The Effects on Acoustic Voice Measures and the Perceived Benefits of a Group Singing Therapy for Adults With Parkinson's Disease

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ABSTRACT: The purpose of this single-group, pre-post, quasi-experimental study was to examine the effects of participation in a therapeutic singing protocol (TSP) on the voice quality and wellbeing of individuals with Parkinson's disease who attended eight weekly Parkinson's community choir rehearsals. We hypothesized that participants would show improvement on vocal outcome measures and report personal-social benefits from choral singing. A board-certified music therapist conducted 50-minute sessions consisting of physical and breathing warm-ups, vocal exercises and singing designed to increase phonatory effort, glottal closure, and to maintain vocal strength. Data included audio recording participants on singing tasks (messa di voce, sustained vowel), speech tasks (reading, conversation), and exit interviews. The Wilcoxon non-parametric signed rank test was used to determine any significant changes ($p < 0.05$) in acoustic measures. Participants showed statistically significant improvements in sample duration, mean intensity, maximum intensity, cepstral peak prominence, jitter, shimmer, and harmonic-to-noise ratio. Post choir interviews noted participants believed their voices had become stronger, reported increased confidence in conversation, improved mood, and that the choir was an intrinsically motivating and meaningful experience. Consequently, TSP may have potential as an adjunct to speech therapy to improve the vocal functioning of individuals with Parkinson's disease.

KEYWORDS: phonatory effort, vocal fold adduction, music therapy, singing, Parkinson's, acoustic, intensity, voice

INTRODUCTION

PARKINSON'S disease (PD) is a degenerative condition affecting 7-10 million people worldwide, with one million reported cases in the United States (Parkinson's Disease Foundation, 2010). Central to decline are problems in movement and speech. Hypokinetic dysarthria occurs in 89% of cases (Ramig et al., 2008), can appear at any stage of PD, worsen in later stages, and cause a progressive loss of functional communication (Logemann et al., 1978; Ramig et al., 1995; Pinto et al., 2004), contributing to decreased quality of life (social skills, relationships and emotional wellbeing) (Selman, 1988; Bright, 2006; Mahler et al., 2015). Hypokinetic dysarthria is characterized in speech by reduced vocal loudness (hypophonia – a 2-4 dB reduced intensity in speech and voice tasks) (Fox & Ramig, 1997), a breathy, hoarse or rough voice quality (dysphonia) (Little et al., 2011), imprecise consonants and distorted vowels, and reduced voice pitch inflections or monotone voice (Mahler et al., 2015). These changes result in reduced intelligibility (Ramig et al., 2008) and also may make adults feel defensive, less confident and less likely to engage in social conversation (Trail et al., 2005; Elefant et al., 2012). Since symptoms of hypokinetic dysarthria increase over time, interventions are considered effective if these improve or maintain skills.

Parkinson's patients often seek help to address voice and speech complaints. A common treatment is the Lee Silverman Voice Treatment (LSVT LOUD), an approach that addresses aspects of vocal function (Ramig et al., 1995; Ramig et al., 1996; Ramig & Dromey, 1996; Sapir et al., 2007; Shih et al., 2012). Music-based interventions have been used to treat the physical (Swallow, 1987) and psychological effects of PD (Kneafsey, 1997; Selman, 1988). Haneishi (2001) found improved mood states and tolerance for rehabilitative exercises following a voice protocol that included singing. Cohen and Masse (1993) found participants with PD showed improvements in functional communication, and drawing on the principles of LSVT, Haneishi (2001) developed a Music Therapy Voice Protocol (MTVP) that showed significant improvement in speech intelligibility, as rated by caregivers, and vocal intensity after individual sessions with people with PD.

In a development of the work of Haneishi (2001) and Perez-Delgado (2007), Yinger and LaPointe (2012) used a group music therapy voice protocol (G-MTVP) to address speech intelligibility. Changes in mean speech intensity were observed from reading and conversational speech tasks measured after the six-week program.

In a post-intervention questionnaire, participants cited benefits to vocal production and group camaraderie that were reflected in the fun, social setting of the choir. Outcome benefits cited by Yinger and LaPointe (2012) suggest that group activities such as choir singing appear to address core psychological concerns including isolation and withdrawal, and may also provide positive social experiences that enhance wellbeing (McNamara et al., 2006; Moore & Seeney, 2007). For example, Dingle, Brander, Ballantyne and Baker (2012) found that participants in a choir discovered a new and valued social group identity, an increased social connectedness, and improved health. Choir singing can also inspire confidence, reduce isolation, and may be of greater benefit than either singing alone or merely participating in a social activity (Skingley & Bungay, 2010).

The literature suggests that music-based interventions, and choral singing in particular, may help patients mitigate some of the negative symptoms associated with PD, thereby enhancing connections to others (e.g. partner, community) and providing a creative, of self-care. This way of understanding music as a resource is consistent with the Folkman et al. (1986) model of stress and coping, in which symptom distress, such as loss of vocal control, is managed by activating available resources that help one cope with the difficulties at hand.

Additionally, meaningful, 'normal' activities (e.g. singing in a choir, focusing on creative expression) are perceived to provide quality of life benefits such as increased interpersonal connections (Yinger & LaPointe, 2012).

PURPOSE

This pilot study examined measurement of the benefits of community choir singing on voice qualities and perceived meaningfulness for adults with PD. It drew from a community that has an active Parkinson's support network, emphasizing not only the benefits to symptoms commonly associated with PD, but also the nature of music as a creative, health enhancing undertaking that promotes connections to others and a sense of belonging. The research questions were:

1. Can objective acoustic analysis measure potential improvements in voice outcomes of adults with Parkinson's disease (hypophonia and dysphonia) participating in an eight-week community choir?
2. Can exit interviews measure choir member perceptions of their functional communication, social interactions, sense of community and wellbeing?

We hypothesized that participants would show improvement on vocal outcome measures and report personal-social benefits from choral singing.

METHODS

This study employed single group, pre-post design, with data collected prior to and at the completion of eight choir rehearsals. The independent variable was choir participation, with a specific Therapeutic Singing Protocol (TSP) guiding each choir rehearsal. Dependent variables were outcome measures obtained from acoustic analysis of voice recordings (described below). In addition, all participants completed exit interviews following completion of the eight-week program.

Participants

This study was conducted in compliance with the Shenandoah University Institutional Review Board, and utilized a convenience sample. Choir members included 15 individuals with Parkinson's disease (4 women and 11 men), and 7 of their caregivers/partners. The caregivers/partners contributed to the choir's social component and enhanced participants' motivation to sing, but were not otherwise included in this study. Participants varied in age from 45-86 years ($M = 66.5$). The data of three participants were excluded from analysis because of missing data points (one received DBS treatment after pre-test data collection, one did not phonate during pre-choir recording, one did not complete post-choir data collection). A total of 19 adults participated in the choir. Participants received no other therapies during the eight-week period of the study.

Participants had stage 2 or 3 PD symptomatology on the Hoehn and Yahr (1967) symptom scale, exhibiting deficits in verbal communication and mobility warranting supportive interventions (Hoehn & Yahr, 1967). Participant prior experience or technical training in voice were not disclosed to researchers. For a summary of participant demographics, see Table 1.

Table 1. Demographic Information on Participants with Parkinson's Disease

Age (Years)	Gender	Years Since PD Diagnosis	Other Treatments/ Therapies
63	female	18	DBS*
63	female	3	None
71	male	9	DBS
86	male	6	LSVT BIG**
62	male	5	DBS
70	male	0.7	Speech Therapy
60	male	8.5	LSVT BIG
45	male	10	DBS
62	male	12	DBS
62	male	12	DBS
83	male	8	None
71	male	3	Speech Therapy

*Deep Brain Stimulation
**LSVT BIG applies the principles of LSVT LOUD to limb movement (LSVT Global, retrieved February 25, 2016)

Procedure

Participants attended eight weekly choir rehearsals, each lasting 50-minutes. Rehearsals followed a specific Therapeutic Singing Protocol (TSP) adapted from Yinger and LaPointe (2012):

1. *Opening song and conversation (5 min):* Choir director welcomed the participants, led them in a vocal warm-up, asked about news in their lives, and summarized the activities in which the participants were about to engage.
2. *Posture/body alignment (2 min):* Choir director directed the group members to place both feet flat on floor at shoulder width, sit tall in chairs, expand chest and lower ribs, lower and relax shoulders, and gently elongate back of neck to align head over spine.
3. *Breathing exercises (3 mins):* Participants stretched three linked rubber bands during exhalation/phonation and released the tension in the linked rubber bands during inhalation. Over the course of the 12 weeks, participants were asked to stretch the linked rubber bands while blowing out air for 12, 16, and ultimately 20 seconds.
4. *Voice warm-ups (5 mins):* Choir director led the choir in three trials of vocal "sighs" sung beginning in the middle of each participant's vocal range and descending in pitch to the bottom of the vocal range. The "sigh" terminated in a vocal fry (or 'scrasp') and participants were guided to execute the fry in a quiet/gentle manner. Participants then mimicked a siren by beginning with a quiet fry, vocalizing up through their vocal range in relaxed manner and upon reaching their apex "sighing" back down and terminating in the fry. Once again employing rubber bands, participants sang five glottal /a/ vowels (/ʔ a/) sustaining the final one while stretching rubber bands. The fry and /ʔ a/ were chosen to strengthen vocal fold adduction.
5. *Applied Technique (10 mins):* Participants used a /ʔ a/ onset to sing a familiar song (e.g. "Amazing Grace") and stretched rubber bands to sing long phrases or support high notes while singing these familiar songs.
6. *Singing familiar songs (20 mins):* Participant-preferred songs (folk, country, pop, and rock) were sung with live guitar accompaniment. Choir director encouraged generalization of techniques from warm-ups and encouraged participants to entertain themselves by inflecting lyrics to subtly change the emotional meaning of songs.
7. *Closing song and conversation (5 min):* Choir director led participants in singing a closing song, identified strengths of the rehearsal, and looked ahead to the next rehearsal.

The primary investigator designed this musical intervention to incorporate the clinical drills developed by Yinger and LaPointe (2012) in a choral setting. This allowed participants to experience each therapy session as a *rehearsal* though the tasks were designed to maintain or improve hypophonia or dysphonia. As such, the emphasis of each choir rehearsal was on the creative group undertaking of making music. Additionally, the primary investigator and music therapist (MT-BC) who conducted the choirs is referred to as the "choir director" in this pilot study.

Data Sources and Collection

Three data sources were included in the research design, summarized in Table 2.

Demographic information

Participants completed a demographic profile including information regarding age, diagnosis, medications and additional/related health concerns. Participants also listed previous and current treatments.

Recordings of Speech and Singing tasks

Voice outcome measures were obtained prior to and following completion of the eight-week choral singing program. Instructions were scripted, recorded, and administered by the choir director. Tasks included:

1. Messa di Voce (MDV). Developed in 1898 by Concone, it is a singing voice exercise and a common building block in voice pedagogy (Titze, 2010). The MDV is singing task in which a single pitch is sung with varying loudness, beginning at a minimal intensity, crescendo to maximal intensity, decrescendo to minimal intensity, sustaining for maximal duration, all on a single breath. This requires a high level of vocal coordination, particularly in the decrescendo phase (Titze, 1996; Christiansen, 2005).
2. Reading of the Rainbow Passage (Ramig et al., 1996).
3. Completion of the Consensus Auditory Perceptual Evaluation of Voice (Zraick et al., 2011) tasks including: the reading of six standard sentences, sustained /i/ and /a/ vowels.

Interviews

At the end of the eight-week choir rehearsal sequence participants completed 30-minute semi-structured interviews, answering the following questions: a) Please describe your experience of being in the choir. b) Comparing how your voice felt before the choir sessions to how your voice feels now, please describe any changes. c) What effects has the choir experience had on your day-to-day quality of life? d) What feedback to do you have for the researchers? e) How could the experience have been improved? In an approach similar to Dingle, et al. (2012), participants' responses were recorded in detailed notes and evaluated in relation to the themes of personal impact, social impact, and functional outcomes perceived by participants. Questions were developed from the researcher's observation of choir members' experience, and their informal comments, during the eight-week choir program.

Acoustic Measures

All audio signals were recorded with a Marantz PMD661MK2 recorder and an Earthworks M30 condenser omnidirectional measurement microphone at 44.1 kHz, 16 bit sampling rate (uncompressed). Recording levels were calibrated with eight seconds of white noise at 90 dB (as verified by a CheckMate Galaxy CM-140 SPL Meter) prior to each sample collection session to preserve the validity of the recordings' intensity data. Participants maintained a 30 cm (on axis) recording distance during sample collection. Recordings were made in the Janette Ogg Voice Research Center, an acoustically treated space with a noise floor of 42 dB.

Acoustic measures included: sample duration, mean intensity, maximum intensity, cepstral peak prominence (CPP), jitter, shimmer, and harmonic to noise ratio (HNR).

Hypophonia (perceived reduced loudness) was objectively evaluated by measuring sample duration (seconds), and mean/maximum sound intensity (dB) of the MDV, the Rainbow Passage, and CAPE-V Sentence tasks.

Cepstral peak prominence (CPP) was employed to objectively measure dysphonia in the voice signal (Heman-Ackah et al., 2014) with lower values indicating greater dysphonia or breathiness, and higher values indicating less dysphonia or breathiness (i.e., greater overall clarity of voice). Stable mid-portions of both the speech and sustained vowel tasks were used for this measure.

Periodicity of the vocal signal was objectively evaluated by measuring jitter, shimmer, and HNR from the stable mid-portion of the sustained vowel task. Jitter and shimmer are measures of signal periodicity that quantify cycle-to-cycle variations in fundamental frequency and amplitude, respectively (Hartelius et al., 1997). Harmonics-to-noise ratio (HNR) detects cycle-to-cycle differences in the voice signal and quantifies spectral noise (Awan et al., 2009).

Data Analysis

Quantitative Analysis

Acoustic analyses of the audio recordings of speaking and singing tasks were performed using Praat Software version 6.0.42 (Boersma & Weenink, 2001). Because the data were not normally distributed the Wilcoxon signed rank test was used to compare pre- and post-test study values for all acoustic analysis variables.

Qualitative Data

The semi-structured interviews were analyzed through standard narrative analysis. Two investigators independently read interview transcripts, divided these into content units, and categorized these under content codes. Disagreements in content codes were resolved through discussion. Subsequently, themes were independently identified; content codes were categorized by theme. Themes containing a greater number of content units were considered more prominent than those with fewer content units.

RESULTS

Acoustic Analyses

Post-therapy values were significantly higher (see Table 2) for all acoustic measures (mean and maximum intensity in dB, CPP, Jitter, Shimmer, and HNR) of task recordings (MDV, Rainbow Passage, CAPE-V Sentences, and CAPE-V Sustained Vowel). MDV and Sustained Vowel tasks were repeated five times with the high and low results discarded. Rehearsal effect may have been confounded by fatigue effect. Participants did not appear to improve with each successive repetition, and participant age appeared to be unrelated to improvements in acoustic results.

Table 2. Mean, SD, and P Values of Acoustic Data Pre- and Post-TSP in Choir Members with PD

Measure	Pre-TSP Mean (SD)	Post-TSP Mean (SD)	*p*-value
Messa di Voce			
Dur	8.03 (3.82)	10.84 (5.87)	0.003**
Mean dB	80.31 (5.63)	84.58 (4.63)	0.012*
Maximum dB	84.9 (6.15)	89.11 (5.11)	0.015*
Rainbow Passage			
CPP	9.5 (1.65)	10.1 (1.57)	0.008**
Mean dB	70.86 (3.21)	72.31 (3.87)	0.008**
Maximum dB	81.65 (4.2)	83.7 (5.36)	0.019*
CAPE-V Sentences			
CPP	9.57 (1.57)	10 (1.59)	0.028*
Mean dB	71.98 (4.93)	81.53 (4.47)	0.003**
Maximum dB	81.53 (4.47)	83.52 (4.48)	0.015*
Sustained Vowel			
CPP	15.74 (2.82)	17.35 (2.23)	0.004**
Jitter	0.4533 (0.1646)	0.3275 (0.1621)	0.003**
Shimmer	6.1858 (3.4699)	3.5308 (1.269)	0.003**
HNR	18.2625 (3.1266)	20.2217 (3.6701)	0.019*

P values on Wilcoxon signed-rank test mean+/-SD of pre-TSP and post-TSP measures are reported. Effects significant at $p<0.05$(*) and $p<0.009$(**) are noted.

Abbreviations: CAPE-V, consensus auditory-perceptual evaluation of voice sentences; CPP, cepstral peak prominence; Dur, duration. HNR, harmonic-to-noise ratio; dB, intensity in dB; MDV, messa di voce; PD, Parkinson's disease; RP, Rainbow Passage; Sent, sentences; SD, standard deviation; ST, sustained vowel; TSP, therapeutic singing protocol.

Semi-structured Interviews

Qualitative analysis of semi-structured post-treatment interviews yielded three themes: 1) wellbeing related to the choir experience, 2) vocal improvement, and 3) motivation for practice/singing (see Table 3).

Table 3. Exit interview responses

Theme 1 – Wellbeing
"Director made it fun"
"Communication, instruction, atmosphere, respect all good"
"Less stressful than other choirs"
"Enhanced attitude"
"Gave me something to look forward to"
"Enjoyed singing, my wife loves it"
"I see myself going out more to contact people"
"Looking forward to talking to someone"
"Psychologically, physically, it was meaningful and worthwhile"
Theme 2 -- Voice
"I can be heard now"
"Louder, better clarity"
"A bit more resonant, authoritative"
"A little more clarity"
"Took less effort to do day-to-day talking"
"Friends say I'm talking much louder, projecting"
"More cognizant of breathing and putting bass in my voice"
Theme 3 -- Motivation
"I want something to bring home to practice"
"Longer sessions – just getting into it when we stop"
"I want more sessions per week, at least twice"
"I was inspired being with others like me and seeing them improve"

Participants described a heightened sense of wellbeing as a result of their participation in the choir. Voice and speech comments revealed increased confidence in speech and the perception that participant voices were louder, had more resonance and clarity, and that it was easier to be heard when employing techniques from choir rehearsals.

Participants expressed motivation to sing for the purpose of improving the speaking voice in the company of caregivers and others with PD. They suggested that the choir sessions be longer, offered twice weekly, and requested homework to be able to generalize therapeutic techniques outside of choir rehearsal. Several comments regarding motivation were closely linked to statements of an enhanced sense of wellbeing.

DISCUSSION

The purpose of this study was to examine the effects of a therapeutic choral singing program on the wellbeing and some acoustic correlates of the voice qualities of individuals with PD. Our hypothesis that participants would show improvement on vocal outcome measures and report personal-social benefits from choral singing was supported by the data. Quantitative acoustic measures revealed pre-post positive effects. Qualitative measures suggested perceived improvements in participant wellbeing, voice, and motivation.

Quantitative measures

Substantial and significant improvements in MDV maximum intensity and duration are indicative of improved vocal function. Thus, a primary gain of the treatment was related to a singing task involving loudness dynamics. As the program was focused on choral singing and loudness, this is not surprising. Likewise, gains in intensity (mean and max) were also observed in the Rainbow passage. Increases in CPP values and reduction in shimmer may also stem from gains in intensity because CPP rises with intensity while shimmer lowers (Maryn et al., 2009) (Orlikoff & Kahane, 1991; Brockmann-Bauser et al., 2018). In sum, the program appears to have had a positive effect on intensity, and consequently, some improvement in voice quality.

Improvements in duration and intensity of singing and speech tasks may have resulted from warm-ups and voice drills in the TSP addressing breath management and improved glottal closure. Note that this study did not include a comparison of the TSP with other therapeutic protocols. Although intensity maximum and average intensity were significantly increased in conversation at study completion, these gains were small (e.g. 1-2 dB). Loudness gains in speaking have shown to require intensive daily practice, (Baumgartner et al., 2001); this was not included in the program.

Qualitative measures

Preferred music sung in a choral setting provided a meaningful experience, and enhanced caregiver relationships and social interaction. Based on the

post-treatment interviews and weekly anecdotes at rehearsal, participants were surprised with how much fun they were having singing familiar songs. Participants knew that voice work was important for quality of life maintenance, but were apprehensive about singing. The choir director celebrated all vocal contributions and prioritized a reduction in anxiety over perfection of craft. Use of eye contact, member names, and humor supported an experience that was, therapeutic and entertaining. Choir members appreciated the accepting, low-stress and anxiety setting of choir rehearsals and found that they were more expressive in their singing because they were treated as 'normal' members of a 'normal' choir rather than as 'sick people' struggling with a 'disease'. Participants' request for an increased frequency of choir practice is particularly interesting. The request for more sessions is likely related to the wellbeing and social benefits associated with choral singing. Since a greater intensity of treatment may result in greater gains, more frequent and more intensive choral practice holds potential for greater vocal improvement. Future studies may find greater voice improvement in choirs that focus primarily on drills, but reduced psychosocial adjustment in their choir members. Balancing the mix of technique, drill and free creative expression in singing is the choir director's 'art'.

Acoustic and qualitative findings are consistent with those of Yinger and LaPointe (2012) regarding the use of choir singing to improve intensity in speech, and reinforce the notion that choir participation may not only support the maintenance of existing skills, but may also improve aspects of speech intelligibility in the face of significant declines often associated with the disease process (Pinto et al., 2004).

Limitations and considerations for further research

Parkinson's disease processes affect characteristics of motor skills in ways that present challenges to data collection. Participants reported in exit interviews that they experience voice variability each day, due to their medication cycles and the extent to which they experience 'good' or 'bad' days (days on which they are more or less symptomatic). Not only do they experience good and bad days but also have 'good' and 'bad' hours and minutes in connection with their medication cycles, and related medical conditions. A number of participants reported that they experienced this phenomenon during the course of the study. Thus, researchers may choose to collect data at a time when each participant reports feeling less symptomatic.

Vocal improvement may in part have resulted from participants' desire to impress the choir director who collected post-treatment data. Future studies should take care to minimize this effect by separating the choir director from any data collection and should consider either family report or covert measures of vocal function.

Choir size was an additional limitation to the current study. Small choirs reduce generalizability of findings, but maximize the choir director's ability to provide individual attention to each choir member – the converse is true of large choirs. Researchers may be able to balance these concerns by determining an optimal choir size range, and/or using multiple choirs during data collection.

Another consideration relates to the regularity and length of choir rehearsals (i.e. "dosage"). The current study featured a low frequency and duration: one rehearsal per week for eight weeks. Increasing the frequency and/or duration of the treatment may improve the measurable impact on dysphonia, but may also limit the recruitment and compliance of participants in future studies. These individuals often have schedules that are full of medical and rehabilitation appointments. Further investigation into the impact of session frequency (number per week), length (time of each rehearsal), and duration (number of weeks), on the maintenance or improvement of voice in individuals with PD is warranted.

A further limitation is the lack of a comparison with different choral programs and protocols to shed additional light on the therapeutic value of specific aspects of the TSP.

Future studies would also benefit from assessment of test-retest reliability of the acoustic measures, pre-treatment laryngeal examinations, and the inclusion of a number of perceptual raters. A recommended number of raters for future studies may be 8-12, as suggested by studies of this population in related fields (Awan et al., 2010).

CONCLUSION

Results suggest that individuals with PD may find improvements in voice quality, functional communication, and sense of wellbeing following a creative musical experience such as the TSP. This supports the findings of Yinger and LaPointe (2012). The neurodegenerative nature of Parkinson's disease poses challenges to therapeutic compliance in this population. Participants in this

study reported feeling motivated to comply with the TSP, and they largely maintained or improved their vocal skills. TSP is a promising adjunct treatment for deficits in functional communication, having the potential to maintain or improve vocal qualities and enhance the wellbeing of adults with PD.

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BIOGRAPHIES

Richard Lewellen is a 40-year member of the Barbershop Harmony Society (BHS) and was the chorus director for the International medalist performances of Lazy Bones/Summertime by the Alexandria Harmonizers in 2004 and 2005. Lewellen won 4 International bronze medals as the baritone of Riptide and is the Category Specialist for Singing in the BHS judging system. In 2013 he formed Bella Nova, a multi-generational chorus that has won two Harmony Inc. International bronze medals. Lewellen is a board-certified Music Therapist having received his Masters in Music Therapy at Shenandoah University in Winchester, Virginia, USA. He has worked in the fields of pain management, Alzheimer's dementia, Parkinson's disease, and developmental disabilities in school-age children.

A leading scholar and researcher of the singing voice, **David Meyer** is an active performer, teacher, clinician, and voice scientist. He serves as associate professor of voice and voice pedagogy at Shenandoah Conservatory, and is Director of the Janette Ogg Voice Research Center. He is also a member of the Scientific Advisory Board of the Voice Foundation and is Co-chairman of the Voice Science Advisory Committee of the National Association of Teachers of Singing. In 2010 he received the Van L. Lawrence Fellowship, a prestigious national award in recognition of his contributions to the field of teaching singing and the use of voice science. Dr. Meyer's students have won numerous awards and have sung in major venues worldwide.

Eva van Leer is an associate professor in the Department of Communication Sciences and Disorders. She is a speech-language pathologist by trade with primary expertise in the treatment and evaluation of voice disorders. Within this area, her research focus lies in treatment outcomes and patient adherence to behavioral voice therapy. She is particularly interested in the

prediction, measurement and improvement of adherence to voice therapy, including through the use of mobile technology and social-cognitive approaches, and has further clinical and research expertise in dysphagia (swallowing disorders).