

Research Report

Transgender voice and communication treatment: a retrospective chart review of 25 cases

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Abstract

Background: People transitioning from male to female (MTF) gender seek speech–language pathology services when they feel their voice is betraying their genuine self or perhaps is the last obstacle to representing their authentic gender. Speaking fundamental frequency (pitch) and resonance are most often targets in treatment because the combination of these two voice characteristics can account for the majority of how listeners perceive a speaker's gender. Intonation, voice quality, pragmatics and non-verbal communication contribute to a lesser extent but are usually recommended in treatment guidelines. There are few examples of effective treatment with male-to-female transgender individuals in the literature. Due to a small number of reports, it remains unclear how closely clinical practice follows recommended approaches and the extent to which gains may be expected.

Aims: The purpose of this study was to examine retrospectively 5 years' worth of cases of voice feminization treatment at a university clinic in order to describe a unique clinical population and report treatment techniques and outcomes.

Methods & Procedures: Demographic information and treatment outcome data (e.g. acoustic measures) were available for collection from 25 of the 32 cases discharged from a university clinic between 2006 and 2010. Behavioural targets of treatment goals also were examined.

Outcomes & Results: Clients were in various stages of male-to-female gender transitions during treatment; at discharge, 80% of them presented as female 100% of the time. A majority (88%) had a history of feminizing hormone treatment and 28% presented with a voice disorder separate from gender presentation concerns. Treatment goals included the following (listed in order of percentage of cases that addressed the topic): forward resonance, increased fundamental frequency or pitch, physical and mental relaxation, intonation, phonotraumatic behaviours, breath control, non-verbal communication, pragmatics, and vocal hygiene. After treatment, clients had increased speaking fundamental frequency in sustained vowel, reading, and monologue tasks by five to six semitones, which is statistically significant. Gains in fundamental frequency correlated significantly with total number of sessions, but no other correlations were significant.

Conclusions & Implications: Treatment goals for clients included in this study were consistent with those goals most often recommended in the research literature regarding voice and communication treatment for transgender clients. Voice and communication treatment resulted in gains in areas important to listeners' perception of gender. Further research is warranted to determine efficacy of specific treatment protocols and potentially influential factors such as initial voice and communication status.

Keywords: Transgender, transsexual, voice, treatment efficacy.

What this paper adds

Based largely on differences between male and female normative value differences and the voice perception literature, speech–language pathologists provide treatment to help transgender clients be perceived as their desired gender. Although theoretically sound and advocated by experts, the effectiveness of targeting a few voice and communication characteristics to change how one is perceived has been examined clinically in only a few small studies. This paper describes the treatment and reported outcome measures for 25 male-to-female transgender people. Treatment based on voice perception research resulted in voice and communication changes for 25 male-to-female transgender individuals with a variety of age and gender-presentation demographics. Acoustic measures consistently and significantly progressed with treatment. Other communication and psychosocial measures should be included in future prospective studies of treatment efficacy.

Introduction

Transgender voice and communication treatment

A person's communication style can influence how people perceive and interact with that person. This is particularly true and critical for people who are transgender, some of whom have described their voice as betraying their genuine self or as the last obstacle to representing their authentic gender (Christianson and Adler 2006). Typically people transitioning from male to female (MTF) report difficulty being perceived as their intended gender, especially when they are on the telephone or in other communicative contexts highly dependent upon auditory channels.

Speech–language pathologists are educated in the assessment and treatment of voice and communication issues, including those in transgender cases. Two areas of research are commonly cited as the rationale for goals and techniques of transgender voice and communication therapy: studies documenting actual and/or perceptible differences between male and female voice and communication, and studies of how the transgender voice and communication changes with specific treatments. The current paper is most similar to the latter. Research over the past several decades confirms that a variety of communicative behaviours influence perception of gender, yet few reports in the literature describe how that information is applied in voice and communication therapy protocols. This paper includes a summary of the research used to identify communication behaviours of most relevance for how listeners perceive speakers' gender, followed by a description and critique of the treatment protocols and outcomes reported in the literature as addressing these behaviours, and finally a report of the treatment goals and outcomes for 25 cases of MTF people enrolled in voice and communication therapy.

Gender-differentiating communication behaviours

Females and males generally use distinctive vocal characteristics specific to their gender. Pitch is perhaps the most recognizable characteristic that distinguishes

these two groups from one another. The average speaking fundamental frequency (SFF) (F0) of adult males is approximately 107–120 Hz, while the average F0 of females is 189–224 Hz (Colton *et al.* 2006). This difference, almost one octave, is typically large enough to eliminate confusion as to a speaker's gender. Studies have shown that in order for biological males to be perceived as female, fundamental frequency must increase to *at least* 155–165 Hz (Gelfer and Schofield 2000, Wolfe *et al.* 1990), and perhaps as much as 180 Hz to be considered feminine (Gorham-Rowan and Morris 2006). Wolfe *et al.* (1990) reported no overlap between the range of speaking fundamental frequencies of nine MTF speakers perceived as male (97–145 Hz) and 11 perceived as female (155–195 Hz). Although only three of the 15 MTF speakers evaluated by Gelfer and Schofield (2000) were identified by listeners as female, their average SFF ranged from 164 to 199 Hz, averaging 187 Hz and statistically significant from speakers perceived as male. Yet, Gorham-Rowan and Morris (2006) reported a minimum F0 value of 180 Hz required for a voice to be perceived as feminine. The disagreement among these studies may be attributable to context: Wolfe *et al.* (1990) reported listener's perceptions of conversation samples; Gelfer and Schofield (2000) used sentences from a read passage; and Gorham-Rowan and Morris (2006) presented only vowels for listener judgment. Another notable difference is that listeners in the Gorham-Rowan and Morris study rated masculinity/femininity on a 100 cm visual analogue scale rather than making a dichotomous judgment regarding the speakers' gender.

While using a higher pitch has been beneficial in efforts to present with a more feminine voice, shifting pitch upwards is only one variable in voice gender perception. Resonance is another vocal characteristic that contributes to the perception of gender. The resonance differences are assumed to be correlated to the anatomical differences between men and women. The vocal tract is shorter in length in women compared with men, resulting in higher formant frequencies (Peterson and Barney 1952). However, the shape and length of the vocal tract may be altered by rounding or retracting the

lips and changing the place and extent that the vocal tract is constricted; these articulatory postures therefore tend to influence voice resonance. According to one MTF case report (Mount and Salmon 1988) and a small study of ten MTF speakers (Carew *et al.* 2007), MTF speakers can effectively raise their formant frequencies by learning to speak with the tongue positioned relatively more forward in the oral cavity and, consequently, sound more feminine. Carew *et al.* found the first three formants of the vowel /a/ to increase significantly after five sessions of oral resonance therapy; formants of vowels /i/ and /u/ also increased, but not always to a statistically significant extent. In both of these reports of increased formants, the speaker's F0 also increased.

Shifting both F0 and resonance is the most effective method in changing the perceived gender of the speaker (Hillenbrand and Clark 2009, Gelfer and Mikos 2005). Hillenbrand and Clark (2009) developed samples of men's and women's voices that had been synthesized to shift only the F0, only the formant envelope, or both the F0 and envelope. These samples were then presented to listeners who judged whether the samples were spoken by a man or woman. When both the F0 and formant envelope were shifted toward the value of the opposite sex, listeners perceived 81.9% of the males' synthesized voice samples to be a female's voice and 82.1% of the females' synthesized voice samples to be a male's voice. However, when only the fundamental frequency was shifted, only 34.3% of the males' samples were perceived as a female's voice and 19.1% of the females' voice samples as a male's voice. Using a similar protocol of synthesizing voice samples to create samples with fundamental frequencies either consistent or inconsistent with the speaker's gender, Gelfer and Mikos (2005) found that listeners' judgments of speakers' gender were most accurate when fundamental frequency and formant values were consistent with one another (i.e. 84% of the males' samples were judged as male when presented at 120 Hz, but only 19% were judged as male when presented at 240 Hz). These studies suggest that F0 coupled with formant frequencies plays a significant role in perception of speakers' gender—more significant than F0 alone.

In addition to the average fundamental frequency, there is the issue of intonation used in speech. Although many people consider women to have more melodic speech, Fitzsimons *et al.* (2001) present data demonstrating that females use a smaller range of semitones than males when speaking declarative and interrogative sentences. Similarly, semitone range was negatively correlated ($r = -0.60$) with perceptual ratings of speaker's femininity in a study of picture descriptions provided by five male, five female and 20 MTF speakers (Owen and Hancock 2010). However, in an analysis of 13 MTF voices, those perceived as female ($n = 3$)

used a greater range of semitones and also had a greater number of upward and downward pitch shifts during a reading task than voices perceived as male ($n = 10$), although these differences did not reach levels of statistical significance (Gelfer and Schofield 2000). Using a conversational sample, Wolfe *et al.* (1990) compared nine MTF voices perceived as female with ten MTF voices perceived as male and determined that the female-perceived voices did have a significantly greater percentage of upward intonations (defined in the study as frequency change without interruption of phonation) and downward shifts (defined as frequency change between phonations). Yet neither of these factors was significant predictors of femininity ratings in a statistical model that included F0 (Wolfe *et al.* 1990). Overall, the research is inconclusive as to gender differences in intonation, and whether any differences are influential to perception of gender.

One study explored vocal quality as an indicator used in perception of gender. Women's voices tend to have a 'breathiness' quality that is 'characterized by an audible frictions noise resulting from an incomplete closure of the vocal folds' (van Borsel *et al.* 2009: 291). In van Borsel *et al.*'s (2009) study, 14 female speakers provided two samples of sustained /a/; three speech-language pathologists verified one sample as breathy and one as normal. It was found that the breathy samples had greater aspiration in the third formant. When all the /a/ samples were presented randomly to 20 listeners, the breathy /a/ samples were perceived as more feminine than those samples with a normal quality /a/. In a second perceptual experiment, the breathy and normal samples from each speaker were presented in pairs and the listeners indicated the more feminine sample. In this experiment more listeners said the breathy sample was the more feminine one. Both of the paradigms in van Borsel *et al.* (2009) suggest that breathiness plays a role in the perception of a more feminine voice. However, this study is based on a single vowel and the findings may not generalize to connected speech conditions.

It is important to note that while effectively changing the client's voice can aid in changing a listener's perception of the client, this alone sometimes does not suffice. In addition to voice characteristics, transgender individuals also may address non-verbal communication (e.g. maintaining eye contact, using hand gestures, more varied facial expressions, posture, and head nodding). Females tend to move their head during conversation and often mirror the movements of their conversational partner (Nelson and Golant 2004). They tend to be more expressive with their hands and use arm movements that are closer in proximity to their own body. Feminine gestures tend to be more fluid than those perceived as masculine and tend to move toward and away from the body (Hirsch 2006: 322).

Treatment goals for the pragmatic aspect of discourse included in treatment for an MTF client may incorporate goals that increase her use of conversation elaboration or increase her use of expressive phrases and self-disclosure (Hooper and Hershberger 2006: 272). Additionally, women may have conversations with more disclaimers and qualifiers and be more emotionally expressive (p. 272). It may be suggested that an MTF client use her own observations of gender markers in the specific environmental context of concern to the client in order to determine what pragmatic characteristics to include in their treatment (Davies and Goldberg 2006). It is difficult to rely on research of gender differences in language use and vocabulary because the research quickly becomes outdated or can be only narrowly applied when considering the context and culture studied.

Reports of effective voice change for MTF persons

There exist several tutorial articles and a book describing how the literature described above is applied in transgender communication treatment (e.g. Adler *et al.* 2006, Gelfer 1999, Davies and Goldberg 2006, De Bruin *et al.* 2000, McNeill 2006, Oates and Dacakis 1983). There are published case reports of effective treatment (e.g. Hancock and Helenius 2012, Kalra 1977, Mount and Salmon 1988) and a few reports describing multiple cases (Carew *et al.* 2007, Dacakis 2000, Meszaros *et al.* 2005, Soderpalm *et al.* 2004). The similarity across the tutorials and cases is notable considering the authors are located across the world (i.e. Australia, Canada, Hungary, Sweden, Netherlands, UK and USA). These published cases demonstrate the effectiveness of speech pathologists utilizing their knowledge of voice physiology and gender differences in communication. As their descriptions below will illustrate, the cases all address the client's overall goal to be perceived as more feminine by prioritizing pitch and resonance and including secondary goals for other areas of communication as appropriate.

Two longitudinal single-subject studies demonstrate the effectiveness of treatment to alter the client's male voice characteristics to resemble more closely those of a female over time. Mount and Salmon (1988) describe the progress made by a 63-year-old MTF speaker over 11 months; Hancock and Helenius (2012) address the other end of the age spectrum with a case of a 15-year-old MTF client. In both cases, primary treatment goals included increasing fundamental frequency and modifying the tongue carriage to change resonance; secondary goals addressed breathy voice onset and inflection patterns. After participating in treatment for 4 months, Mount and Salmon's (1988) case was able to raise her F0 for the vowels /i,a,u/ from 110 to 205 Hz.

Increases in values for the first three formants of those vowels were also achieved, but not until the end of 11 months (88 sessions) of treatment. Although the client's values increased to a stable level relatively quickly, it was not until the client's second formant (F2) values also increased that she reported being perceived as female over the telephone by a listener. The most notable F2 increase was made on the vowel /i/, from 2092 Hz at the initiation of treatment to 2383 Hz at the termination of treatment. The frequency and resonance gains were maintained at least 5 years after treatment ended. The adolescent case reported by Hancock and Helenius (2012) had similar results: F0 increased from 134 to 204 Hz during sustained vowel task and from 136 to 172 during conversation. Spontaneous speech samples were recorded during each of the 16 sessions and then presented in random order to listeners who rated various characteristics of the voice. Significant gains in listener's perceptions of femininity and softness of the voice confirm social validity of the voice and communication treatment for Hancock and Helenius' adolescent case.

A group study of ten MTF people explored the effect of five sessions of oral resonance voice treatment (Carew *et al.* 2007). These sessions focused on two goals: 'lip spreading' and 'forward tongue carriage', with speakers first learning to discriminate the clinician's model productions, then engaging in positive/negative practice, and finally progressing through vocalizations increasing in length (vowels to conversation). Acoustic data revealed treatment gains in forward oral resonance (as measured by formant frequencies) as well as fundamental frequency. Although fundamental frequency was not directly targeted, the mean F0 value increased from 119 to 133 Hz post-treatment. Listeners' perceptual ratings confirmed that the femininity of the voices increased post-treatment for seven of the ten speakers. Unfortunately the data were not reported separately for speakers who achieved being perceived as female from those who did not. In another study of treatment outcomes, Meszaros *et al.* (2005) treated only three male-to-female individuals, but also included data for two untreated individuals as control subjects. This unique inclusion allowed for clear conclusions that the treatment, and not just time or self-instruction, caused positive and significant voice changes. In addition to resonance, Meszaros *et al.*'s treatment included pitch, articulation, breathing and reducing muscular tension. Voice quality, maximum phonation time, habitual F0 and intensity generally improved, but frequency range decreased due to elevation of lower range limit. No listener data are presented, but the authors note that all three cases 'appeared definitely female' by the end of treatment (Meszaros *et al.* 2005: 117). Although both studies demonstrated treatment effectiveness, there

were differences in the participants as well as treatment techniques. Carew *et al.* (2007) used only five treatment sessions, all focused on resonance, and included participants ranging in age from 25 to 64 years with only six of the ten participants living as female full-time. Meszaros *et al.*'s treatment addressed a variety of communication behaviours in several sessions ranging from 8 to 19 months and included only three participants between the ages of 20 and 26 years, but all had been living full-time as female for at least 2 years. The relative effectiveness of various treatment approaches has not been investigated, nor has the influence of age or time presenting as desired gender on treatment outcome and prognosis.

Dacakis (2000) examined whether F0 gains made in treatment can be maintained once treatment has been terminated. Speaking F0 during monologue was measured for ten MTF speakers at three stages of treatment: initial consultation (baseline), discharge from treatment and at long-term follow-up. All speakers had received services at a university voice clinic and 'focused primarily on increasing mean fundamental frequency', though number of sessions ranged from ten to 90 (Dacakis 2000: 551). Long-term follow-up ranged from 1 to 8.9 years with an average of 4.3 years post-discharge from treatment. Participants ranged in age from 32 to 58 years, with an average age of 44.5 years. As a group, the participants made gains in F0 during the course of treatment with an average increase of 43 Hz, yet at the individual level gains varied from 10 to 78 Hz (no semitone information is provided). At follow-up, four speakers had returned to within 3 Hz of baseline F0 levels, four had maintained levels above baseline but below discharge, and two had maintained levels within 3 Hz of discharge levels. There was a significant positive correlation ($r = 0.745$) between the number of sessions attended and the *maintenance* of F0 gains achieved during treatment, but not between the number of sessions attended and F0 gains during treatment (Dacakis 2000). Dacakis (2000) concludes that F0 change can be made and maintained, and that length of treatment may be one indicator of long-term maintenance. However, the majority of the participants lost at least some gains made in treatment, and without perceptual rating data the social validity or overall impact of this pitch change on perception of gender cannot be determined. Additional studies are needed to determine how long targets other than F0 can be maintained after communication treatment, and the extent to which treatment gains continue to influence listener perception after discharge from treatment.

Perhaps the largest group study to date, Soderpalm *et al.* (2004) evaluated 22 MTF and three female to male (FTM) persons referred to their clinic over a period of 11 years, although only 18 MTF agreed to

treatment and only 16 agreed to have their results published. Treatment data are available for only one FTM person. Demographic data for the 16 participants are not provided, but the authors report that 'half of the patients [were] over 40' (Soderpalm *et al.* 2004: 20). Length of therapy ranged from 1 month to more than 4 years, averaging 17 sessions (range = three to more than 45 sessions). The treatment protocol included vocal hygiene (e.g. physical and mental relaxation, decreased muscular tension, balanced respiratory–phonatory effort) as well as pitch raising and anterior articulation in treatment. There is no indication of individual differences in the extent or amount of time each of the 16 MTF speakers spent on these elements. Soderpalm *et al.* (2004) present each of the original 23 cases' data separately in an appendix, with few group descriptive statistics regarding the 16 people who completed treatment. They do note that fundamental frequency increased to above 155 Hz for five of the 12 people who had complete data for baseline, treatment and follow-up assessments. No listener perception data were collected. The authors note 'no dramatic changes occurred' after therapy for speakers' self-perception of femininity/masculinity, which the authors believe reflects the participant's view that femininity involves more than voice. Overall, this study includes some descriptive data over time for a large number of cases in west Sweden, but offers little in the way of general conclusions regarding treatment procedures or outcomes. Unlike the current study, the 16 cases reflect a population in Europe where eligibility and coverage for transgender healthcare is significantly different than in the USA; the cases also span a 10-year period (i.e. 1991–2001) which did not have the benefit of the treatment guidelines and studies that are available now.

Summary

From this review of the literature, it is apparent that several parameters of voice and communication contribute to perception of gender and this is used as rationale for speech–language pathologists to help transgender speakers modify these parameters behaviourally. There are published examples of how these parameters are incorporated in treatment targets and techniques for vocal feminization with MTF persons. The treatment studies indicate fundamental frequency and resonance are common targets for modification and can be effectively modified with treatment. However, inclusion of intonation, language and non-verbal communication goals as suggested in the literature does not appear to be common. The small number of reports each include a fairly small number of cases and few experimental controls; limiting conclusions about what MTF clients need

and how those needs are actually met in clinical practice.

Purpose

The purpose of this study is to report 5 years of cases of voice feminization treatment. Unlike the tutorial articles prescribing what should be done in treatment, this paper aims to describe what has been implemented in several cases. It is expected that some characteristics common in the literature will be addressed in these cases (e.g. fundamental frequency and resonance) but the degree of homogeneity among the cases in terms of speaker characteristics, treatment goals or techniques, and outcomes is uncertain. The assessment data from these cases will characterize a large group of transgender patients and voice and communication treatment methods. This information will inform practitioners and researchers about a rapidly growing segment of their caseload and provide an indication of what measures have emerged as most relevant for achieving goals of being perceived as a female. In addition, data from a large cohort may provide a basis for setting reasonable expectations and prognoses. Specific research aims are as follows:

- Describe the characteristics of clients (i.e. general demographic and health history, voice disorder history, gender transition history and status—including hormone and sexual reassignment surgery status).
- Describe the treatment duration and goals.
- Describe, and quantify where possible, reported gains made in treatment goals.
- Explore the potential for demographic or initial-status measures to predict treatment outcomes by calculating correlations.

Method

Clinical setting and case inclusion criteria

The George Washington University Speech and Hearing Center (GWUSHC) is located in Washington, DC. As it is a university clinic, the majority of attending clinicians are first- and second-year graduate students supervised by licensed and certified speech–language pathologists and audiologists. Currently and during the period reviewed in this study the clients at the GWUSHC vary widely in age, ethnicity, socio-economic status and handicap. At any given time, approximately ten MTF transgender individuals receive assessment or treatment services at the GWUSHC for voice and communication. Approximately five new clients enrol each year as space becomes available. The GWUSHC has served

the transgender community for several decades with a positive and widespread reputation.

For this study a chart review was conducted of any MTF client discharged from treatment in 2006–2010. This resulted in 34 charts for MTF individuals who sought voice treatment for vocal feminization as part of their gender transition process. Nine of those clients did not have final evaluation measures and therefore were excluded from the study, leaving a remaining group of 25 MTF clients. Many of those excluded clients had fewer than five sessions; noted reasons for leaving included finances, moving, scheduling and personal conflicts. This study was approved by the Institutional Review Board (#111022).

Data-collection procedures

Demographic information such as age, biological gender, desired gender, date of initial and final evaluation, hormone treatment, and any relevant vocal and mental health concerns were recorded. Acoustic data from initial and final evaluations were included as quantitative measures. Mean F0 and intensity during sustained /a/, reading and monologue, as well as minimum and maximum frequency were collected. The GWUSHC uses a standard protocol for acoustic data collection (e.g. Reading the Rainbow Passage, task elicitation instructions). Frequency range was elicited by asking the client to ‘take a breath and say /a/ at a comfortable pitch and go up the scale as high as you can, like this (model provided)’ and then ‘Now start at a comfortable pitch and go down the scale as low as you can without getting gravelly, like this (model provided)’. Only the modal and falsetto registers were marked for analysis. Means and standard deviations of pre- and post-treatment values were calculated for acoustic data. All acoustic data were collected in a quiet (but not sound-proof) room in the GWUSHC using a Dell computer with Visi-pitch software with a Shure 48 microphone and pre-amplifier (Kay Pentax, Montvale, NJ, USA). Calibration information for intensity measures was not available. When present in the file, the Transgender Self-Evaluation Questionnaire (TSEQ; Dacakis 2006, Davies and Goldberg 2006), Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V; American Speech–Language–Hearing Association 2002), and Grade, Roughness, Breathiness, Asthenia, Strain scale (GRBAS; Hirano 1981) scores were included as well. The subjective ratings (i.e. CAPE-V and GRBAS) were completed by the student clinicians and verified by the supervising speech–language pathologist. No inter- or intra-rater reliability data were available; however, these instruments have been found to have adequate psychometric properties (Karnell *et al.* 2007). To understand what measures

Table 1. Demographic data for 25 male-to-female transgender individuals

	Range	Mean (SD)	Median
Age at treatment start (years)	21–60	43 (11.7)	48
Percentage of time presenting as female (initial assessment session)	0–100%	52% (34)	50%
Percentage of time presenting as female (final assessment session)	25–100%	90% (21)	100%
Number of sessions attended	2–77	22 (18)	16

were addressed to help the clients achieve their goals, a checklist of commonly used treatment targets was created. If the target was addressed at any time during the course of treatment, it was marked as being present. When described in the chart, activities or protocols for targeting a goal were noted; these were then compared across clients and are summarized below.

Results

Research aim 1: Description of cases

The 25 clients included in this study were all MTF clients (for demographic data, see table 1). At the time of initial assessment, four presented as female 100% of the time, nine presented as female 50–99% of the time, and 12 presented less than 50% of the time. By the final assessment, 20 were presenting as female 100% of the time. Information regarding sexual reassignment surgery was reported inconsistently. Clients ranged in age from 21 to 60 years. Twenty-one (84%) of the clients reported being employed; four clients (16%) were either unemployed or did not report an occupation. A majority of clients were either self-referred or had been referred to treatment at the GWUSHC by a friend in the transgender community; some were referred by a social worker or other healthcare provider. A majority (88%) of the clients included in the study had been on some variety of feminizing hormone treatment. Only six clients reported a history of depression or anxiety, otherwise clients did not report any significant mental health issues. Seven clients (28%) presented with some type of vocal disorder. Of those seven, the speech–language pathologist noted mild to mild-to-moderate dysphonia for four of the clients, some form of vocal tension or strain for two others, and only one client's chart included a report from an otolaryngologist diagnosing the client with bilateral sulcus vocalis. Unlike patients with voice disorders, transgender voice

and communication guidelines do not require client's to obtain a full voice evaluation from an otolaryngologist, therefore most of the charts did not include (or rule out) a medical diagnosis (World Professional Association for Transgender Health 2011).

Research aim 2: Description of treatment

Treatment sessions were typically once per week on a semester schedule. The GWUSHC is open approximately 10–12 weeks in each Fall, Spring, and Summer semester. Clients were provided with homework activities to maintain progress during semester breaks. These clients were enrolled in treatment for an average of 22.34 sessions. Many clients' reports included a long-term goal of achieving a feminine voice production and feminine language 100% of the time. Every client addressed at least one of the following in treatment goals: phonotraumatic behaviours, vocal hygiene, relaxation techniques, fundamental frequency, intonation, resonance, vocabulary, pragmatics, non-verbal communication and respiration. Figure 1 presents the frequency with which each area was addressed.

Mean F0 was targeted in treatment for 23 (92%) of the clients. All clients who focused on this aspect of speech reported wanting to attain a higher or more feminine pitch range. Activities included increasing speaking F0 while using visual feedback (i.e. frequency tracing software). Clients focused on increasing F0 by 5 Hz increments during different communication contexts, such as while producing the vowels /e/, /o/, /i/, /a/ and /u/, saying the days of the week, reading from a passage, or delivering a monologue. Of the two people who did not work on raising F0, one began treatment with a relatively high-frequency voice (186 Hz) and the other had several complicating factors. In addition to presenting with a low F0, her voice was characterized by mild-to-moderate dysphonia and within her first four sessions she reported stress at work and that 'voice therapy was re-prioritized towards the bottom of her list.'

Resonance, referenced in the charts either as increased oral resonance or forward resonance, was addressed with 24 clients (96%). Activities focused on having the client produce three to five syllable phrases using forward oral resonance with faded modelling. Clients aimed to use resonant voice in words with initial position bilabial (e.g. /m/) and semivowel (e.g. /w/) phonemes with a certain percent of accuracy (generally 80%) and progress to using a resonant voice in phrases containing words with other phonemes. Some activities attempting to achieve forward resonance incorporated nasal sounds and sensory feedback or other forward focus techniques. Generally all activities included under the resonance treatment goal focused on increasing

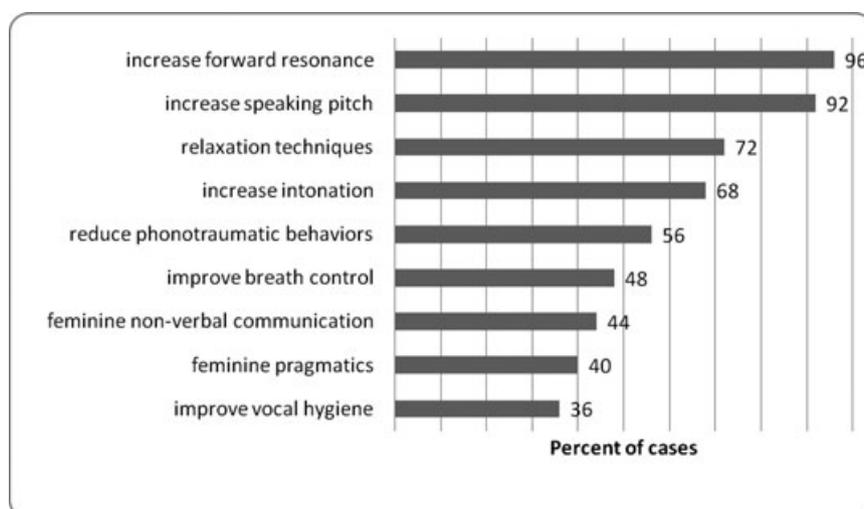


Figure 1. Percentage of the 25 MTF cases that included at least one goal for the topic.

forward resonance in a variety of different communication contexts.

Intonation treatment goals were targeted by 17 clients (68%). This goal focused on having the client demonstrate appropriate vocal variety and increasing intonation, and was independent from goals to increase SFF. Activities required the client to demonstrate upward intonation. Clients also practiced using expressive intonation at the phrase, sentence and paragraph level.

Goals relating to pragmatics (e.g. turn-taking, use of tag questions, specific or elaborate adjectives) were targeted by ten (40%) of the clients. Activities included having the client demonstrate appropriate turn taking with the clinician and asking the clinician appropriate follow up questions and tag questions (e.g. 'I didn't think so, did you?'). Clients were also instructed to use more adverbs, intensifiers (e.g. 'very' difficult) and relatively descriptive adjectives (e.g. lavender instead of purple) to gain a more feminine style of using language.

Non-verbal treatment goals were targeted by 11 (44%) of the clients. These focused on increasing feminine non-verbal body language such as facial expression and hand gestures. Clients were asked to observe and reflect upon differences between male and female communication styles. Clients also worked on attaining a 'feminine posture', though a description of such posture was not available.

Relaxation techniques were targeted in treatment for 18 (72%) of the clients. Relaxation treatment goals included working to maintain the appropriate posture to reduce muscle tension in the head and neck, stretching exercises, and shoulder rolls. Reducing laryngeal tension was commonly addressed by means of laryngeal massage by the clinician. Whole body relaxation led by the clinician was also used during treatment to help the

client feel more relaxed during the session and reduce effortful practice.

Breath control was targeted in treatment for 12 (48%) of the clients. Activities focused on increasing diaphragmatic breathing during conversational speech to ensure ample breath support while speaking. Clients initially learned to use diaphragmatic breathing without phonation and progressed to using it during phonatory activities.

Reducing specific phonotraumatic behaviours and improving overall vocal hygiene was a treatment goal targeted amongst 14 (56%) and nine (36%) of the clients, respectively. It is likely that vocal care was discussed with every client, but only in these cases did the client's poor vocal care habits warrant behavioural goals and significant time in treatment sessions. Generally, reducing phonotraumatic behaviours focused on decreasing hard glottal attack by using easy onset of voicing (e.g. produce words or phrases with easy voice onset in 8 out of ten opportunities). Vocal hygiene goals addressed levels of hydration, amount and intensity of daily voice use, and occasionally reflux precautions.

Research aim 3: Treatment outcomes

There were insufficient data to report general findings regarding standard subjective measures of voice (e.g. CAPE-V, GRBAS) and self-reports of voice-related quality of life (TSEQ, VHI). While reports included these measures at some point in the client's treatment, most did not include the same measure at both initial and final assessment times. Only one client had CAPE-V scores in both initial and final assessment: (all scores were normal or 'mildly deviant') and another client had complete GRBAS scores for both assessments (all scores were normal or 'slight'). Four of the 25 clients

Table 2. Mean notes and Hertz (SD) for acoustic data collected during voice feminization treatment for 25 male-to-female transgender individuals

Parameter	<i>n</i>	Initial assessment	Final assessment	Mean gain
/a/ f_0	24	C3, 136 Hz (46)	F#3, 184 Hz (34)	6 ST, 48 Hz (33)
Reading mean SFF	25	B2, 124 Hz (24)	D#3, 156 Hz (31)	5 ST, 32 Hz (24)
Monologue mean SFF	25	B2, 122 Hz (23)	D#3, 150 Hz (29)	5 ST, 28 Hz (21)
Minimum Hz	24	F#2, 90 Hz (26)	F#2, 88 Hz (31)	0 ST, -2 Hz (34)
Maximum Hz	24	A#4, 465 Hz (232)	E5, 579 Hz (279)	6 ST, 109 Hz (297)
Semitone range	24	27.3 ST (11)	31.8 ST (11)	4 ST (13)
/a/ intensity	14	64.9 dB (6.6)	69.4 dB (6.4)	4.2 dB (9)

Note: f_0 , fundamental frequency; SFF, speaking fundamental frequency; minimum, maximum and semitone range were collected during the glissando task. ST, semitones.

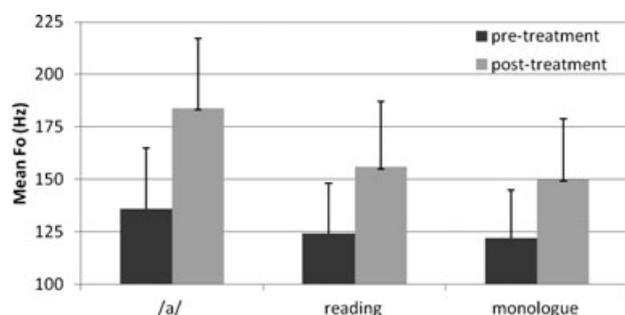


Figure 2. Mean pre- and post-treatment values (with SD bars) for mean F0 during three conditions ($n = 25$). All differences between these pre- and post-values were statistically significant at the $p < 0.05$ level.

completed a TSEQ at the beginning as well as end of the treatment course; three of them made overall gains on the 150 point scale (scores decreased from 98 to 32, from 94 to 70, and from 68 to 40) and one client's scores was fairly stable (score increased from 90 to 93).

There were data for the behavioural communication goals in nearly all cases. Table 2 and figure 2 display the acoustic properties of these client's voices before and after treatment. On average, clients gained 48 Hz (six semitones) during sustained /a/. This increase transferred to reading and monologue contexts, which both increased five semitones. On average, clients' frequency range expanded by almost half an octave, mostly due to increase at the higher end of their range (i.e. maximum frequency). For the 14 clients with initial and final intensity measures, sustained /a/ intensity increased by an average of 4 dB. It is important to note that standard deviations are large relative to the mean values, which indicates large variability and perhaps a heterogeneous sample. However, assumptions for parametric ANOVA were met. Repeated-measures ANOVAs found significant differences between pre- and post-treatment data for F0 during sustained /a/ ($F(1,23) = 49.2$, $p = 0.000$), reading ($F(1,24) = 44.0$, $p = 0.000$), and monologue ($F(1,24) = 42.5$, $p = 0.000$). No statistical differences were found for

minimum ($F(1,23) = 0.07$, $p = 0.791$) and maximum ($F(1,23) = 3.39$, $p = 0.079$) Hz during glissando task, total range in semitones ($F(1,23) = 3.02$, $p = 0.096$), or vocal intensity during /a/ ($F(1,13) = 3.20$, $p = 0.097$). Partial eta-squared effects sizes were large for changes in sustained /a/ (0.681), reading (0.647), and monologue (0.639). Medium effects were found for maximum Hz during glissando task (0.128), total range in semitones (0.116), and vocal intensity during /a/ (0.198), and small effects noted for minimum during glissando (0.003).

Research aim 4: Prognostic indicators

Pearson correlations were used to explore the potential for demographic and initial assessment voice data to predict gains from treatment. No significant correlations were found between the demographic variables of age, percent of time presenting as female at initial or final assessment and the voice variables listed in table 2. The total number of sessions did not correlate with any initial nor final acoustic data, but did significantly ($p < 0.01$) correlate to overall gains in F0 during sustained /a/ ($r = 0.534$), reading ($r = 0.552$) and monologue ($r = 0.564$). In other words, one may expect greater gains in F0 as the number of sessions increases.

Discussion

The aim of this study was to describe a large sample of transgender clients seeking voice and communication services with speech-language pathologists and explore the course and outcomes of services provided. Such information, particularly when based on a sample this large, can provide insight into the needs of transgender speakers as well as reasonable expectations for voice and communication services.

The 25 cases included in this study represent a large array of MTF individuals who seek voice treatment. The participant group consisted of MTF clients of varied stages of transition, ages, and educational

and occupational status. Not all cases addressed every variable discussed in the literature, and some used different measures or contexts for measures of certain variables (e.g. CAPE-V or GRBAS, fundamental frequency in sustained vowel or reading) at pre- and post-treatment assessments, resulting in limited conclusions about treatment gains. Nonetheless, in every case examined, improvement was made over the course of treatment in several areas. Based on the gains seen in a variety of voice and communication goals for these cases, it is likely that voice treatment can help the client progress toward a more gender appropriate speaking voice.

Several communication areas were addressed in these cases and data regarding individual progress on each treatment goal indicated clients were able to meet goal criteria before discharge; however, only the objective acoustic data could be pooled across cases for analysis. Previous reports in the literature (described above) suggest a mean fundamental frequency of at least 180 Hz for vowels (Gorham-Rowan and Morris 2006) and 155 Hz for connected speech (Wolfe *et al.* 1990) is necessary to achieve perception as a female voice. Those values are highly consistent with the average post-treatment data collected from these 25 cases. It should be noted that pitch is perhaps the most significant contributor to gender perception, but it is not the only contributor. The acoustic data here provide evidence that MTF speakers can change these voice parameters to a significant extent; however, that those changes correspond to the desired perception of gender and indicate evidence of treatment effectiveness is somewhat speculative.

The 16 cases in west Sweden reported by Soderpalm *et al.* (2004) have some similar characteristics to the 25 American cases reported in this paper: mean age at initial treatment near 40 years and few voice pathologies. Like the MTF cases in Soderpalm *et al.*, duration of treatment varied but behaviours addressed were fairly consistent across cases. In both reports, a significant increase in fundamental frequency was made during the period of intervention. Two cases in Soderpalm *et al.* underwent phonosurgery (i.e. crico-thyroid approximation) after being dissatisfied with therapy. The current review did not find any reports of discharge due to client's pursuit of phonosurgery, but this must be viewed with caution as no attempts were made to follow-up with any case to determine whether phonosurgery was sought.

Twenty-five cases allows for use of inferential statistics to draw conclusions that may apply to a majority of the clients seen in similar settings (i.e. American university speech-language pathology clinics). However, within these 25 cases a few notable outliers existed. For example, most people spent two or three semesters in treatment but one person required 77 sessions (i.e. eight semesters, about 2.5 years) to

meet her goals. This might be attributed to a speaking fundamental frequency of 80 Hz and a limited range of 14 semitones at the time of initial assessment. Therefore, it should be emphasized that this study's findings simply describe a general state of clinical affairs and are not intended to be prescriptive per se. It may be that some variables can predict treatment outcomes or prognosis; however, at this time the only clear predictor for an outcome of increased fundamental frequency is increased number of treatment sessions.

Future research

A retrospective chart review is a first step toward establishing treatment evidence. The data in this report certainly suggest that speech-language pathology should move forward with prospective research designs utilizing empirical controls. With that in mind, a few observations from this project are offered for consideration in the development of future treatment protocols. First, objective measurement of forward resonance should be incorporated in assessment protocols. As resonance and formant frequencies are indicative vocal characteristics of speaker gender, it is important to objectively measure change in this aspect of the voice, or at least establish validity and reliability of subjective methods (i.e. rating scales used by clinicians). While a standard measurement would be helpful for all the measures, we prioritize resonance because it is among the most often suggested treatment targets. It is acknowledged that this issue of resonance measurement pervades all voice research and is not unique to transgender voice.

Second, the TSEQ or other appropriate self-report measure of impairment, activity, and participation restriction should be utilized during each initial and final assessment to measure the client's satisfaction with the changes (or lack thereof) in their voice during treatment. For treatment to be considered effective, the client's satisfaction with their voice must be included when establishing treatment goals.

Third, documentation of a client's satisfaction with services or reason for leaving is valuable in evaluating the effectiveness of treatment protocols for every person who enrolls, not just those who complete treatment. The current review was not able to determine why some clients discontinued treatment before clinicians noted complete vocal feminization. It is possible that the clinician's and the client's standards were not aligned, or perhaps the client felt the costs (e.g. time, money, effort) were no longer justified if adequate gains had been made. It is also possible that those clients had misconceptions about the treatment process and possible outcomes, or did not feel comfortable with students in a university clinic. Any explanation is speculative at this point, but a thorough examination of the client expectations and

the value placed on treatment of voice and communication could guide the format and delivery of treatment protocols in the future.

Future research using prospective methods and larger number of participants would advance evidence-based practice for transgender voice and communication. Such studies should include objective voice data as well as reliable and valid procedures for subjective measures. Transgender therapy is typically designed with an assumption that gains in particular objective measures (e.g. fundamental frequency) correspond to changes in how patients are perceived. Therefore, clients' self-perceptions as well as unfamiliar listener's perceptions should be collected before and after therapy in order to examine social validity of treatment. Also, a prospective research design or a broader survey might discover prognostic indicators useful for clients' planning for time and financial costs of voice and communication treatment.

Conclusion

Treatment goals for clients included in this study are consistent with those goals most often recommended in the research literature regarding voice and communication treatment for transgender clients. The vocal characteristics considered highly salient to gender attribution (i.e. fundamental frequency and resonance) were the most targeted during the treatment for these clients. Speech and non-verbal characteristics that were suggested to effect the perception of speaker gender were also addressed to some degree in most cases. Voice and communication treatment for these MTF individuals did result in changes and thus appears to have been effective, although measures of how communication partners perceive the speaker's gender would be most useful to determine the effectiveness of the ultimate goal: passing as desired gender. Further research is warranted to determine the efficacy of specific treatment protocols and potentially influential factors such as initial voice and communication status.

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References

ADLER, R. K., HIRSCH, S. and MORDAUNT, M., 2006, *Voice and Communication Therapy for the Transgender/Transsexual Client: A Comprehensive Clinical Guide* (San Diego, CA: Plural).

AMERICAN SPEECH–LANGUAGE–HEARING ASSOCIATION, 2002, *Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V)*

(Rockville, MD: American Speech–Language–Hearing Association).

CAREW, L., DACAKIS, G. and OATES, J., 2007, The effectiveness of oral resonance therapy on the perception of femininity of voice in male-to-female transsexuals. *Journal of Voice*, **21**, 591–603.

CHRISTIANSON, A. and ADLER, R., 2006, Psychosocial issues. In R. K. Adler, S. Hirsch and M. Mordaunt (eds), *Voice and Communication Therapy for the Transgender/Transsexual Client: A Comprehensive Clinical Guide* (San Diego, CA: Plural), 317–343.

COLTON, R. H., CASPER, J. K. and LEONARD, R. (eds), 2006, *Understanding Voice Problems: A Physiological Perspective for Diagnosis and Treatment*, 3rd edn (Baltimore, MD: Lippincott Williams & Wilkins).

DACAKIS, G., 2000, Long-term maintenance of fundamental frequency increases in male-to-female transsexuals. *Journal of Voice*, **14**, 549–556.

DACAKIS, G., 2006, Assessment and goals. In R. K. Adler, S. Hirsch and M. Mordaunt (eds), *Voice and Communication Therapy for the Transgender/Transsexual Client: A Comprehensive Clinical Guide* (San Diego, CA: Plural), 101–126.

DAVIES, S. and GOLDBERG, J. M., 2006, Clinical aspects of transgender speech feminization and masculinization. *International Journal of Transgenderism*, **9**, 167–196.

DE BRUIN, M. D., COERTS, M. J. and GREVEN, A. J., 2000, Speech therapy in the management of male-to-female transsexuals. *Folia Phoniatrica et Logopaedica*, **52**, 220–227.

FITZSIMONS, M., SHEAHAN, N. and STAUNTON, H., 2001, Gender and the integration of acoustic dimensions of prosody: implications for clinical studies. *Brain and Language*, **78**, 94–108.

GELFER, M. P., 1999, Voice treatment for the male-to-female transgendered client. *American Journal of Speech–Language Pathology*, **8**, 201–208.

GELFER, M. P. and MIKOS, V. A., 2005, The relative contributions of speaking fundamental frequencies to gender identification based on isolated vowels. *Journal of Voice*, **19**, 544–554.

GELFER, M. P. and SCHOFIELD, K. J., 2000, Comparison of acoustic and perceptual measures of voice in MtF transsexuals perceived as female versus those perceived as males. *Journal of Voice*, **14**, 22–33.

GORHAM-ROWAN, M. and MORRIS, R., 2006, Aerodynamic analysis of male-to-female transgender voice. *Journal of Voice*, **20**, 251–262.

HANCOCK, A. and HELENIUS, L., 2012, Adolescent male-to-female transgender voice and communication. *Journal of Communication Disorders*, **45**, 313–324.

HILLENBRAND, J. M. and CLARK, M. J., 2009, The role of fundamental frequency and formant frequencies in distinguishing the voices of men and women. *Attention, Perception, and Psychophysics*, **71**(5), 1150–1166.

HIRANO, M., 1981, Psycho-acoustic evaluation of voice. In G. E. Arnold, F. Winckel and B. D. Wyke (eds), *Disorders of Communication*, 5 (New York, NY: Springer), pp. 81–84.

HIRSCH, S., 2006, Nonverbal communication: assessment and training. In R. K. Adler, S. Hirsch and M. Mordaunt (eds), *Voice and Communication Therapy for the Transgender/Transsexual Client: A Comprehensive Clinical Guide* (San Diego, CA: Plural), pp. 317–343.

HOOPER, C. R. and HERSHBERGER, I., 2006, Language: pragmatics and discourse. In R. K. Adler, S. Hirsch and M. Mordaunt (eds), *Voice and Communication Therapy for the Transgender/Transsexual Client: A Comprehensive Guide* (San Diego, CA: Plural), pp. 269–282.

- KALRA, M. A., 1977, Voice therapy with a transsexual. In R. Gemme and C. Wheeler (eds), *International Congress on Sexology* (New York, NY: Plenum), pp. 77–84.
- KARNELL, M. P., MELTON, S. D., CHILDES, J. M., COLEMAN, T. C., DAILEY, S. A. and HOFFMAN, H. T., 2007, Reliability of clinician-based (GRBAS and CAPE-V) and patient-based (V-RQOL and IPVI) documentation of voice disorders. *Journal of Voice*, **21**, 576–590.
- MCNEILL, E. J. M., 2006, Management of the transgender voice. *Journal of Laryngology and Otology*, **120**, 521–523.
- MESZAROS, K., VITEZ, L. C., SZABOLCS, I., GOTH, M., KOVACS, L., GOROMBEL, Z. and HACKI, T., 2005, Efficacy of conservative voice treatment in male-to-female transsexuals. *Folia Phoniatrica et Logopaedica*, **57**, 111–118.
- MOUNT, K. H. and SALMON, S. J., 1988, Changing the vocal characteristics of a postoperative transsexual patient: a longitudinal study. *Journal of Communication Disorders*, **21**, 229–238.
- NELSON, A. and GOLANT, S. K., 2004, *You Don't Say: Navigating Nonverbal Communication between the Sexes* (Englewood Cliffs, NJ: Prentice-Hall).
- OATES, J. M. and DACAKIS, G., 1983, Speech pathology considerations in the management of transsexualism: a review. *British Journal of Disorders of Communication*, **18**, 139–151.
- OWEN, K. and HANCOCK, A. B., 2010, The role of self- and listener perceptions of femininity in voice therapy. *International Journal of Transgenderism*, **12**(4), 272–284.
- PETERSON, G. and BARNEY, H., 1952, Control methods used in a study of the vowels. *Journal of Acoustical Society of America*, **24**, 175–184.
- SODERPALM, E., LARSSON, A. and ALMQUIST, S. A., 2004, Evaluation of a consecutive group of transsexual individuals referred for vocal intervention in the west of Sweden. *Logopedics, Phoniatrics and Vocology*, **29**, 18–30.
- VAN BORSEL, J., JANSSENS, J. and DE BODT, M., 2009, Breathiness as a feminine voice characteristic: a perceptual approach. *Journal of Voice*, **23**(3), 291–294.
- WOLFE, V. I., RATUSNIK, D. L., SMITH, F. H. and NORTHROP, G., 1990, Intonation and fundamental frequency in male-to-female transsexuals. *Journal of Speech and Hearing Disorders*, **53**, 43–50.
- WORLD PROFESSIONAL ASSOCIATION FOR TRANSGENDER HEALTH, 2011, *Standards of Care for the Health of Transsexual, Transgender, and Gender Non-Conforming People*, 7, pp. 52–54.