment fundamental frequencies for four of the five participants fell within the average female fundamental frequency range. One of the participants (P004) increased the fundamental frequency but it did not fall with the average fundamental frequency range for females. Instead, the fundamental frequency for this participant fell in the gender neutral fundamental frequency range. This may have been a result of the participant's lack of willingness to use her voice and participate in therapy due to fear of being misgendered.

Interestingly, all five of the participants rated their "voice" as gender neutral even though their post treatment fundamental frequency fell within the female range except for participant 004. This self-perception may be due to the unrealistic standards that the participants hold such as "sounding female can only be achieved when the voice (pitch) is extremely high and breathy". When the participants were asked about their satisfaction with the voice, following

voice modification treatment, all five participants reported a greater level of satisfaction with the voice. Furthermore, all five of the participants reported that voice modification treatment was helpful. The results of this study are congruent with those in the literature that advocate targeting fundamental frequency in management of voice in male to female transindividuals.

6.1 Limitations

This study had a sample size of five transwomen. This is considered a small sample size. Therefore, the results of this study cannot be generalized to the population. However, these results provide some evidence to support the use of traditional voice therapy to manage voice modification in transwomen. Another limitation of the study was that the sample only consisted of transwomen, not transmen. This is due to the limited number of transmen who seek voice modification treatment as lowering of pitch is achieved as a result of the endocrine therapy. However, very little evidence exists in the literature to support no need for voice management in transmen. Therefore, studies should include transmen and pre and post voice management measures should be compared. Furthermore, this study did not compare transwomen to a group of cisgender women with voice disorders and examine which group makes greater changes in voice following traditional voice therapy. Another limitation is the instrumentation used in this study. PRAAT (2016) was used to obtain pre and post treatment measures. PRAAT (2016) is a free computer program used for speech analysis. Laptops were used to do the recordings and are not calibrated to a specific standard. Therefore, the recordings may have included background noise that may have influenced the measures.

6.2 Future Direction

This study should be continued by assessing gender identification by unfamiliar listeners. This may provide some perceptual evidence that voice modification treatment is effective at

assisting transwomen in reaching the accepted female fundamental frequency range in order to be identified as female in their environment.

References

- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.
- Adler, R. K., Hirsch, S., Mordaunt, M., & Hirsch, Y. (2012). *Voice and communication therapy for the transgender/transsexual client: A comprehensive clinical guide*. (2nd ed.). San Diego, CA: Plural Publishing.
- American Speech-Language and Hearing Association. (2015). *Cultural Competence*. Retrieved from: <http://www.asha.org/Practice-Portal/Professional-Issues/Cultural-Competence/>
- Bralley, C., Bull, G., Gore, C., & Edgerton, M. (1978). Evaluation of vocal pitch transsexuals. *Journal of Communication Disorders*, 11, 443-449. doi:
- Conway, L. (2001). How frequently does transsexualism occur? Retrieved from: <http://ai.eecs.umich.edu/people/conway/TS/TSp prevalence.html>
- Davies, S., Papp, G. V., & Antoni, C. (2015). Voice and communication change for gender nonconforming individuals: Giving voice to the person inside. *International Journal of Transgenderism*, 16(3), 117-159, doi:10.1080/15532739.2015.1075931
- Fairbanks, G. (1960). *Voice and articulation drill book*, 2nd edn. New York: Harper & Row. pp124-139.
- Flores, A. R., Herman, J. L., Gates, G. J., & Brown, T. (2016). *How many adults identify as transgender in the United States?* Los Angeles, CA: The Williams Institute.
- Gelfer, M. P. (1999). Voice treatment for the male-to-female transgendered client. *American Journal of Speech-Language Pathology*, 8, 201-208. doi:10.1044/1058-0360.0803.201

- Gelfer, M. P., & Mikos, V. (2005). The relative contributions of speaking fundamental frequency and formant frequencies to gender identification based on isolated vowels. *Journal of Voice*, 19, 544-554. doi:
- Gelfer, M. P., & Schofield, K. (2000). Comparison of acoustic and perceptual measures of voice in male-to-female transsexuals perceived as female versus those perceived as male. *Journal of Voice*, 14, 22-33. doi:
- Gelfer, M. P., & Tice, R. M. (2013). Perceptual and acoustic outcomes of voice therapy for male-to-female transgender individuals immediately after therapy and 15 months later. *Journal of Voice*, 3, 335-347. doi: 10.1016/jvoice.2012.07.009
- Hancock, A. B., & Garabedian, L. M. (2013). Transgender voice and communication treatment: A retrospective chart review of 25 cases. *International Journal of Language & Communication Disorders*, 48(1), 54-65. doi:
- Hancock, A. B., & Haskin, G. (2015). Speech-language pathologists' knowledge and attitudes regarding lesbian, gay, bisexual, transgender, and queer (LGBTQ) populations. *American Journal of Speech-Language Pathology*, 24, 206-221. doi: 10.1044/2015_AJSLP-14-009
- Hancock, A. B., Krissinger, J., & Owen, K. (2011). Voice perceptions and quality of life of transgender people. *Journal of Voice*, 25(5), 553-558. doi: 10.1016/j.jvoice.2010.07.013
- Hector, G. (2016). Gender identity and disorder [PowerPoint slides]. Retrieved from: personal communication.
- Kaye J., Bortz, M., & Tuomi, S. (1993). Evaluation of the effectiveness of voice therapy with a male-to-female transsexual subject. *Scandinavian Journal of Logopedics Phoniatrics*, 18, 105-109. doi:

- King, R. S., Brown, G. R., & McCreea, C. R. (2012). Voice parameters that result in identification or misidentification of biological gender in male-to-female transgender veterans. *International Journal of Transgenderism*, 13(3), 117-130. doi: 10.1080/15532739.2011.664464
- Meszaros, K., Vitez, L., Szabolcs, I., Goth, M., Kovacs, L., Gorombej, Z., & Hacki, T. (2005). Efficacy of conservative voice treatment in male-to-female transsexuals. *Folia Phoniatica Logopedics*, 57, 111-118. doi:
- Solderpalm, E., Larsson, A., & Almquist, S. (2004). Evaluation of a consecutive group of transsexual individuals referred for vocal intervention in the west of Sweden. *Logopedic Phoniatics Vocology*, 29(1), 18-30. doi:
- Zhang, Z. (2016). Mechanics of human voice production and control. *The Journal of the Acoustical Society of America*, 140(4), 2614-2635. doi: 10.1121/1.4964509

Appendix A

The Rainbow Passage

When the sunlight strikes raindrops in the air, they act as a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon.

There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow.

Throughout the centuries people have explained the rainbow in various ways. Some have accepted it as a miracle without physical explanation. To the Hebrews it was a token that there would be no more universal floods. The Greeks used to imagine that it was a sign from the gods to foretell war or heavy rain. The Norsemen considered the rainbow as a bridge over which the gods passed from earth to their home in the sky.

Others have tried to explain the phenomenon physically. Aristotle thought that the rainbow was caused by reflection of the sun's rays by the rain. Since then physicists have found that it is not reflection, but refraction by the raindrops which causes the rainbows.

Many complicated ideas about the rainbow have been formed. The difference in the rainbow depends considerably upon the size of the drops; the width of the colored band increases as the size of the drops increases. The actual primary rainbow observed is said to be the effect of a super-imposition of a number of bows. If the red of the second bow falls upon the green of the first, the result is to give a bow with an abnormally wide yellow band, since red and green light when mixed form yellow. This is a very common type of bow, one showing mainly red and yellow, with little or no green or blue.

Vita

Emily Ann Marquez was born and raised in Toms River, New Jersey as the first daughter of George Henry Dalton and Louise Ann Dalton. She completed her undergraduate degree at Towson University in Maryland, where she was involved in the color guard and Tau Beta Sigma, an honorary band service sorority. She held numerous leadership positions throughout her undergraduate career, her favorite being the Vice President of Service for her sorority. She found herself interested in research, specifically voice, and took the opportunity to become a research assistant for Dr. Paul Evitts. She assisted him in developing and completing research on phonotraumatic behaviors in adults with dysphonia. She presented the research at multiple conferences including the Colonial Academic Alliance Conference at Drexel University, at the Towson University Undergraduate Research Expo, and at the Maryland Speech-Language-Hearing Association (MSHA) Conference.

Emily worked as a summer intern at Franklin Square Med Star Hospital during her undergraduate career. She completed an independent research literature analysis on Stuttering, Childhood Apraxia of Speech, and Bilingualism and presented it to the rehabilitation board.

Emily volunteered at the VA Hospital under the supervision of speech pathologist, Melissa Zilberstein, for a year prior to pursuing a master's degree at the University of Texas at El Paso. There, she became the research assistant for Dr. Patricia Lara for the Transgender Voice Lab. She was chosen as the Graduate Student Representative by the UTEP Speech Pathology program faculty.

After completion of this degree, Emily wishes to work in a pediatric outpatient clinic or a school for her clinical fellowship year. She plans to continue her interests in transgender voice and hopes to share her knowledge and experiences with future clinicians.