

The University of Maine

DigitalCommons@UMaine

Honors College

Spring 5-2020

The Use of Smartphone Apps as a Supplement to Transgender Voice and Communication Therapy

Maura Philippone

Follow this and additional works at: <https://digitalcommons.library.umaine.edu/honors>



Part of the [Communication Sciences and Disorders Commons](#), and the [Lesbian, Gay, Bisexual, and Transgender Studies Commons](#)

This Honors Thesis is brought to you for free and open access by DigitalCommons@UMaine. It has been accepted for inclusion in Honors College by an authorized administrator of DigitalCommons@UMaine. For more information, please contact um.library.technical.services@maine.edu.

THE USE OF SMARTPHONE APPS AS A SUPPLEMENT TO TRANSGENDER
VOICE AND COMMUNICATION THERAPY

by

Maura Philipponne

A Thesis Submitted in Partial Fulfillment
of the Requirements for a Degree with Honors
(Communication Sciences and Disorders)

The Honors College

University of Maine

May 2020

Advisory Committee:

Nancy Hall, Professor of Communication Sciences and Disorders, Advisor

Sandra Caron, Professor of Family Relations and Human Sexuality

Kathleen Ellis, Lecturer in English and Preceptor in the Honors College

Jessica Lewis, Lecturer and Staff Speech-Language Pathologist in
Communication Sciences and Disorders

Nancy Lewis, Adjunct Faculty in Women's, Gender, and Sexuality Studies and
Department Head of Reference and Information Literacy for
Fogler Library

ABSTRACT

This university IRB-approved thesis follows a case study research design and investigates the effectiveness of the app “Voice Analyst” as a supplement to transgender voice and communication therapy. It is hypothesized that the use of “Voice Analyst” outside the clinic will enable participants to make greater progress and to increase their ability to retain their progress. The participants are four transgender women who want to raise the pitch of their speaking voices. The participants are asked to record themselves reading “The Rainbow Passage,” and their data are tracked in a spreadsheet. “The Rainbow Passage” is the standardized passage used for all tracked recordings in this study. The study includes 4 phases and spans 12 weeks. For the first phase, participants take 7 recordings during one week to provide a baseline. During weeks 2-4, participants attend therapy sessions, practice with “Voice Analyst,” and submit weekly recordings. During weeks 5-8, they attend therapy, but do not use “Voice Analyst”. For weeks 9-12, they continue with therapy and resume “Voice Analyst” use. Quantitative data on pitch and volume changes, as well as qualitative interview data regarding the participants’ experience with the app are presented in tabular and graphic form. Trends observed and future directions are discussed.

ACKNOWLEDGEMENTS

I would like to thank the chair of my honors thesis, Dr. Nancy E. Hall, Ph.D, CCC-SLP, for her continuous instruction and support throughout my academic career at the University of Maine. This includes (but is by no means limited to) her counsel throughout the design, implementation, and analysis of this thesis study. I also want to thank the other members of my committee, including Dr. Sandra Caron, Nancy Lewis, Jessica Lewis, and Kathleen Ellis. I wish to thank Dr. Adrienne Hancock, Ph.D, CCC-SLP, for her expert guidance during the formation of the methodology used in this study. Finally, I wish to thank my family for their boundless and endless support. I would like to give special thanks to my parents, who housed me for the COVID-19 quarantine months in New York, during which time this thesis was prepared and defended.

TABLE OF CONTENTS

Chapter I: Review of the Literature	1
Introduction	1
Therapeutic Considerations for Transgender Individuals	3
Quality of Life	4
Interventions	6
Supplements to Voice and Communication Therapy	10
Retention of Skills/Practicing Skills	17
Purpose of this Study	19
Chapter II: Methods	20
Study Design	21
Data Analysis	22
Chapter III: Results	24
Results for Individual Participants	24
Participant 141	24
Participant 161	26
Participant 182	26
Participant 113	28
Qualitative Results	30
Chapter IV: Discussion	32
Chapter V: Limitations	34
Chapter VI: Conclusion	39

References	40
Appendices	45
Appendix A: Average Speaking Pitches for Participants (Baseline Data)	46
Appendix B: Average Speaking Pitches for Participants	47
Appendix C: Change in Participant Pitch Ranges Over Time	48
Appendix D: IRB Approval Letter	49
Appendix E: Recruitment Flyer	50
Appendix F: Informed Consent Form	51
Appendix G: “The Rainbow Passage”	55
Author’s Biography	56

CHAPTER I

REVIEW OF THE LITERATURE

Introduction

While the exact number of transgender individuals in the U.S. is unknown, there is a need for increased competency regarding transgender healthcare among medical professionals. Korpaisarn and Safer (2018) investigated the relationship between medical professionals' understanding of healthcare needs for transgender individuals and the accessibility of healthcare services for transgender individuals and found that a lack of education about transgender healthcare needs was the most commonly reported barrier to healthcare in transgender populations. In order to better understand the needs of transgender clients and provide appropriate services, it is important to have a working knowledge of terms and definitions that are relevant to this population. Some terms and definitions are provided for clarity.

The American-Speech-Language-Hearing Association (ASHA) currently categorizes transgender voice and communication as a *communication difference*, which is “a variation of a symbol system used by a group of individuals that reflects and is determined by shared regional, social, or cultural/ethnic factors” (ASHA.org, 2019). This means that transgender voice and communication should not be regarded as a disorder, but rather a voluntary option for transgender individuals to choose to increase their comfort while communicating. *Gender identity* describes what a person knows their gender to be (e.g., male, female, nonbinary, genderfluid, agender, etc.) (Trans Student

Educational Resources, 2019). *Gender incongruence* describes the conflict between gender a person was assigned at birth and their true gender identity (Södersten, Nygren, Hertegård, & Dhejne, 2019). *Gender Dysphoria* refers to the discomfort or distress resulting from gender incongruence (Trans Student Educational Resources, 2019). *Cisgender* describes an individual whose gender matches the gender they were assigned at birth. The term *transgender* refers to any individual whose gender identity does not match the gender they were assigned at birth. It is acknowledged that the term “transgender” is an umbrella term used to describe individuals whose gender identities do not correspond to the genders they were assigned at birth. Although there are many different transgender identities (e.g. transgender male, transgender female, nonbinary), the present study investigates the effectiveness of the smartphone application (app) *Voice Analyst* as a supplemental tool for transgender clients, regardless of their gender identity.

Meerwijk and Sevelius (2016) sought to find the current size of the transgender population in the U.S., as well as to study the trends in the U.S. transgender population over time. The authors conducted a meta-regression of 12 population-based surveys that incorporated self-reported transgender identity data and used probability sampling. The results showed a population estimate of approximately one million transgender adults in the U.S. The authors concluded that the transgender population (i.e., the number of individuals who self-report a transgender identity) would likely continue to increase. That said, the authors acknowledged that finding a more precise estimate of the size of the transgender population is difficult because transgender individuals must self-identify on surveys in order to be counted in the total population. To mitigate this difficulty, the authors recommended that healthcare providers administer surveys with standardized

questions regarding gender identity. Having to self-identify as transgender can be a barrier to healthcare for many transgender individuals. This barrier may prevent healthcare professionals from providing affirming and effective care to transgender clients. For this reason, it is important for healthcare professionals to address an individual's gender identity in a clear, affirming way. Additionally, it is important for these professionals to help transgender clients feel cared for and validated throughout the course of their healthcare treatments.

Therapeutic Considerations for Transgender Individuals

The World Professional Association for Transgender Health (WPATH) is an organization devoted to promoting optimal healthcare for transgender individuals all around the world (see wpath.org for more information). WPATH has developed the “Standards of Care for the Health of Transsexual, Transgender, and Gender Nonconforming People,” which includes guidelines for voice and communication therapy provision. These guidelines recommend that healthcare professionals have an understanding of transgender voice and communication needs (e.g. using correct pronouns, gender-specific pragmatics), a basic understanding of medical care for transgender individuals (e.g. hormonal treatments, surgical treatments), transgender-specific psychosocial issues (e.g. gender dysphoria resulting from gender incongruence), and that healthcare professionals continuously educate themselves to stay up-to-date with appropriate terminology (Coleman et al., 2012). Continuing education is vital for effective therapy services, as research has shown there is a considerable lack of continuing education programming pertaining to transgender healthcare (Wylie et al.,

2016). It is important for healthcare professionals to have an accurate understanding of the needs of transgender individuals so that they can provide the highest quality, most ethical, and most effective care possible. Doing so may improve quality of life for transgender clients.

Quality of Life

Voice function and quality of life have been shown to be related (e.g., Yu et. al., 2019; Pelletier, 2014). Yu et. al. (2019) studied how quality of life differed between teachers with voice disorders and teachers without voice disorders. The authors compared Voice-Related Quality of Life (V-RQOL) (Hogikyan & Sethuraman, 1999) and Voice Activity and Participation Profile (VAPP) (Ma & Yiu, 2001) scores in a sample of 672 teachers of varying grade levels. There were 218 male and 454 female participants, and all participants were given a stroboscopic examination to determine their vocal health. It is presumed that all participants were cisgender. 322 of the total 672 participants exhibited voice disorders, while the remaining 350 did not have voice disorders. After administering the V-RQOL and VAPP questionnaires, the authors found that the participants with voice disorders had a lower quality of life than the participants without voice disorders. Furthermore, female teachers showed poorer results on the V-RQOL than male teachers. The authors note that different voice disorders appeared to impact voice-related quality of life differently, but that the study found a moderate-to-strong correlation between V-RQOL and VAPP questionnaire results. This shows how voice and quality of life are related, and how voice can either negatively or positively impact an individual's quality of life.

Research has also shown there is a relationship between voice and gender identity. Owen and Hancock (2011) asked listeners to rate speaking voices on a scale of masculine-to-feminine. The speakers were transgender women. The results indicated that listeners rated speaking voices with higher speaking fundamental frequency (SFF) as sounding more feminine. This was especially true for speaking voices in the more feminine range of 250 Hz. Research has also shown a relationship between speaking voice, gender congruence (i.e. how close a person feels to the gender they were assigned at birth), and quality of life (Pelletier, 2014). Pelletier (2014) examined the relationship between speaking voice, gender identity, and quality of life in transmale and transfemale populations. The 28 participants were asked to complete an online survey comprised of numerous self-rating scales. It included the Transgender Congruence Scale (TCS; citation), which measures how closely one's external gender presentation matches their gender identity. For this measurement scale, participants respond to statements (e.g. My outward appearance represents my gender identity) using a scale of one-to-five, with one being "strongly disagree" and five being "strongly agree." The TCS also contains self-reported subscales pertaining to voice, including components from the Voice Handicap Index (VHI; cite), the Transgender Voice Questionnaire for Male-to-Female Transsexuals (TVQ^{MtF}), and the Voice-Related Quality of Life (V-RQOL). Incorporating these measurements into the survey enabled the researcher to gather data relevant to each participant's gender identity, gender presentation, feelings of gender dysphoria, and how their speaking voice impacted each individual's quality of life. These data offer valuable insight into the magnitude of the impact one's speaking voice has on their quality of life, especially for those who are transgender. The results revealed that those who indicated

more negative self-ratings of voice demonstrated lower levels of gender congruence, a more negative impact of voice on their daily lives, and decreased voice-related quality of life; however, it is noted that none of the 28 participants indicated that they were receiving speech therapy services at the time the study was conducted (Pelletier, 2014). This shows a need for speech-language pathologists (SLPs) who offer voice and communication therapy to people who are transgender because it may improve voice-related quality of life, and it may also mitigate feelings of gender dysphoria in transgender populations.

Interventions

According to ASHA, the purpose of voice therapy intervention is to improve voice production, breathing, and coordination of breathing and vocal fold movement. ASHA additionally specifies that a voice disorder diagnosis can be made if a person is concerned about having an abnormal voice, regardless of how others perceive the person's voice. Per these ASHA guidelines, interventions are implemented with the intent to: (1) foster awareness of individual strengths and weaknesses; (2) promote independence in daily life activities by providing the individual with new skills and strategies for communication; and (3) provide education concerning environmental factors that may impede improvement in vocal ability and the ways in which an individual can modify their environment to optimize communication (ASHA, 2019). While treatment approaches may differ from client to client, there are some general approaches taken by SLPs when treating voice disorders.

Interventions for Voice Disorders. The approaches SLPs use to treat voice disorders generally fall into two categories: direct approaches and indirect approaches. Direct approaches include techniques that aim to physically manipulate anatomical structures used in voice production (e.g. laryngeal palpation and massage) in order to change vocal behaviors. Research has indicated that a causal relationship exists between increased laryngeal tension and pain in the neck and throat, and some clinicians use laryngeal palpation and massage in an effort to decrease laryngeal tension (Woznicka et.al., 2017); however, a systematic review of literature regarding manual laryngeal therapy found that it was no more effective than other direct voice therapy interventions (such as) for adults with behavior dysphonia (Ribeiro et. al., 2018). Per ASHA (2019) guidelines, indirect approaches aim to “modify the individual’s cognitive, behavioral, psychological, and physical environments.” Indirect approaches are comprised of both patient education about vocal hygiene and counseling for the purpose of mitigating psychosocial processes that can harm the voice (see <https://www.asha.org/PRPSpecificTopic.aspx?folderid=8589942600§ion=Treatment> for more information). The use of indirect approaches is especially relevant to transgender voice and communication therapy due to the presence of both biological (e.g., an individual’s anatomy) and psychological factors (e.g., how a person perceives their own gender) in a transgender identity. As a result, client education is an important component of indirect interventions for transgender voice and communication. Improving transgender clients’ understanding of the anatomical and psychological processes involved in vocalizing will provide them with a better understanding of how speech is produced. Given the relationship between speaking voice and quality of life (Pelletier,

2014), it is important for clinicians to consider these factors when creating intervention plans for transgender clients so as to promote optimal quality of life for these clients.

Interventions for Transgender Voice and Communication. Interventions used for transgender clients are similar to those used for voice disorder clients in general. For a full discussion of transgender voice and communication interventions, the reader is referred to *Voice and Communication Therapy for the Transgender/Gender Diverse Client: A Comprehensive Clinical Guide* (Adler, Hirsch, & Pickering, 2019). Treatment goals typically include establishing a new habitual pitch and teaching the client new skills they can generalize to non-clinical contexts. For transmasculine individuals who have taken testosterone, the physiological lowering of pitch is irreversible (Block, Papp, & Adler, 2019). While pitch naturally lowers as a result of testosterone use, vocal lowering generally occurs at a more rapid rate in the first six months of testosterone treatment than in the second, and it continues at a diminished speed into the second year. Any observed upward shifts in vocal pitch for transmasculine individuals is generally attributed to individual choices made by the speaker (e.g. tensing of laryngeal muscles) (Block et al., 2019).

Since transfeminine individuals looking to raise their voice do not experience the same medically-induced vocal changes as transmasculine individuals, different interventions are needed in order to facilitate the desired changes in speaking pitch. Oates (2019), quoting Oates and Dacakis (1997), discusses the most common therapy goals for transfemale clients. These are “to increase fundamental frequency to at least 155 Hz, increase formant frequencies, decrease intensity and vocal effort slightly, and alter

intonation patterns so that the use of level and downward tones are reduced, upward tones are increased, and the overall number of intonation shifts is increased” (Oates, 2019, p. 91-92). A combination of direct and indirect approaches are typically used to foster these changes in voice; however, it is especially important to consider an individual’s environment and culture when conducting evaluations and providing therapy.

Although a person’s speaking fundamental frequency (SFF) is determined to a certain degree by their personal anatomy and physiology, sociocultural factors play a large role in the determination of a person’s SFF (Block, et al., 2019). The socially-accepted behaviors, SFF, intonation, intensity, body language, and communicative gestures vary among different locations and cultures. What is acceptable in one area or in one culture may not be acceptable in another. It is important for the client to feel comfortable communicating in their personal environments, and the SLP must provide them with the skills and strategies needed to do this. Helou and Hirsch (2019) recommend a framework for vocal behavior maintenance that differs from traditional maintenance frameworks. Their framework encourages clinicians and clients to acknowledge that clients will occasionally regress from their newly-learned vocal behaviors, and that such regression is normal. Accounting for this regression, clients are assessed on their ability to use the strategies they have learned in therapy to return to their target voice as quickly and easily as they can. These authors also make some recommendations for promoting awareness of vocal maintenance and regression, including setting a semi-regular alarm to remind clients to check in with their voice and periodically making “selfie” videos of occupational or social activities to see how their voice is doing. The relatively recent development of smartphone applications (apps)

designed to foster vocal change in transgender individuals (e.g. *Voice Analyst*) has expanded the materials with which SLPs can facilitate transgender voice and communication therapy.

Supplements to Voice and Communication Therapy

As intervention methods have evolved, so have the tools that accompany them. The advancement of technology has made it possible to use numerous technological devices to facilitate the practice of skills learned in therapy. One approach to facilitating change in speech or language behaviors involves the use of biofeedback, which can be delivered via a number of mechanisms or devices (e.g., electromyography, auditory feedback, real-time visual depiction of behaviors). Biofeedback can be used to monitor body movements and provide real-time analysis of a person's performance of a given action. This information can be used to formulate therapeutic goals and treatment plans. Other devices that are commonly used in therapy are audio recording devices, video recording devices, and portable media players (e.g. smartphones, laptops, tablets). These may also be used to create therapeutic goals and treatment plans. All of these devices may be used for a wide variety of purposes, including the provision of transgender voice and communication therapy.

Biofeedback. Biofeedback is commonly used in the speech-language pathology field, both for voice-related diagnoses and for other diagnoses. For example, biofeedback devices have been used for decades to treat people who stutter (Gordon et al., 1981; Buzzeti & Oliveira, 2018). Gordon et al. (1981) investigated the impact of

electromyographic biofeedback device use on stuttering-induced muscle tension. Of the three participants, one had a mild stutter, one had a moderate stutter, and one had a severe stutter. The participants attended five therapy sessions during a three-week time period. To investigate the impact of electromyographic biofeedback device use, data were obtained from the signals of two electrodes that were converted into visual and auditory feedback. The electrodes were placed on either side of the mouth and on either side of the neck at midline, with a ground electrode attached to the elbow. The visual feedback consisted of a visual meter reading, and the auditory feedback consisted of a variable frequency audio tone. Participants wore earphones that enabled them to hear the auditory feedback, read a passage, and gave a spontaneous speech sample. The results showed that participants' fluency improved after participating in biofeedback sessions, and the authors note that this improvement occurred "on both a descriptive and an inferential level." (Gordon et. al., 1981, p.1) While studies such as this laid the foundation for biofeedback use in stuttering interventions, more recent research has explored the effectiveness of other types of biofeedback in treating people who stutter. For example, Buzzeti and Oliveira (2018) investigated the immediate impact of delayed auditory feedback on stuttering-like disfluencies. Using a cross-sectional and experimental study design, the authors recruited 30 participants of ages ranging from 8-46, all of whom had been diagnosed with persistent developmental stuttering. In order to be eligible to participate, participants needed to demonstrate at least three percent of stuttering-like disfluencies and mild stuttering as reflected by a score on the Stuttering Severity Instrument-4 (SSI-4). The authors used The Fono Tools software to create a delayed audio effect. Participants demonstrated a statistically significant decrease in most

stuttering-like disfluencies, including a decrease in word repetition and flow of syllables per minute. Consequently, the authors concluded that delayed auditory feedback decreases the frequency of stuttering-like disfluencies in people with persistent developmental stuttering (Buzzeti & Oliveira, 2018). Research such as this highlights the importance of technology in speech therapy, as well as the potential for technological advancements in the speech-language pathology field that may increase treatment effectiveness.

Biofeedback for Voice. In addition to treating people who stutter, biofeedback devices are commonly used to provide interventions for people with voice disorders. In a pilot study examining the use of biofeedback devices in voice therapy, Van Stan, Mehta, and Hillman (2015) investigated the impact of portable biofeedback devices on daily performance and retention of newly-acquired vocal skills among people who have “normal voices” (i.e. people who are not diagnosed with a vocal disorder and who do not show symptoms of a voice disorder). With a group of six participants, the authors used a KayPENTAX Ambulatory Phonation Monitor to gather data from participants over the course of seven days. This biofeedback device was constructed so as to notify participants when their vocal intensity exceeded a participant-specific Sound Pressure Level (SPL) for the purpose of facilitating conscious reduction of vocal intensity. The first three days were used to obtain baseline data. For the following four days, the participants used the biofeedback device on the first and third days, but not on the second and fourth days. The results showed that, while using biofeedback has been shown to modify vocal behavior, removal of the technology was observed to lead to decreased

retention of learned behaviors and skills. The authors called for further research concerning portable biofeedback devices and how they can be improved to promote optimal retention of learned vocal behaviors skills. Research such as this is particularly important because it illustrates how biofeedback technology can benefit not only those with communication disorders, but those who do exhibit communicative differences as well (e.g. transgender identity, dialectal differences). Additionally, the continuous advancement of technology used for communication interventions has made biofeedback technology increasingly portable and increasingly available to the general public in such forms as websites and smartphone apps. Although these developments are relatively recent and therefore require further analysis before they can be deemed either effective or ineffective, they present SLPs with the opportunity to provide services via newer media than before.

Portable Technology. In addition to its impact on communicative performance, portable technology has been found to improve individuals' motivation and desire to practice learned vocal skills. van Leer and Connor (2012) investigated whether or not digital media players could be used by SLPs to increase motivation and adherence to treatment plans, thereby increasing the effectiveness of voice therapy interventions. A group of 13 adult participants who had been referred for resonant voice therapy were given portable media players. Using these media players, participants could watch videos of voice exercises, made either by themselves or by their clinicians. The study followed a randomized crossover design using the following conditions: (1) standard of care voice therapy, which distributed written descriptions of homework assignments; and (2) video-

enhanced voice therapy, which allowed participants to watch clinician- or self-made videos of therapy exercises using a portable digital media player. Each participant was subjected to a single condition for one week each (i.e. one week of standard of care voice therapy and one week of video-enhanced voice therapy). At the end of each session, participants self-reported their levels of motivation and practice frequency. The results were that participants practiced vocal exercises significantly more frequently during the week of video-enhanced voice therapy than during the week of standard of care voice therapy. In addition to this, participant motivation to practice, overall commitment to practicing, importance assigned to practice, and confidence in personal capability to practice were greater during the week of video-enhanced voice therapy. The authors concluded that these results supported the inclusion of video examples and portable digital media players in voice therapy treatment plans for people who are comfortable with using technology of that kind. The effectiveness of biofeedback devices in communication therapy interventions, coupled with the improvement in individual motivation and desire to practice learned vocal skills, indicate that the future of portable biofeedback technology use in the speech-language pathology field is promising.

Smartphone Apps. While there is no research concerning the effectiveness of smartphone apps for transgender vocal change, smartphone technology has been used in other areas of the communication sciences and disorders (CSD) field to promote progress.

McNaughton and Light (2013) list numerous benefits of mobile technology advancements with regard to Augmentative and Alternative Communication (AAC). These benefits include bolstered awareness and social acceptance of AAC, augmented

consumer empowerment, increased access to and use of AAC technology, enhanced performance and interconnectivity of AAC technology, and expansion of AAC research and development. While acknowledging a number of challenges to implementing mobile technologies in communication therapy, McNaughton and Light (2013) call for AAC researchers to take advantage of the ongoing advancement of smartphone technology, asserting that research findings concerning mobile AAC technology may be used to improve service delivery and facilitate evidence-based interventions. Furthermore, McNaughton and Light (2013) specify that multidisciplinary collaboration between individuals, families, education professionals, medical professionals, researchers, engineering professionals, and smartphone technology developers is crucial for the continuous improvement of mobile AAC technology. (McNaughton & Light, 2013). The recommendation for multidisciplinary collaboration highlights the versatility of mobile technology use in SLP interventions, especially mobile smartphone technology use, and how this technology can be used to target a broad range of communicative foci during therapy. Provided here are some examples of how smartphone technology has been used in other areas of the CSD field.

Moffatt, Pourshahid, and Baecker (2015) examined trends in how technology is used to treat clients with aphasia. They administered an online survey to professionals who work with people with aphasia (e.g. SLPs, Occupational Therapists, Communicative Disorder Assistants) investigating AAC device use in their interventions. Additionally, the authors incorporated group therapy session observations and a focus group of aphasia clinicians. The group therapy observations showed how clients used AAC devices, while the focus group offered insight into how the professionals incorporated AAC into their

interventions. The authors note that clinician input constituted a larger portion of their focus because clinicians, “...will work with a broad and varied sample of individuals. Thus, they were best positioned to reflect on broad and long-term needs and to envision future designs” (Moffatt, et al., 2015, p. 119). There were 67 participants, 49 clinicians from Canada and 18 clinicians from the United States.

The study found Dynavox to be the most commonly used device, while the iPad® was the most commonly recommended device. Concerning the iPod touch®, the most commonly cited advantage was “less stigma” associated with using the device, and the most commonly cited disadvantage was that the screen was hard to read. The study found the most commonly cited factor impacting device use was an individual’s motivation to use the device (according to survey responses from aphasia clinicians). This study highlights the diverse array of mobile AAC that can be incorporated into aphasia interventions, as well as the impact patient perception of a given device can have on the patient’s progress with that device.

Barczik and Serpanos (2018) investigated accuracy of numerous self-hearing test apps. Twenty-two adults, 10 people with normal hearing and 12 people with sensorineural hearing loss, participated in the study. The three types of transducers used in this study were earbud earphones, supra-aural headphones, and circumaural headphones. While the results indicated differences among different frequencies and transducer types, the authors concluded that self-hearing test apps are effective in assessing and screening for mild or greater hearing loss (>25 dB HL) so long as the appropriate transducers are used.

Despite the lack of research regarding smartphone apps for transgender voice and communication, the Barczik and Serpanos findings support the use of smartphone or portable technology for screening and assessment purposes. While anecdotal reports of app effectiveness are available in the form of ratings on stores such as the Google Play store and the Apple App Store®, further clinical research is needed in order to determine the effectiveness of these apps as a method of therapeutic intervention for transgender individuals. Since smartphone app technology will likely continue to advance, it is important for SLPs to familiarize themselves with it so as to be able to provide more effective and accessible therapy to clients. According to ASHA, “The ultimate goal [of transgender voice and communication therapy] is to assist the client in achieving an authentic voice and communication style based on their needs” (ASHA.org, 2019). In order to achieve a new, “authentic voice and communication style,” clients must be able to retain skills learned in therapy.

Retention of Skills/Practicing Skills

The relationship between gender identity, speaking voice, and quality of life (Pelletier, 2014) makes it important for SLPs to provide effective transgender voice and communication therapy so that clients may feel comfortable engaging with people in their personal environments outside of the clinic. However, as van Leer and Connor (2012) pointed out, it is often difficult to facilitate lasting changes in vocal behaviors when clients are finding it difficult to adhere to their treatment plans. In addition to making progress while receiving services, it is important for transgender clients to gain sufficient

vocal skills so as to be able to generalize what they have learned to different social contexts and to be able to feel confident in their abilities even after they have stopped receiving services. A survey of SLPs specializing in voice found that 85% agreed that the most important factor in verifying individual readiness for discharge in “traditional” voice therapy populations is the individual’s capacity to independently generalize skills learned in isolation to conversational speech contexts (Gillespie & Gartner-Schmidt, 2017).

Other factors impacting readiness for discharge included the individual’s ability to use their new voice production in their daily life, the individual’s ability to discern which vocal habits are good and which are bad, the individual’s willingness to take responsibility for their own vocal behaviors, and the individual’s ability to use a voice that sounds like it has shown improvement from the established baseline (Helou & Hirsch, 2019). Helou & Hirsch (2019) note that, “Clients often benefit from seeing their own progress across time by listening to earlier recordings of their voice” (Helou & Hirsch, 2019, p. 368). In other words, using biofeedback to show clients the progress they have made may enhance the therapeutic process in ways that positively impact the client’s progress. That said, clients cannot merely be discharged from therapy and be completely finished with their voice. They will likely need to come up with ways to maintain their vocal progress to prevent regression.

One method of practicing that combines the aforementioned approaches of biofeedback and portable technology is the smartphone app, “Voice Analyst.” The app user can set parameters so that it can be used to provide biofeedback for the voice in real time. They can also make recordings that can be stored, reviewed, and transmitted

(Speechtools LTD, 2014/2019). Given the established effectiveness of portable biofeedback interventions for voice therapy, apps such as “Voice Analyst” offer increasingly accessible ways for transgender voice clients to both practice and retain their learned vocal skills.

Purpose of this Study

At this point, there has been no research concerning the use of smartphone apps as a supplement to transgender voice and communication therapy. This study seeks to contribute to cutting edge work by analyzing the progress made by participants who both receive voice therapy services at the University of Maine’s Conley Speech, Language and Hearing Center (CSLHC) and use the *Voice Analyst* (Speechtools LTD, 2014/2019) to practice outside of the clinic. This study investigates whether or not “Voice Analyst” is an effective supplemental tool to transgender voice and communication therapy. It is hypothesized that the use of portable technology, such as smartphone apps, is a way to facilitate the practice of skills outside of the clinic. Additionally, it is hypothesized that the use of *Voice Analyst* outside the clinic will enable participants to make greater progress and to increase their ability to retain their progress.

CHAPTER II

METHODS

Using a case study research design, the study examines the effectiveness of app use in the process of voice therapy in four participants who are at least 18 years old and self-identify as transgender. Following approval by UMaine's Institutional Review Board for the Protection of Human Subjects, participants were recruited through a partnership with a local health center. Mabel Wadsworth Center (MWC) in Bangor, ME distributed flyers (See Appendix E) to MWC clients who are transgender. Any individuals who met the requirements and wanted to participate were asked to contact the principal investigator. Although it was not the explicit intention of the principal investigator, all four participants were transgender women.

Prior to collecting data, the four participants met with the principal investigator and the faculty sponsor individually for approximately 20-30 minutes to explain the study, purpose, review the consent form (See Appendix F), and conduct app use training. The principal investigator, faculty sponsor, and participants (individually) were the only people present at these meetings. The purposes of these meetings were to address individual participant needs, concerns, and questions about the project, focusing on the functionality of the app. Additionally, participants were recorded reading "The Rainbow Passage" (Fairbanks, 1960) aloud in order to obtain a baseline speech sample. "The Rainbow Passage" is a 55-word passage used by speech-language pathologists that

contains all English language phonemes in all appropriate contexts and includes varied intonation (See Appendix G). This passage takes approximately 2 minutes to read aloud.

Study Design

The study design included four phases:

Phase 1- Baseline (Week 1 of study): Before beginning the study, participants were asked to meet with the principal investigator to discuss what they would need to do for this study. Following this initial meeting, participants were asked to make daily recordings of their voice in the app while reading “The Rainbow Passage.” Participants were asked to make these daily recordings for one week, resulting in a total of seven baseline recordings. The participants were asked to send the daily recordings to the principal investigator via email from the app.

Phase 2A- Treatment & App (Weeks 2-4): Beginning in the second week, participants started attending communication therapy sessions at CSLHC. This type of treatment typically includes one-to-two hours of direct therapy per week. In this study, participants attended one 50-minute therapy session per week. Each session was conducted by two graduate student clinicians and supervised by a master clinician. For the purposes of this study, voice modification was required to be among the goals and objectives for each participant. Thus each participant worked on modifying some aspect of voice (e.g. loudness or pitch) along with other aspects of communication (e.g. pragmatics, nonverbal communication). During the first treatment phase (2A), participants were also asked to use the *Voice Analyst* app to facilitate at-home practice of skills that were introduced and developed in therapy. Additionally, during this time period, participants had once a week,

20-30 minute check-ins with the P.I. to discuss their experiences with the app, address any concerns, and collect speech samples. These weekly check-ins focused mainly on the functionality of the app and collecting a speech sample (a reading of “The Rainbow Passage”).

Phase 3- Treatment with No App (Weeks 5-8): During phase 3, participants continued with communication therapy as specified in their plans of care, but were asked to refrain from using the *Voice Analyst* app for outside practice as outlined in 2A. Participants were asked to continue sending weekly recordings to the principal investigator during this phase. Participants also continued to have weekly check-ins with the principal investigator during this phase.

Phase 2B- Treatment & App (Weeks 9-12): The final phase of the study continued with communication treatment and reinstated use of the *Voice Analyst* app for outside practice as outlined in phase 2A. Participants continued to have weekly check-ins with the principal investigator until they completed this phase.

Following the completion of phase 2B, data collection was completed. At this point, participants were offered the opportunity to continue with communication therapy as standard clients of the CSLHC.

Data Analysis

The goal of the principal investigator was to obtain a minimum of 10 data points (one per weekly update) from each participant. After participants sent their data to the principal investigator, the data from their *Voice Analyst* app was tracked in spreadsheets

and analyzed to determine whether speaking pitch was altered. Each participant was randomly assigned a 3-digit number that was used in place of their name to ensure confidentiality. The four participant ID numbers, 141, 161, 182, 113, are used in the presentation of the results.

CHAPTER III

RESULTS

Using the *Voice Analyst* app, baseline and data point measures for pitch and volume were collected for all participants. Due to scheduling difficulties and restrictions following the global COVID-19 outbreak, only one participant was able to complete the study in its entirety. Participant 141 completed the study in its entirety. Only 4 data points out of 10 were gathered for participant 161. Only 3 data points out of 10 were gathered for participant 182. Only 3 data points out of 10 were gathered for participant 113 (See Appendices B and C). Due to scheduling difficulties, baseline data for participants 182 and 113 were obtained from data collected by the graduate student clinicians who provided therapy to these two participants (See Appendix A). The *Voice Analyst* app provided pitch measurements in hertz (Hz), which were converted to semitones (ST) using a computer program called “Semitone Conversions” (de Pijper, IPO, & Eindhoven, ND; <http://users.utu.fi/jyrtuoma/speech/semitone.html>) (See Appendix C). The results for each of the 4 participants are presented and described in the following sections.

Results for Individual Participants

Participant 141

Participant 141 was the only participant to complete the study in its entirety, although only six baseline data points were collected because of interruptions in scheduling. Table 3 (See Appendix C) shows that participant 141 did not experience a

significant change in the size of her pitch range. The first data point shows a pitch range of 303 Hz (23.42 ST), and the 10th data point shows a pitch range of 280 Hz (23.29 ST). While participant 141 exhibited few changes in the size of her pitch range, her average speaking pitch changed throughout the course of the study. For each baseline recording of “The Rainbow Passage,” *Voice Analyst* calculated the average speaking pitch, which resulted in a baseline measurement of 128.63 Hz as the average speaking pitch for this participant (See Appendix A). This falls below what is considered to be the average female vocal pitch (160-300 Hz). The participant had two therapy sessions at the CSLHC prior to collection of the 10 data points. 199 Hz, 193 Hz, 201 Hz, 203 Hz, 190 Hz, 190 Hz, 201 Hz, 196 Hz, 196 Hz, and 194 Hz were the 10 average speaking pitches obtained throughout the course of this study (See Appendix B). Average speaking pitches of 190 Hz, 190 Hz, 201 Hz, and 196 Hz were recorded successively for weeks 5-8, during which phase participants were asked not to practice with *Voice Analyst* outside of therapy. This participant reported practicing with *Voice Analyst* between 0-2 times per week outside of therapy sessions during the phases of the study in which outside practice was permitted. During weeks 5-8, the participant reported practicing with *Voice Analyst* 0 times per week. Given that participant 141 had a baseline average speaking pitch measurement of 128.63 Hz, the data indicate that there was a positive correlation between the use of the *Voice Analyst* app in conjunction with transgender voice and communication therapy and a progressive increase in the average speaking pitch of this participant.

Participant 161

As shown in Table 3, participant 161 exhibited some change in pitch range from the first data point to the 4th data point (See Appendix C). The first data point shows a pitch range of 152 Hz (18.43 ST), and the 4th data point shows a pitch range of 160 Hz (16.13 ST). While 7 baseline points were collected for participant 161, it was done over the course of approximately 10 days instead of 7. After the 5th baseline recording was made on the day of the 2nd check-in, the participant and the principal investigator made the decision to take recordings in the afternoons, outside of check-in meetings. For the baseline recordings, some were made in the early morning and some were made in the afternoon. For the 4 data points that were taken, all recordings were made in the afternoon. The baseline average speaking pitch measurement for this participant was 134 Hz (See Appendix A). From the 4 data points gathered for this participant, the average speaking pitches in chronological order were 152 Hz, 156 Hz, 145 Hz, and 151 Hz (See Appendix B). Given that this participant had a baseline average speaking pitch of 134 Hz, the data indicate a positive correlation between the use of the *Voice Analyst* app in conjunction with transgender voice and communication therapy and changes in the average speaking pitch of this participant.

Participant 182

Participant 182 attended at least six weeks of therapy sessions and missed four weeks of therapy sessions before she and the principal investigator were able to have the initial check-in meeting via phone. During this check-in meeting, based on how many

therapy sessions this participant had both attended and missed, the principal investigator and participant 182 determined that she was in Week 8 of the study; however, while this participant had been attending therapy sessions and signed an informed consent form, she told the principal investigator that she had known nothing about having to use *Voice Analyst* while receiving therapy at the CSLHC. Due to a scheduling conflict, the principal investigator gave the informed consent form to the clinicians who would be working with participant 182. The principal investigator asked the clinicians to have her read through the form, asked the clinicians to return the signed form to the faculty sponsor, and asked the clinicians to inform the participant that she may contact the principal investigator with any questions via email. At some point, there was a miscommunication with the participant about the requirements for participation in this study. This participant received over six weeks of therapy and missed four weeks of therapy before understanding that she was supposed to be using *Voice Analyst* to practice until Week 5 of participation in the study. Consequently, she did not begin using the app until what was determined to be her 8th week in the study. Additionally, since the initial check-in meeting occurred after participant 182 had attended at least six weeks of therapy, the principal investigator obtained baseline data from the clinicians (See Appendix A). This baseline data was collected from the first speech sample, which was taken at the first therapy session; however, it was not collected from a verbal reading of “The Rainbow Passage.” The reported baseline fundamental frequency for this participant was 117.5 Hz. The three data points obtained for this participant showed average speaking pitches of 118 Hz, 109 Hz, and 112 Hz consecutively; however, the recordings for these data points were submitted to the principal investigator over the course of two days. For this reason, the pitch range

values for participant 182 are shown in red text in the data tables, as these data points were taken too close together to show change over an extended period of time (See Appendices A, B, and C). Following the initial check-in meeting, it is unclear whether participant 182 used *Voice Analyst* to practice because there was no further communication after she submitted the three *Voice Analyst* recordings over the course of two days to the principal investigator. Therefore, the inconsistent use of *Voice Analyst* and attendance of CSLHC therapy sessions made it difficult to determine whether or not participant 182's speaking voice was impacted by either therapy or *Voice Analyst* use.

Participant 113

Similar to participant 182, participant 113 missed at least four weeks of therapy throughout the course of the study. Additionally, due to scheduling difficulties, the principal investigator was unable to have the initial check-in meeting with this participant until after she had attended therapy for at least 3 weeks. The initial check-in meeting took place via phone. During this meeting, the principal investigator and the participant determined that participant 113 was in week 4 of the study; however, there was a miscommunication similar to the miscommunication that occurred with participant 182. While this participant had been attending therapy sessions and signed an informed consent form, she told the principal investigator that she had known nothing about having to use *Voice Analyst* while receiving therapy at the CSLHC. Due to a scheduling conflict, the principal investigator gave the informed consent form to the clinicians who would be working with participant 113. The principal investigator asked the clinicians to have her

read through the form, asked the clinicians to return the signed form to the faculty sponsor, and asked the clinicians to inform the participant that she may contact the principal investigator with any questions via email. At some point, there was a miscommunication with the participant about the requirements for participation in this study. As a result, this client did not begin using *Voice Analyst* until after the initial check-in meeting with the principal investigator. Similar to participant 182, given the fact that participant 113 had already attended at least 3 weeks of therapy, baseline data for participant 113 was obtained from data taken during her first session at the CSLHC (See Appendix A). Similar to participant 182, the baseline data came from a speech sample taken at the first session, and was not obtained from a reading of “The Rainbow Passage.” The clinicians who worked with her reported a fundamental frequency of 121 Hz. The 3 data points gathered for this participant came from 3 *Voice Analyst* recordings submitted over the course of one week. For this reason, the pitch range values for participant 182 are shown in red text in the data tables (See Appendices A, B, and C), as these values were taken too close together to show change over an extended period of time. The average speaking pitches of these recordings were 128 Hz, 154 Hz, and 157 Hz consecutively (See Appendix B). Following the initial check-in meeting, it is unclear whether participant 182 used *Voice Analyst* to practice because there was no further communication after she submitted the 3 *Voice Analyst* recordings to the principal investigator. Therefore, the inconsistent use of *Voice Analyst* and attendance of CSLHC therapy sessions makes it difficult to determine whether or not participant 113’s speaking voice was impacted by either therapy or *Voice Analyst* use.

Qualitative Results

During check-in meetings, the primary investigator asked participants how they felt while using *Voice Analyst* and what they thought about the app. Since participant 141 was the only participant to complete the study, the majority of the qualitative data gathered came from her. Participant 161 constitutes the remaining portion of the qualitative data, as check-in meetings with participants 182 and 113 were primarily spent on scheduling times for data collection.

Concerning app functionality, participant 141 noted that *Voice Analyst* had slow recording download and export speeds. When recordings of participant 141 were made during check-in meetings using the app, it would often take 2-5 minutes for the recording to download, then another 2-5 minutes for the recording to export via email. It is unclear whether or not the app's download and export speeds were related to consistent use of the "eduroam" wifi network on the UMaine campus; however, the speed at which the app downloaded and exported recordings was consistent for all recordings taken during check-in meetings with the principal investigator. When asked by the principal investigator, participant 161 stated that she did not find the downloading and exporting speeds to be particularly slow. Since participant 161 made her recordings outside of check-in sessions, this indicates a possible relationship between download speed, export speed, and wifi functionality.

With regard to changes in speaking voice, participant 141 noted that she felt more forward focus after attending therapy and using *Voice Analyst*. Participant 141 mentioned that she could feel the sound "buzzing" more in her forehead and nose than she had previously felt before participating in this study. Additionally, she noted that the "visual

representation of progress” (i.e., the biofeedback graphs shown in *Voice Analyst*) was helpful in monitoring how she speaks. During the final check-in meeting, participant 141 stated that she had an “overall positive experience.” Participant 161 remarked that, once she became more familiar with “The Rainbow Passage,” it was easier for her to concentrate on “forward focus and breath support.” She noted that, although she had tried a few free apps to raise her speaking pitch before, she thought this app was “better” than the ones she had tried before. Participant 161 commented that she liked the option to set pitch parameters in *Voice Analyst*.

CHAPTER IV

DISCUSSION

While the data obtained in this study did not clearly show that using *Voice Analyst* as a supplement to therapy facilitated a change in the speaking voices of these participants, the qualitative data provide insight into what participants thought of *Voice Analyst* as a supplement to their therapy sessions. Knowing that participant 141 disliked the slow download speed of *Voice Analyst* indicates that clients may prefer apps with faster download speeds to those with slower download speeds. Additionally, knowing that participant 161 appreciated the ability to set parameters in *Voice Analyst* indicates that the ability to set acoustic parameters with a supplemental app may be a feature that clients would appreciate in an app used for supplemental vocal practice. These qualitative data concerning participant opinions of *Voice Analyst* enhance understanding of what transgender clients are looking for in a portable, supplemental tool for speaking voice practice outside of therapy.

As noted in the previous section, due to scheduling difficulties and communication difficulties between the principal investigator and CSLHC clinicians, not all participants were able to complete the study as the IRB-approved methodology instructed. It is reasonable to conclude that this may have impacted the results of this study. Additionally, it was more difficult to compare participant results within this study because the participants all began the study at different times. With participants completing different phases at different times from one another, as well as the fact that

some participants missed therapy sessions for multiple weeks, it was largely unclear whether the results observed in these participants were specific to the individual, caused by the individual schedule, or common to all participants. That said, for participants 141 and 161, progressive increase in average speaking pitch was observed. Since these two participants followed the methodology more closely than participants 182 and 113, the results of these participants indicate a potential positive correlation between consistent *Voice Analyst* use, consistent attendance of therapy sessions, and changes in average speaking pitch.

This study was unable to collect data regarding retention of skills after therapy due to restrictions related to the COVID-19 pandemic. Governmental restrictions led to the closure of UMaine, which in turn led to the closure of the CSLHC. The closure of these facilities made it impossible for the principal investigator to continue collecting data from the participants, as data collection without CSLHC therapy sessions would be a deviation from the IRB-approved methodology.

CHAPTER V

LIMITATIONS

For the methodology in general, the principal investigator did not provide therapy to clients. This resulted in numerous miscommunications concerning participant responsibilities and the objectives of this thesis research. While it was not possible for the principal investigator to be the primary clinician working with participants due to insufficient licensure (the principal investigator is an undergraduate student), it is recommended that future studies investigating this subject stipulate that the principal investigator will be the primary clinician providing therapy to participants. An alternative recommendation is that the principal investigator and primary clinician establish a regular schedule of communication to prevent miscommunication during the research process.

Concerning the functionality of the *Voice Analyst* app, limitations included the app's measurement of both non-linguistic and non-human frequencies in the recording environment. Data analysis showed that the app included human sounds such as sniffing and throat-clearing in its frequency measurements. Data analysis also showed that the app occasionally included sounds such as participants shifting in their seats or making some movement past the microphone in its frequency measurements. It is recommended that future studies investigating the effectiveness of smartphone applications as a supplement to transgender voice and communication therapy provide participants with specific instructions regarding distance from the microphone when recording, and that future studies use a controlled environment to make recordings with *Voice Analyst*.

Alternatively, it is recommended that future studies investigating this subject utilize software designed to separate voice data from non-voice data during data analysis.

With regard to scheduling, one limitation was that the principal investigator was unable to have all four participants complete the study on the same schedule within the same 12-week period. This was partially related to individual schedule limitations and partially related to the timing of IRB approval for this study. Although the principal investigator had intended for the participants to complete the phases of this study at the same time so that their data could be compared, this was ultimately impossible.

Another limitation was that not all participants consistently submitted data as the methodology instructed. Due to scheduling difficulties and difficulties with transportation, participant 182 missed approximately 4 weeks in a row and did not communicate with the principal investigator during this time. Due to scheduling difficulties, participant 113 also missed at least 4 weeks during the course of the study and did not communicate with the principal investigator during this time. Additionally, due to scheduling difficulties, the principal investigator was unable to meet with participants 182 and 113 until they had already been in therapy for at least 3 weeks each. Consequently, baseline data for these participants were obtained from data collected by the graduate student clinicians who provided therapy to these two participants. This data was taken from each participants' first session at the CSLHC. Additionally, by the time participants 182 and 113 met with the principal investigator for the first time, they had both missed more than 3 weeks of therapy each.

Scheduling initial meetings with the principal investigator was negatively impacted by scheduling difficulties and the UMaine winter break. For participants 182

and 113, it took over a month to find a time for each participant to meet 1:1 with the principal investigator. The timing of UMaine's winter break served as a communication barrier between the principal investigator, participants 182, and participant 113 (individually). Following winter break, the principal investigator had trouble contacting participant 182 due to the participant's personal scheduling and transportation difficulties. The principal investigator also had trouble contacting participant 113 during this time period due to the participant's personal scheduling difficulties. This resulted in delayed initial meetings and fewer check-in meetings than the methodology prescribed for participants 182 and 113.

For participants 113 and 182, the principal investigator conducted check-in meetings via phone. This was ultimately a limitation because recordings could not be taken during a phone meeting. Additionally, some check-in meetings were missed when the principal investigator called and the participants did not answer the phone. Participant 113 missed 2 check-in meetings, and participant 182 missed one check-in meeting.

Another limitation is related to the time at which participant 161 met with the principal investigator each week. Since participant 161 and the principal investigator met before 9:00am each week, a decision was made to shorten this weekly meeting to 15 minutes and for participant 161 to send the weekly recording to the principal investigator sometime in the afternoon. While this change was made to ensure that this participant's vocal abilities and vocal quality in the early morning would not impact the data, it is listed as a limitation because it is a deviation from the methodology. That said, participant 161 typically submitted weekly recordings to the principal investigator within less than one week of the weekly check-in meeting.

Regarding outside practice with *Voice Analyst*, a limitation of this study was that the principal investigator neither created nor implemented an explicit set of recommendations for outside practice with the app. Participants were simply instructed to practice with the app, and were encouraged to practice at least 2-3 times per week outside of therapy during the phases of the study in which this was permitted. Consequently, not all participants practiced with the app the same number of times per week. Future studies investigating the effectiveness of smartphone applications as a supplement to transgender voice and communication therapy should incorporate a specific schedule for outside practice with the app during the course of the research.

Finally, this study was inhibited by the COVID-19 pandemic and the resulting restrictions. Although the faculty sponsor and principal investigator had decided to use only data collected before March 16, 2020 for the thesis defense on May 1, 2020, the principal investigator had intended to continue data collection until all participants had finished the study (through the end of April 2020). The intent of the principal investigator was to try to collect a full set of 10 data points for each participant, even if the data collected after March 16, 2020 was not collected in time to be reported in the May 1, 2020 thesis defense. Collecting this data may have enabled the principal investigator to fully document any vocal changes participants 161, 182, and 113 experienced during the course of the study. Unfortunately, the COVID-19 pandemic restrictions closed the CSLHC, so these 3 participants were unable to continue receiving therapy. Since participants 161, 182, and 113 were no longer receiving therapy, their participation in the study was terminated. This is because attending therapy was a crucial component of the IRB-approved methodology for this study. Additionally, the COVID-19 restrictions

prevented the principal investigator from staying in contact with clients. This made it impossible for this study to determine the relationship between *Voice Analyst* use as a supplement to therapy and the ability of transgender clients to retain skills learned in voice and communication therapy.

CHAPTER VI

CONCLUSION

Participants 141 and 161 were the two participants who most closely followed the participation instructions outlined in the methodology. These two participants both showed an increase in average speaking pitch. It is reasonable to conclude that the combination of *Voice Analyst* use and therapy at the CSLHC caused these changes for these participants. Given the progressive increase in average speaking pitch shown by the data gathered for participant 161, it is believed that her average speaking pitch would have continued to increase with continued use of *Voice Analyst* in conjunction with therapy at the CSLHC. The progressive increase in average speaking pitches demonstrated by participants 141 and 161 indicate a positive correlation between change in speaking pitch and using *Voice Analyst* in conjunction with regular voice and communication therapy in half of the participants. Additionally, this study found that participants had an overall positive opinion about the app with regard to the pitch and volume measurement features.

The COVID-19 pandemic and the resulting restrictions prevented the principal investigator from staying in contact with the participants. Consequently, this study was unable to determine the relationship between *Voice Analyst* use as a supplement to therapy and the ability of transgender clients to retain skills learned in voice and communication therapy. It is recommended that future studies include a follow-up questionnaire after research completion to investigate skill retention of transgender individuals who have received voice and communication therapy.

REFERENCES

- Adler, R., Hirsch, S., & Pickering, J. (2019). *Voice and Communication Therapy for the Transgender/Gender Diverse Client*. 3rd ed. Plural Publishing, Inc., pp. 91-92, 142, 146-148, 359, 366-369.
- Albuquerque, L. C. A., Pernambuco, L., da Silva, C. M., Chateaubriand, M. M., & da Silva, H. J. (2019). Effects of electromyographic biofeedback as an adjunctive therapy in the treatment of swallowing disorders: A systematic review of the literature. *European Archives of Oto-Rhino-Laryngology*, 276(4), 927-938. doi:10.1007/s00405-019-05336-5
- American Speech-Language-Hearing Association. (2019). *Definitions of communication disorders and variations*. [online] Retrieved from: <https://www.asha.org/policy/RP1993-00208/> [Accessed 7 Nov 2019].
- American Speech-Language-Hearing Association. (2019). *Voice and Communication Services for Transgender and Gender Diverse Populations*. [online] Retrieved from: <https://www.asha.org/public/speech/disorders/Voice-and-Communication-Change-for-Transgender-People/> [Accessed 15 Dec 2019].
- American Speech-Language-Hearing Association. (2019). *Voice disorders: Overview*. [online] Retrieved from: <https://www.asha.org/PRPSpecificTopic.aspx?folderid=8589942600§ion=Overview> [Accessed 1 October 2019]
- American Speech-Language-Hearing Association. (2019). *Voice disorders: Treatment*. [online] Retrieved from: <https://www.asha.org/PRPSpecificTopic.aspx?folderid=8589942600§ion=Treatment> [Accessed 1 October 2019].
- Block, C., Papp, V., & Adler, R. (2019). San Diego, CA. In R. Adler, S. Hirsch & J. Pickering, *Voice and communication therapy for the transgender/gender-diverse client: A comprehensive clinical guide* (3rd ed., pp. 142, 146-148). San Diego, CA: Plural Publishing, Inc.

- Buzzeti, P.B.M, & Oliveira, C.M.C. (2018). Immediate effect of delayed auditory feedback on stuttering-like disfluencies. *Revista CEFAC*, 20(3), 281-290. doi:10.1590/1982-0216201820319417
- Coleman, E., Bockting, W., Botzer, M., Cohen-Kettenis, P., DeCuypere, G., Feldman, J., Fraser, L., Green, J., Knudson, G., Meyer, W. J., Monstrey, S., Adler, R. K., Brown, G. R., Devor, A. H., Ehrbar, R., Ettner, R., Eyler, E., Garofalo, R., Karasic, D. H.,... Zucker, K. (2012). *Standards of Care* (7th ed., pp. 52-54). USA/Hamburg: World Professional Association for Transgender Health (WPATH). Retrieved from: https://www.wpath.org/media/cms/Documents/SOC%20v7/Standards%20of%20Care_V7%20Full%20Book_English.pdf [Accessed 12 Dec, 2019]
- de Pijper, IPO, & Eindhoven (ND). *Semitone Conversions*. <http://users.utu.fi/jyrtuoma/speech/semitone.html> [Accessed 14 Apr, 2020]
- Fairbanks, G. (1960). *The rainbow passage: Voice and articulation drillbook* [Ebook] (2nd ed., pp. 124-139). New York: Harper & Row. Retrieved from <https://docplayer.net/21663069-The-rainbow-passage-from-fairbanks-g-1960-voice-and-articulation-drillbook-2-nd-edn-new-york-harper-row-pp124-139.html> [Accessed 14 Apr, 2020]
- Gillespie, A. I., & Gartner-Schmidt, J. (2017). Voice-specialized speech-language pathologist's criteria for discharge from voice therapy. *Journal of Voice: Official Journal of the Voice Foundation*. Retrieved from: <https://doi.org/10.1016/j.voice.2017.05.022>
- Gordon, E., Gordon, A., Gordon, L., Shapiro, M., Mentis, M., & Suchet, M. (1981). Biofeedback and stuttering. *The South African Journal of Communication Disorders (Die Suid-Afrikaanse Tydskrif Vir Kommunikasieafwykings)*, 28(1), 105. doi:10.4102/sajcd.v28i1.357
- Helou, L., & Hirsch, S. (2019). Considerations for discharge and maintenance. In R. Adler, S. Hirsch & J. Pickering, *Voice and communication therapy for the transgender/gender-diverse client: A comprehensive clinical guide* (3rd ed., pp. 359, 366-369). San Diego, CA: Plural Publishing, Inc.

- Hogikyan, N. D., & Sethuraman, G. (1999). Validation of an instrument to measure voice-related quality of life (V-RQOL). *Journal of Voice*, 13(4), 557-569. doi:10.1016/S0892-1997(99)80010-1
- Korpaisarn, S., & Safer, J. D. (2018). Gaps in transgender medical education among healthcare providers: A major barrier to care for transgender persons. *Reviews in Endocrine and Metabolic Disorders*, 19(3), 271-275. doi:10.1007/s11154-018-9452-5
- LGBTQ+ Definitions. (2019). *Trans Student Educational Resources*. Retrieved from: <http://www.transstudent.org/definitions> [Accessed 15 Dec, 2019]
- Ma, E. P., & Yiu, E. M. (2001). Voice activity and participation profile: Assessing the impact of voice disorders on daily activities. *Journal of Speech, Language, and Hearing Research*, 44(3), 511-524. doi:10.1044/1092-4388(2001/040)
- McNaughton, D., & Light, J. (2013). The iPad and mobile technology revolution: Benefits and challenges for individuals who require augmentative and alternative communication. *Augmentative and Alternative Communication*, 29(2), 107-116. doi:10.3109/07434618.2013.784930
- Meerwijk, E. L., & Sevelius, J. M. (2017). Transgender population size in the united states: A meta-regression of population-based probability samples. *American Journal of Public Health*, 107(2), e1-e8. doi:10.2105/AJPH.2016.303578 [Accessed 11 Nov, 2019]
- Oates, J. (2019). Evidence-based practice in voice training for trans women. In R. Adler, S. Hirsch & J. Pickering, *Voice and communication therapy for the transgender/gender-diverse client: A comprehensive clinical guide* (3rd ed., pp. 91-91). San Diego, CA: Plural Publishing, Inc.
- Owen, K., & Hancock, A. B. (2011). The role of self- and listener perceptions of femininity in voice therapy. *International Journal of Transgenderism*, 12 (4), 272-284. doi:10.1080/15532739.2010.550767. Retrieved from: <https://www-tandfonline-com.prxy4.ursus.maine.edu/doi/full/10.1080/15532739.2010.550767>

- Pelletier, A. J. (2014). The relationship between speaking voice and gender identity among transgender and transsexual individuals. *Electronic Theses and Dissertations*. 2072. Retrieved from: <https://digitalcommons.library.umaine.edu/etd/2072> [Accessed 10 May 2019].
- Ribeiro, V. V., Pedrosa, V., Silverio, K. C. A., & Behlau, M. (2018). Laryngeal manual therapies for behavioral dysphonia: A systematic review and meta-analysis. *Journal of Voice*, 32(5), 553-563. doi:10.1016/j.jvoice.2017.06.019
- Södersten, M., Nygren, U., Hertegård, S., & Dhenje, C. (2019). A multidisciplinary approach to transgender health. In R. Adler, S. Hirsch & J. Pickering, *Voice and communication therapy for the transgender/gender-diverse client: A comprehensive clinical guide* (3rd ed., pp. 1-2). San Diego, CA: Plural Publishing, Inc.
- Speechtools LTD (2014/2019). *Voice analyst: Pitch & volume*. [online] Apple App Store®. Retrieved from: <https://itunes.apple.com/us/app/voice-analyst-pitch-volume/id732245213?mt=8> [Accessed 15 Apr. 2019].
- van Leer, E., & Connor, N. P. (2012). Use of portable digital media players increases patient motivation and practice in voice therapy. *Journal of Voice*, 26(4), 447-453. doi:10.1016/j.jvoice.2011.05.006
- Van Stan, J. H., Mehta, D. D., & Hillman, R. E. (2015). The effect of voice ambulatory biofeedback on the daily performance and retention of a modified vocal motor behavior in participants with normal voices. *Journal of Speech, Language, and Hearing Research: JSLHR*, 58(3), 713-721. doi:10.1044/2015_JSLHR-S-14-0159.
- Woznicka, E., Niebudek-Bogusz, E., Morawska, J., Wiktorowicz, J., & Sliwinska-Kowalska, M. (2017). Laryngeal manual therapy palpatory evaluation scale: A preliminary study to examine its usefulness in diagnosis of occupational dysphonia. *Medycyna Pracy*, 68(2), 179+. Retrieved from: https://link-gale-com.prxy4.ursus.maine.edu/apps/doc/A560556675/HRCA?u=maine_oro_no&sid=HRCA&xid=5b068c43

Wylie, K., Prof Dr, Knudson, G., MD, Khan, S. I., PhD, Bonierbale, M., MD,
Watanyusakul, S., MD, & Baral, S., MD. (2016). Serving transgender people:
Clinical care considerations and service delivery models in transgender health.
The Lancet, 388(10042), 401-411. doi:10.1016/S0140-6736(16)00682-6

Yu, L., Lu, D., Yang, H., Zou, J., Wang, H., Zheng, M., & Hu, J. (2019). A comparative
and correlative study of the voice-related quality of life (V-RQOL) and the voice
activity and participation profile (VAPP) for voice-related quality of life among
teachers with and without voice disorders. *Medicine*, 98(9), e14491.
doi:10.1097/MD.00000000000014491

APPENDICES

APPENDIX A: AVERAGE SPEAKING PITCHES FOR PARTICIPANTS
(BASELINE DATA)

Average Speaking Pitches for Participants (Baseline Data)				
Participant ID	Baseline 1	Baseline 2	Baseline 3	Baseline 4
141	176 Hz	167 Hz	171 Hz	158 Hz
161	132 Hz	119 Hz	131 Hz	134 Hz
182	117.5 Hz	*	*	*
113	124.5 Hz	*	*	*
Participant ID	Baseline 5	Baseline 6	Baseline 7	
141	180 Hz	177 Hz	*	
161	136 Hz	142 Hz	144 Hz	
182	*	*	*	
113	*	*	*	

LEGEND:

- * : No data available
- Text in red print represents participant data obtained in conjunction with deviation(s) from the prescribed methodology

APPENDIX B: AVERAGE SPEAKING PITCHES FOR PARTICIPANTS OVER TIME

Average Speaking Pitches for Participants Over Time					
Participant ID	Data Point 1	Data Point 2	Data Point 3	Data Point 4	Data Point 5
141	199 Hz	193 Hz	201 Hz	203 Hz	190 Hz
161	152 Hz	156 Hz	145 Hz	151 Hz	*
182	118 Hz	109 Hz	112 Hz	*	*
113	128 Hz	154 Hz	157 Hz	*	*
Participant ID	Data Point 6	Data Point 7	Data Point 8	Data Point 9	Data Point 10
141	190 Hz	201 Hz	196 Hz	196 Hz	194 Hz
161	*	*	*	*	*
182	*	*	*	*	*
113	*	*	*	*	*

LEGEND:

- * : No data available
- Text in red print represents participant data obtained in conjunction with deviation(s) from the prescribed methodology

APPENDIX C: CHANGE IN PARTICIPANT PITCH RANGES OVER TIME

Change in Participant Pitch Ranges Over Time											
Participant ID	Range 1 (Hz)	Range 1 (semitones)	Range 2 (Hz)	Range 2 (semitones)	Range 3 (Hz)	Range 3 (semitones)	Range 4 (Hz)	Range 4 (semitones)	Range 5 (Hz)	Range 5 (semitones)	
141	303 Hz	23.42 ST	323 Hz	27.82 ST	280 Hz	21.91 ST	322 Hz	27.78 ST	333 Hz	28.46 ST	
161	152 Hz	18.43 ST	142 Hz	16.83 ST	94 Hz	10.84 ST	160 Hz	16.13 ST	*	*	
182	114 Hz	18.06 ST	98 Hz	15.45 ST	96 Hz	14.81 ST	*	*	*	*	
113	201 Hz	19.55 ST	222 Hz	20.43 ST	242 Hz	23.63 ST	*	*	*	*	
Participant ID	Range 6 (Hz)	Range 6 (semitones)	Range 7 (Hz)	Range 7 (semitones)	Range 8 (Hz)	Range 8 (semitones)	Range 9 (Hz)	Range 9 (semitones)	Range 10 (Hz)	Range 10 (semitones)	
141	269 Hz	23.36 ST	252 Hz	21.42 ST	275 Hz	23.40 ST	258 Hz	22.72 ST	280 Hz	23.29 ST	
161	*	*	*	*	*	*	*	*	*	*	
182	*	*	*	*	*	*	*	*	*	*	
113	*	*	*	*	*	*	*	*	*	*	

LEGEND:

- * : No data available
- Text in red print represents participant data obtained in conjunction with deviation(s) from the prescribed methodology

APPENDIX D: IRB APPROVAL LETTER

APPLICATION FOR APPROVAL OF RESEARCH WITH HUMAN SUBJECTS Protection of Human Subjects Review Board, 400 Corbett Hall

(Type inside gray areas)

PRINCIPAL INVESTIGATOR:

Maura Philippone

CO-INVESTIGATOR:

CO-INVESTIGATOR:

FACULTY SPONSOR: Nancy E. Hall

(Required if PI is a student):

TITLE OF PROJECT: The Use of Smartphone Apps in Rehabilitating the Voices of Individuals Who Identify as Transgender

START DATE: 10/4/19

EMAIL:

maura.philippone@maine.edu

EMAIL:

EMAIL:

EMAIL: nhall@maine.edu

PI DEPARTMENT: CSD

STATUS OF PI: FACULTY/STAFF/GRADUATE/UNDERGRADUATE U

(F,S,G,U): U

If PI is a student, is this research to be performed:

X for an honors thesis/senior thesis/capstone?

Submitting the application indicates the principal investigator's agreement to abide by the responsibilities outlined in Section I.E. of the Policies and Procedures for the Protection of Human Subjects. Faculty Sponsors are responsible for oversight of research conducted by their students. The Faculty Sponsor ensures that he/she has read the application and that the conduct of such research will be in accordance with the University of Maine's Policies and Procedures for the Protection of Human Subjects of Research.

REMINDER: if the principal investigator is an undergraduate student, the Faculty Sponsor MUST submit the application to the IRB.

Email this cover page and complete application to UMRIC@maine.edu

FOR IRB USE ONLY Application #2019-09-03 Review (F/E): F Expedited

Category:

ACTION TAKEN:

Judged Exempt; category Modifications required? Accepted (date)

Approved as submitted. Date of next review: by Degree of Risk:

X Approved pending modifications. Date of next review: by 10/3/2020 Degree

of Risk: Minimal

Modifications accepted (date): 10/4/2019

Not approved (see attached statement)

Judged not research with human subjects

FINAL APPROVAL TO BEGIN

Date

10/4/2019

APPENDIX E: RECRUITMENT FLYER

The flyer has a green and yellow striped background. The title is in large, bold, black capital letters. The description of the study is in black text. The eligibility criteria are in bold black text. The bottom section is split into two columns: 'Participants will:' on the left and 'About the Principal Investigator:' on the right. The left column has a dark blue background with white text for the list of activities. The right column has a dark blue background with white text for the investigator's bio and contact information. A small blue speech bubble points from the contact information to the list of activities.

RESEARCH STUDY LOOKING FOR TRANSGENDER PARTICIPANTS!

This study is investigating the use of the app "Voice Analyst" in shifting the pitch range of speaking voice in people who are transgender

**People who are ages 18+, are transgender,
AND would like to change the pitch range of
their voice are invited to participate!**

Participants will:

- Participate in regular voice/communication therapy sessions at the Conley Speech, Language, & Hearing Center (In Dunn Hall at UMaine in Orono) for approximately 12 weeks
 - **Therapy plans will be determined on an individual basis, but sessions will be scheduled at each person's convenience
- Use the app Voice Analyst to practice and document vocal progress
- Attend weekly 30-minute check-ins to talk about how the app is working

About the Principal Investigator:

Maura Philippone is a senior undergraduate Communication Sciences and Disorders major here at UMaine. She would eventually like to specialize in voice and communication therapy for people who are transgender. This project will fulfill the requirements for Maura's Honors thesis.

**For more information, please
contact
Maura Philippone at
maura.philippone@maine.edu**

- The maximum number of participants for this study is 5. Please contact Maura Philippone ASAP if interested.

APPENDIX F: INFORMED CONSENT FORM

INFORMED CONSENT FORM

Summary:

You are invited to participate in a research project looking at the usefulness of a smartphone app, *Voice Analyst*, in modifying pitch range of speaking voice in transgender individuals.

Before you consider the research, you should be aware of the following information:

- Research is voluntary. You do not have to be in this study.
- Alternative procedures to this course of treatment include purchasing and using *Voice Analyst* on your own (without therapy), pursuing therapy at the Conley Speech, Language, and Hearing Center (CSLHC) on the University of Maine campus (Orono, ME), or pursuing therapy at another clinic.
- Participation includes receiving direct training in the use of the app and communication therapy designed to help you learn communication skills that are consistent with your gender identity (speech, language, nonverbal).
- Participation in this project requires attendance at therapy sessions (scheduled at your convenience) at the CSLHC on the University of Maine campus (Orono, ME).
- You will be asked to make weekly recordings of your voice using the *Voice Analyst* app.
- There is little anticipated risk associated with the proposed project.
- If you think you want to be in the study, you should read the rest of this document. The document explains what will happen to people in the study.

The principal investigator for this project is Maura Philipponne, an undergraduate student in the Department of Communication Sciences and Disorders at the University of Maine. The faculty sponsor for this research project is Nancy E Hall, PhD, CCC-SLP. The purpose of the research is to analyze vocal pitch progress made by transgender individuals when using the smartphone app *Voice Analyst* in conjunction with voice therapy provided by the Conley Speech, Language and Hearing Center (CSLHC). You must be at least 18 years of age and identify as transgender to participate.

What Will You Be Asked to Do?

If you decide to participate, you will be asked to:

- Meet with the principal investigator and faculty sponsor for approximately 20-30 minutes before beginning therapy to ensure your understanding of the Voice Analyst app and the research project goals. These meetings will take place in This will occur during the first week of the 12 weeks of this study.
- It is estimated that you will attend between 12 and 24 therapy sessions over the course of the 12 weeks of this study. You are free to withdraw from the research project at any time, without discontinuing CSLHC services.

- The phases of this study will progress as follows:
 - Week 1: Make daily recordings of a passage being read (“The Rainbow Passage”) for one week (one time per day; 7 recordings total) and send these recordings to the principal investigator via email prior to beginning therapy. The passage will be provided to you, and it takes approximately two minutes to read it aloud. This will occur during the first week of the 12 weeks of this study.
 - Weeks 2-4: Attend individual communication therapy sessions for 12 weeks at the CSLHC and use the *Voice Analyst* app outside of clinic.
 - Therapy sessions are scheduled on an individual basis according to individual needs and goals. This is done through the Conley Speech, Language and Hearing Center (CSLHC). Typically, a therapy session lasts approximately 50 minutes.
 - Weeks 5-8: Continue to attend individual therapy sessions at the CSLHC, but STOP *Voice Analyst* use.
 - Weeks 9-12: Continue to attend individual therapy sessions at the CSLHC and return to using *Voice Analyst*.
- Attend weekly check-ins (approximately 20-30 minutes in length) with the principal investigator to discuss your experiences with the app, address any concerns, and read “The Rainbow Passage” aloud (a copy will be provided). These will take place before your scheduled therapy sessions.
- Use the *Voice Analyst* app for at-home practice of the voice skills taught in therapy sessions.
- Allow the principal investigator to track your vocal progress by analyzing the Voice Analyst data sent to the principal investigator via email.

If you would like to continue receiving treatment after you have finished participating in this study (December 2019), you can do so by making arrangements with the clinical staff at CSLHC. Attendance of therapy sessions after the study is completed is not required. Should you choose to continue, you will be responsible for covering the cost of any sessions attended after the research project has finished.

Risks

There is little anticipated risk associated with the proposed project.

- You may become uncomfortable with activities or exercises you are doing while using the app.
- While it is unlikely, it is possible to experience vocal injuries or illnesses resulting from attempts at changing your voice during your participation in this study. In the event of vocal injury, you will be referred to a physician for treatment.
- Transmitting voice recordings via email results in a small risk of the emails being intercepted; however, because the raw data and recordings have no identifying information attached to them, others will have no way of knowing to whom they belong.

Benefits

- You may experience gender-affirming changes in your speaking voice.
- You will receive free communication therapy services at the Conley Speech, Language and Hearing Center for the duration of the research project. Typically, these services occur on a once or twice a week basis, are provided by one or a team of two graduate students supervised by a nationally certified and state licensed speech-language pathologist.
- This research may help us learn more about the effectiveness of using the Voice Analyst app to help people who are transgender make progress through voice therapy.

Compensation

You will be provided financial support for the purchase of the Voice Analyst phone application. The app costs \$9.99 in both the Apple App Store and the Google Play Store. You will be given \$10 to cover this expense.

Confidentiality

Your name will not be on any of the data. A code number will be used to protect your identity. Only the principal investigator (Maura Philippone) and the faculty sponsor (Dr. Nancy E. Hall) will have access to the key linking your name to your code number. This key will be kept on a separate flashdrive from the one collecting the Voice Analyst data in this study. The flashdrives will be stored in separate places (data flashdrive in Dr. Hall's locked lab; key and name data in Dr. Hall's locked office). The individuals who will have access to your Voice Analyst data are the principal investigator (Maura Philippone), the faculty sponsor (Dr. Nancy E. Hall) because they will be collecting, storing, and analyzing your data. Additionally, Jessica Lewis, MA CCC-SLP, a clinician at the CSLHC who has experience with providing voice therapy to people who are transgender, and the assigned graduate clinician(s) will have access to your data because they will be providing the voice therapy. Your name or other identifying information will not be reported in any publications. The key linking your name to the data will be destroyed after data analysis is complete (approximately May 2020).

Voluntary

Participation is voluntary. If you choose to take part in this study, you may stop at any time. Should you choose to discontinue the research project, CSLHC services will no longer be free. If you wish to continue with services once the research project has been completed, you will be expected to pay for those services. If you do not fully complete the full study, your data will be kept and used until it is deleted after data analysis is complete (approximately May 2020).

Contact Information

If you have any questions about this study, please contact me at maura.philippone@maine.edu. You may also reach the faculty advisor on this study at nhall@maine.edu. If you have any questions about your rights as a research participant,

please contact the Office of Research Compliance, University of Maine, 207/581-2657 (or e-mail umric@maine.edu).

Your signature below indicates that you have read the above information and agree to participate. You will receive a copy of this form.

Signature

Date

APPENDIX G: “THE RAINBOW PASSAGE”

The Rainbow Passage

When the sunlight strikes raindrops in the air, they act like 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 men 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.

Other men 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 rainbow. Many complicated ideas about the rainbow have been formed. The difference in the rainbow depends considerably upon the size of the water drops, and 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 the superposition 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 lights 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.

\\\\wchi\\wchi\\User documents\\mtowey\\My Documents\\MPT\\Voice Course\\CSD 582 Spring 2005\\Assessment\\Rainbow Passage.doc

AUTHOR'S BIOGRAPHY

Maura Philipponne was born in Syracuse, NY on January 6, 1998. She was raised in Camillus, NY and graduated from West Genesee Senior High School in 2016. Maura has minors in French and in Women's, Gender, and Sexuality Studies. She is a member of the National Student Speech Language Hearing Association (NSSLHA). She has received the Outstanding Undergraduate Student and the Jean A. and David A. Webb '56 Speech Scholarship from the University of Maine Communication Sciences and Disorders Department.

Upon graduation, Maura plans to pursue a master's degree in speech-language pathology at George Washington University. She plans to specialize in transgender voice and communication therapy.