1-1-2012

The Lee Silverman voice treatment delivered via distance therapy

Kate Harrington
Eastern Illinois University

THESIS MAINTENANCE AND REPRODUCTION CERTIFICATE

TO: Graduate Degree Candidates (who have written formal theses)

SUBJECT: Permission to Reproduce Theses

An important part of Booth Library at Eastern Illinois University's ongoing mission is to preserve and provide access to works of scholarship. In order to further this goal, Booth Library makes all theses produced at Eastern Illinois University available for personal study, research, and other not-for-profit educational purposes. Under 17 U.S.C. § 108, the library may reproduce and distribute a copy without infringing on copyright; however, professional courtesy dictates that permission be requested from the author before doing so.

By signing this form:

- You confirm your authorship of the thesis.
- You retain the copyright and intellectual property rights associated with the original research, creative activity, and intellectual or artistic content of the thesis.
- You certify your compliance with federal copyright law (Title 17 of the U.S. Code) and your right to authorize reproduction and distribution of all copyrighted material included in your thesis.
- You grant Booth Library the non-exclusive, perpetual right to make copies of your thesis, freely and publicly available without restriction, by means of any current or successive technology, including but not limited to photocopying, microfilm, digitization, or Internet.
- You acknowledge that by depositing your thesis with Booth Library, your work is available for viewing by the public and may be borrowed through the library's circulation and interlibrary departmenst or accessed electronically.
- You waive the confidentiality provisions of the Family Educational Rights and Privacy Act (FERPA) (20 U.S.C. § 1232g; 34 CFR Part 99) with respect to the contents of the thesis, including your name and status as a student at Eastern Illinois University.

Petition to Delay:

I respectfully petition that Booth Library delay maintenance and reproduction of my thesis until the date specified and for the reasons below. I understand that my degree will not be conferred until the thesis is available for maintenance and reproduction.

Date: ____________

Reasons: ____

Kate Clarrington 4/15/12

Author's Signature Date

This form must be submitted in duplicate.

The Lee Silverman Voice Treatment Delivered Via Distance Therapy

(TITLE)

BY

Kate Harrington

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

Master's of Science

IN THE GRADUATE SCHOOL, EASTERN ILLINOIS UNIVERSITY
CHARLESTON, ILLINOIS

2012

YEAR

I HEREBY RECOMMEND THAT THIS THESIS BE ACCEPTED AS FULFILLING
THIS PART OF THE GRADUATE DEGREE CITED ABOVE

[signature] 4-9-12
THESIS COMMITTEE CO-CHAIR — DATE

Gail J Richard 4/9/12
DEPARTMENT/SCHOOL CHAIR OR CHAIR'S DESIGNEE — DATE

Rebecca Throneburg 4-9-12
THESIS COMMITTEE ~~MEMBER~~ CO-CHAIR — DATE

[signature] 4-9-12
THESIS COMMITTEE MEMBER — DATE

THESIS COMMITTEE MEMBER — DATE

THESIS COMMITTEE MEMBER — DATE

The Lee Silverman Voice Treatment Delivered Via Distance Therapy

Kate Harrington

Eastern Illinois University

Abstract

The purpose of this study was to determine the efficacy of the Lee Silverman Voice Treatment (LSVT) on improving the vocal loudness in patients with Parkinson's disease when delivered via distance therapy. This study utilized a non-concurrent multiple baseline across subjects research design. Subjects were recruited through local Parkinson's Support Groups. A total of five subjects participated in the study and each subject received the standard LSVT techniques which included focus on using correct breath control to project voice, projecting a range of high to low notes, and speaking written sentences and words as loud as possible.

Three subjects received traditional face to face treatment and two subjects received distance treatment via web camera through Skype. Treatment in both conditions utilized the recommended one hour per day, four days per week treatment for four weeks, along with homework and carryover tasks completed all 30 days. All five subjects reported being satisfied with the treatment and indicated they would complete the treatment again if necessary. The three subjects who received face to face therapy demonstrated improvement in sound pressure level for at least two tasks from pre-treatment to post-treatment. One subject who received distance therapy demonstrated improvement in sound pressure level for three tasks from pre-treatment to post-treatment. The second subject who received distance therapy did not demonstrate an improvement in sound pressure level from pre-treatment to post-treatment. Those subjects who were motivated to complete the therapy and who received positive feedback from family and friends demonstrated greater improvement in speech gains.

Acknowledgements

I would like to thank the faculty of the Communication Disorders and Sciences Department for giving me the opportunity to complete this thesis and for the encouragement I have received along the way. I would most like to thank my thesis chairs, Dr. Rebecca Throneburg and Mr. Frank Goldacker. Without their guidance, support, and expertise, this project would not have been possible. I am forever grateful for the time and commitment they offered throughout this long journey. I would also like to thank all the members of the Sarah Bush Lincoln Parkinson's Disease Support Group and Carle Hospital's Central Illinois Parkinson's Awareness Group for allowing me to attend meetings and share my project ideas. I extend my gratitude to those individuals who participated in the therapy for their cooperation and joint effort throughout this project.

Thanks to all the 2012 graduate girls who consistently offered interest and encouragement throughout the year. Lastly, I would like to thank my family for their encouragement and support throughout my many endeavors. Without you, my accomplishments would mean nothing.

Table of Contents

Abstract 2

Acknowledgement 3

Table of Contents 4

List of Tables 6

List of Figures 7

Chapter I-Introduction 8
Medical Treatment for Parkinson's disease 9
Speech Therapy for Hypokinetic Dysarthria Associated with PD 9
Development and Outcome of LSVT 10

Chapter II-Review of Literature
Motor, Sensory and Neuropsychological Deficits in Parkinson's disease 12
Speech and Voice Characteristics in Parkinson's disease 14
Speech Treatment for Hypokinetic Dysarthria Associated with Parkinson's Disease 16
Development and Rationale for LSVT 19
The Effects of LSVT on Individuals with Hypokinetic Dysarthria and Parkinson's disease 21
Immediate and Long-Term Effects of LSVT 28
Distance Therapy 33
Lee Silverman Voice Treatment via Distance Therapy 34
Purpose of This Study 39

Chapter III-Methodology
Subject Selection 41
Research Design 48
Independent Variable- LSVT Treatment 48
Dependent Variable-Probe Measures (Baseline, Treatment) 52
Pre- and Post-Measures 53
Post-Treatment Only Measure 54

Chapter IV-Results
Analysis of Pre- to Post-Assessment Speech Gains 56
Probe Measures 59
Post-Treatment Measures-Participant Satisfaction 62

Chapter V-Discussion
Summary of Results and Factors That May Have Influenced Results 64
Distance versus Face-to-Face Treatment 67
Medical Procedures and Disease Duration/Severity 68
Motivation and Generalization 69
Technical Difficulties 70
Clinician Experience 70
Satisfaction with LSVT Delivered via Face to Face Therapy vs. Distance Therapy 71
Relationship to Previous Research 72
Clinical Implications 73
Limitations of Study and Need for Future Research 73
Conclusions 76

References 77

Appendix A- Initial Interview Questions 84
Appendix B- Unified Parkinson's Disease Rating Scale 87
Appendix C-Voice Handicap Index 93
Appendix D-Patient Satisfaction Surveys 95

List of Tables

Table

1. Subject Selection Criteria 42

2. Pre, Post, Gain, and Group Mean scores for Face to Face and Distance Therapy Subjects 57

List of Figures

Figure

1.	Loudness of /ah/ (Face to Face)	60
1.1	Loudness of /ah/ (Distance)	60
2.	Duration of /ah/ (Face to Face)	61
2.1	Duration of /ah/ (Distance)	61
3.	Loudness of Conversation (Face to Face)	62
3.1	Loudness of Conversation (Distance)	62

Chapter I

Introduction

Idiopathic Parkinson's disease (PD) is a form of Parkinsonism in which there is no known cause. The main characteristic of Parkinson's disease is the loss of dopamine producing brain cells that aid in the control of muscle activity. Symptoms can manifest as tremors of the face, limbs and jaw, stiffness of the limbs and trunk, bradykinesia, and lack of balance and coordination (Bellenir, 1999). Communication abilities can be reduced in individuals with PD due to abnormal speech and vocal productions, along with lack of facial expressions (Pitcairn, Clemie, Gray, & Pentland, 1990). Individuals with PD develop speech, voice, and swallowing disorders due to increased rigidity of the vocal cords and slow, imprecise, and uncoordinated movements of the lips, tongue, and throat. The type of speech disorder exhibited by patients with PD is dysarthria, which is a motor speech disorder characterized by "a disturbance in muscular control over the speech mechanism due to damage to the central or peripheral nervous system" (Boone, McFarlane, Von Berg, & Zraick, 2010, p. 86). Hypokinetic dysarthria is most commonly associated with PD and can be described as presenting with a breathy, hoarse voice that is reduced in loudness, along with poor articulation abilities, irregular rate, and lack of intonation (Scott, Caird, & Williams, 1985). Among individuals affected by Parkinson's disease, 89% exhibit speech that is disordered (Logemann, Fisher, Boshes, & Bionsky, 1978), while only 4% actually receive treatment (Hartelius & Svensson, 1994) for their speech disorder.

Medical Treatment for Parkinson's disease

Drug therapy is crucial in reducing rigidity and tremors in individuals with PD. Dopamine agonists, a drug that produces missing dopamine, and levodopa are both pharmacological drugs prescribed for the medical management of Parkinson's disease. Levodopa has been shown to increase the life expectancy of individuals with PD, and when paired with a peripheral dopadecarboxylase inhibitor, such as carbidopa, fewer side effects and increased efficiency are observed (Scott et al., 1985). Depending on the dosage of drug therapy, speech can be adversely affected. Surgical management of the motor aspects of PD includes deep brain stimulation-subthalamic nucleus (DBS-STN), thalamotomy, and pallidotomy. Although these pharmacological and surgical management techniques can reduce the frequency of motor deficits associated with PD, positive and long-term effects have not been shown to help speech (Schultz, 2007).

Speech Therapy for Hypokinetic Dysarthria Associated with PD

Traditional speech therapy for hypokinetic dysarthria in Parkinson's disease focuses on the components of the speech production system in deficit. For example, exercises and techniques to improve respiratory drive are practiced; exaggerated articulation techniques are taught; high effort techniques to increase vocal loudness are trained; and slow rate techniques are utilized. Ramig et al. (2001a) have questioned some of these traditional behavioral techniques. According to research (Kleinow, Smith, & Ramig, 2001) speech treatment for PD that focuses on speaking at a slower rate produces more variability in the articulatory processes for speech when compared to loudness therapy. Treatment that focuses on hyperarticulating (Dromey, 2000) also creates more variability in the articulatory processes for speech when compared to treatment that targets loudness.

Development and Outcome of LSVT

The Lee Silverman Voice Treatment (LSVT) was developed in 1985 by Dr. Lorraine Olson Ramig in response to an individual with PD who was unable to communicate with her family (National Center for Voice and Speech, n.d.). The patient's difficulties were due to reduced loudness in her voice. The target of the voice treatment was to increase vocal fold adduction in order to increase vocal loudness and quality. LSVT is delivered in an intensive, high effort manner with the idea that maximizing practice capitalized on neural plasticity in the brain resulting in optimal degrees of change (Kleim & Jones, 2005). Vocal loudness is targeted using an intensive, high effort approach in order to promote generalization. An additional key characteristic of individuals with PD is a sensory deficit that causes them to perceive that they are shouting when they are really speaking at a normal level. LSVT techniques also target this sensory problem and promote generalization.

LSVT is the most researched speech treatment for the dysarthria associated with PD. More than 20 published research articles have documented that LSVT treatment techniques provide immediate and long term speech improvements in groups of patients with PD (Huber, Stathopoulos, Ramig, & Lancaster, 2003; Ramig, Countryman, Thompson, & Horii, 1995; Ramig et al., 2001a; Ramig, Sapir, Fox, & Countryman, 2001b; Sapir, Spielman, Ramig, Story, & Fox, 2007).

Due to the intensive, time consuming aspect of the treatment, most individuals with PD are unable to receive LSVT treatment, especially if they do not live in an urban area. To address this issue researchers have looked at the effects that LSVT has on the vocal intensity of patients with PD when treatment is delivered via distance therapy. In contrast to the wealth of evidence documenting the efficacy of delivering LSVT in a traditional face to face venue, only three studies with fewer than 15 participants total have been conducted to evaluate LSVT using distance technology (Constantinescu et al., 2010; Howell, Tripoliti, & Pring, 2009; Theodoros et al., 2006). All three studies provided treatment only via distance therapy with no direct comparison being made between gains in distance delivery and traditional face- to-face intervention. Therefore the purpose of the current study is to compare gains made in traditional face to face LSVT with gains made in distance LSVT for five individuals with PD.

Chapter II

Review of Literature

Motor, Sensory and Neuropsychological Deficits in Parkinson's Disease

The speech and voice characteristics exhibited by individuals with PD are closely associated with the motor deficits of the disease. Motor deficits can manifest as rigidity, bradykinesia, hypokinesia, and tremor. Diminished stimulation of the cortical motor areas from the basal ganglia, and subsequent diminished drive to the motor neuron pools result in reduced amplitude of movement (hypokinesia) and slowed movement (bradykinesia). Diminished movement can be evidenced in individuals with PD during walking, such as reduced arm swing or a shuffling gait, writing, and talking, such as reduced vocal intensity (loudness) (Fox, Morrison, Ramig, & Sapir, 2002). Due to the diminished movement associated with PD, the functions of underlying respiratory and laryngeal structures needed for production of a loud, good quality voice are compromised, and result in insufficient vocal intensity.

The motor deficits associated with the speech and voice characteristics of PD can be exacerbated by sensory processing deficits. Individuals with PD exhibit sensorimotor deficits of the orofacial structures and abnormal auditory, temporal, and perceptual processing of their own voice and speech (Trail et al., 2005). The basal ganglia control movement by filtering out necessary sensory information (Trail et al., 2005). Due to deficits in areas of the basal ganglia, it is likely that sensory inputs that control movement in individuals with PD are also impaired. This further contributes to the production of voice that is reduced in loudness. A challenge in achieving successful therapeutic outcomes has been targeting the sensory processing deficits associated with PD.

Individuals with PD do not think they are speaking too softly, but rather that their spouse "needs a hearing aid" (Fox & Ramig, 1997; Marsden, 1982). When these individuals are asked to speak in a louder voice, most will respond with a statement like, "I feel as if I am shouting," when in fact they are judged to be speaking within normal limits (Trail et al., 2005). When these individuals listen to an audio recording of them speaking in a loud, good quality voice, they perceptually judge themselves as speaking in a normal voice, but still comment that they feel like they are shouting. This judgment suggests that the breakdown may occur in online auditory and proprioceptive feedback during speaking (Trail et al., 2005).

Neuropsychological impairments are not directly related to voice and speech characteristics observed in individuals with PD, but they may impact the benefits obtained from speech treatment. Mahler and Cummings reported around 40-60% of individuals with PD experience a decline in cognitive functioning (as cited in Fox et al., 2002). Even individuals who are mildly affected by PD may display neuropsychological deficits (Fox et al., 2002). In a systematic review of studies on the prevalence of dementia in PD, known as PDD, Aarsland, Zaccai, and Brayne (2005) determined that 24 to 31% of PD patients have dementia, and 3 to 4 % have dementia due to PDD. Individuals with PD who do not have dementia, but display cognitive deficits during neuropsychological testing, are likely to have undetectable or minimal cognitive dysfunctions during interactions (Fox et al., 2002). Impairment in memory, attention, executive function skills, and visuospatial skills are associated with cognitive impairment in PD (Verbaan et al., 2007). The neuropsychological changes observed in individuals with PD include:

slow thinking, slow learning, problems shifting cognitive sets, problems internally cueing, and problems in procedural memory (Fox et al., 2002).

Speech and Voice Characteristics in Parkinson's Disease

Laryngeal abnormalities are concomitant factors associated with the speech and voice deficits in individuals with PD. Laryngeal structural abnormalities, such as bowing of the vocal folds, glottal gaps, and incomplete vocal fold adduction during phonation, have been observed (Duffy 2005). Diminished laryngeal efficiency can contribute to the speech and voice characteristics of PD and may be related to neuromuscular abnormalities associated with PD (Duffy, 2005). A number of research studies have documented an elevated fundamental frequency in individuals with hypokinetic dysarthria (Duffy 2005). However, perceptual ratings in a study done by Darley, Aronson, and Brown (1969) revealed that perceptual observations of individuals' voices tended to be perceived as lower. This discrepancy may be due to factors such as intersubject variability in fundamental frequency and pitch, gender differences, and other factors such as monopitch, monoloudness, and reduced loudness (Duffy, 2005). With regard to intensity, several studies have documented reduced vocal intensity during speech tasks, such as vowel prolongation, and alternating motion rate (AMR) tasks (Duffy 2005). Perceptual deficits associated with PD can affect an individual's ability to regulate loudness level during speech. Voice tremor has been documented in some studies (Duffy, 2005), although, voice tremor is not a remarkable perceptual characteristic associated with the speech and voice characteristics of PD. However, individuals with PD have been documented as having abnormally high jitter and shimmer measures, which may be due to the insufficient neuromuscular control of the abductory and adductory muscles of the vocal folds (Duffy, 2005).

Respiratory deficits are common in PD and may also result in some of the perceptual features of voice of PD, such as reduced prosody and loudness (Duffy, 2005). Individuals with PD experience reduced vital capacity, decreased amplitude of chest wall movements during breathing, diminished respiratory muscle strength and endurance, irregularities in breathing patterns, and increased respiratory rates (Huber et al., 2003). The respiratory deficits that affect speech performance during vocal tasks in individuals with PD include reduced maximum vowel duration, reduced airflow volume during vowel prolongation, fewer syllables per breath group, use of greater than average percentage of vital capacity per syllable, and increased breath groups during reading (Duffy, 2005). These abnormalities, along with laryngeal abnormalities can contribute to difficulty producing a loud, good quality voice.

Individuals with PD often exhibit imprecise articulation and a reduced range of articulatory movements which can cause articulatory undershooting and displacement (Duffy, 2005). Reduced range of movement, rigidity, and articulatory movements can lead to imprecise articulation. This can manifest as lip muscle stiffness and rigidity, reduced range and velocity of lip and jaw movements, and electromyographic results of reduced duration and amplitude of lip muscle action potentials (Duffy, 2005). Abnormal muscle contractions can diminish jaw opening and closing, which can also lead to articulation deficits in individuals with PD (Duffy, 2005).

Along with laryngeal, respiratory, and articulatory abnormalities, individuals with hypokinetic dysarthria secondary to PD often exhibit increased rate of speech. However, research has documented both reduced rate and fast rate of speech in individuals with hypokinetic dysarthria (Duffy, 2005). Hypokinetic dysarthria is the only type of dysarthria that is perceptually perceived as being accelerated in rate (Duffy, 2005). However, a study by Torp and Hammen (2000) found that individuals with PD were perceived as having a faster speaking rate when compared to a control group, even when speaking rates were actually the same. This suggests that perceptual ratings of speech rate should be judged cautiously. Along with rate abnormalities and reduced loudness, prosodic insufficiency can be observed in individuals with PD. Prosodic deficits can be related to stress, pause, and between-syllable duration differences (Duffy, 2005).

Speech Treatment for Hypokinetic Dysarthria Associated with Parkinson's Disease

Many textbooks and journal articles contain traditional treatment techniques that can be used to target or compensate for difficulties in respiration, phonation, articulation, prosody and rate that may be associated with the speech of patients with PD. Commonly held opinion about traditional speech treatment for hypokinetic dysarthria associated with PD is that success is achieved within the therapy room, but little carryover is achieved (Duffy, 2005). Treatment that focuses on respiration for individuals with hypokinetic dysarthria may not be required because improvement at the phonatory, resonatory, and articulatory level promotes efficient breath usage (Darley, Aronson, & Brown, 1975). Some procedures that focus on increasing respiratory support directly include non speech tasks such as blowing into a glass manometer or air pressure transducer, and speech tasks such as providing feedback during maximum vowel phonation and practicing exhaling at a steady rate (Duffy, 2005). Other procedures include pushing and pulling or bearing down during speech and non speech tasks to increase laryngeal valving. Postural adjustments, inhaling more deeply before speech and shortening phrases are all compensatory strategies that can be used to increase the amount of breath support.

Individuals with hypokinetic dysarthria who have difficulty controlling their rate of speech may benefit from rate control therapy. Several research studies have documented the success of external devices, such as delayed auditory feedback (DAF) and pacing boards, on slowing down an individual's rate of speech (Duffy, 2005). Other techniques used to control rate of speech include hand/finger tapping, rhythmic or metered cueing, and modified pauses. In a systematic review study of the treatment of dysarthria, Yorkston, Hakel, Beukelman, and Fager (2007) documented 19 studies in which the treatment focus was on manipulating the rate of speech. Outcomes from these studies indicated that manipulating speech rate can increase intelligibility, but the outcomes are variable and based on the severity of dysarthria and the types of intervention. The studies did not determine if these techniques can be generalized outside of therapy during normal conversational interactions.

There are also interventions that focus on the prosodic characteristics of monoloudness and monopitch associated with hypokinetic dysarthria. These techniques include biofeedback and behavioral instruction. Yorkston et al. (2007) identified 10 studies that focused on intervention of prosody, with a majority of the studies being case reports focusing on ataxic dysarthria. Outcomes indicated some improvement of prosodic characteristics, but none reaching normal speech. Further research needs to be conducted to assess the generalization of prosodic intervention.

Articulation therapy has been an integral part of the treatment of dysarthria. However, most therapy approaches do not focus directly on place and manner of articulation, but rather focus on other functions that facilitate improved intelligibility (i.e. loudness, rate, or respiratory support) (Duffy, 2005). Behavioral speech treatment tasks that focus on articulation for hypokinetic dysarthria include stretching, biofeedback, over articulation, intelligibility drills, and phonetic placement.

Individuals with hypokinetic dysarthria may exhibit dysphonia caused from bowing or weakness of the vocal folds. Medical approaches to improve voice may be achieved by medialization laryngoplasty or Teflon/collagen injections (Duffy, 2005). Surgical interventions that are used to help relieve movement disorders related to PD, but are not directly related to improvement in speech; include thalamotomy, pallidotomy, and deep brain stimulation (DBS). Behavioral voice therapy to increase phonatory effort in individuals with PD is a promising and beneficial intervention. Some of these techniques include effortful closure techniques, promoting abrupt glottal attack, and intense-high level phonatory effort. A frequently researched intervention for hypokinetic dysarthria is LSVT, which is a high effort, intensive speech treatment that focuses on increased phonatory effort. Yorkston et al. (2007) identified 21 research articles reporting outcomes of loudness intervention, with a majority of the articles focusing on LSVT. A total of 308 participants were part of these studies and a majority of the subjects displayed hypokinetic dysarthria secondary to PD. The outcome measures indicated a significant improvement in the vocal loudness levels of those participants who had completed LSVT. Evidence for LSVT was strengthened by long-term (2-year) follow-up measures and by comparing LSVT to other treatment approaches (Yorkston et al., 2007).

Development and Rationale for LSVT

The focus of the Lee Silverman Voice Treatment (LSVT) is to increase loudness and phonatory effort in individuals whose voice is reduced in loudness secondary to PD or other related disorders. The treatment also focuses on teaching patients to self-monitor and identify that their voice is within normal limits. The treatment is delivered in an intensive, high effort manner with the idea that maximizing practice will take advantage of maximal plasticity in the brain (Kleim & Jones, 2008). Delivery of treatment is in one hour sessions over four consecutive days for four weeks. The one hour sessions focus on correct breath control to project voice, projecting a range of high to low notes, and speaking scripted sentences and words as loud as possible. Daily homework and carryover tasks are completed all 30 days of the month in order to promote self-monitoring and generalization outside the therapy room.

Due to the sensory processing deficits associated with PD, LSVT specifically targets this area in order to maximize the benefit and generalization of treatment. Audio recordings of the patients' 'loud' voice are played for the patient to provide feedback and awareness of how their new voice sounds. Loudness diagrams are used to educate the patients on how loud their voice needs to be in order to communicate effectively. With continued practice, the patient will begin to self-monitor and utilize internal cues in order to produce a loud, good quality voice.

The simple, repetitive nature of treatment tasks and the single target of loudness in LSVT address possible neuropsychological issues associated with PD. Individuals with PD may experience cognitive decline due to the progressive nature of the disease. The instructions for LSVT tasks do not need elaborate explanations, are easy to follow, and will not likely exceed the working memory capacity of those individuals with PD who may also have dementia (Fox et al., 2002). The techniques employed to shape a loud, good quality voice are through modeling, such as "Do as I do," as opposed to verbal explanations.

The mode of delivery of the LSVT program is unlike other traditional speech treatments in that the patients exert a high effort during tasks and receive the treatment in one hour sessions, four times per week for four weeks. This type of approach has not been seen with traditional speech treatment in which the target is articulation and rate, but traditional motor training has been seen as a means for behavioral recovery (Fox et al., 2006). Recently, the neurobiological aspects underlying the principles of motor training have shown a positive effect on central nervous system (CNS) functioning (Fox et al., 2006). Research has focused on neural plasticity or the brain's ability to "heal itself" (Fox et al., 2006). The neurobiological processes that are triggered by exercise and motor training promote cell survival in the brain (Fox et al., 2006). The mode of delivery of LSVT is consistent with motor training principles that promote neural plasticity (Kleim, Jones, & Schallert, 2003), such as the intensity of treatment, complexity of practice, and saliency and relevance of treatment (Fox et al., 2006). The intensity and self –monitoring of training allows for generalization and long-term changes. Repetition of tasks in an increased effort is consistent with the idea that continued practice of a new motor skill is necessary for long-term changes, since acquisition of a skill is not enough to promote neural change (Fox et al., 2006). As treatment progresses, the complexity of the vocal tasks increases in order to promote greater neural plasticity (Fox et al., 2006). This includes simple words vocalized in the therapy room, with increased complexity in conversations while walking in settings outside the therapy room. Along with the complexity, tasks that are more salient and rewarding promote greater effects on neural plasticity (Fox et al., 2006). In LSVT, patients are rewarded in daily communication tasks for using the targeted loudness technique through simple comments such as, "I can hear you better" or "Your voice sounds great" (Fox et al., 2006). The salient and relevant tasks that are used in the therapy room can be easily generalized in daily communication tasks.

The Effects of LSVT on Individuals with Hypokinetic Dysarthria and Parkinson's Disease

Ramig et al. (1995) evaluated the effects of two speech treatments, respiration only and respiration and phonation (Lee Silverman Voice Treatment) on individuals with Parkinson's disease. Individuals with Parkinson's disease commonly display hypokinetic dysarthria which is characterized by reduced loudness in speech, slow articulatory movements, and a breathy or weak voice.

The subjects in the study included 45 volunteers with idiopathic Parkinson's disease. All subjects were tested for speech, hearing, and cognition. The subject selection criteria included age, gender, and severity of the disease. The subjects who had PD longer were found to have increased motor problems and more severe speech and voice characteristics based on a correlation between time since diagnosis, severity of speech, stage of PD, and depression rating. The subjects were randomly assigned to either the respiratory only treatment group or the LSVT group.

Pre-treatment data was collected one week before treatment and post-treatment data was collected one week after treatment. Data collection tasks included maximum forced vital capacity, maximum duration of sustained vowel phonation, reading of the

"Rainbow Passage" (Fairbanks, 1960) and 25-30 seconds of a conversational monologue. Each procedure was meant to be intensive and effortful.

The subjects received treatment for 50 minute sessions four times a week for four weeks. The respiratory treatment targeted increased respiratory effort and maintaining a sustained exhalation for voice production. The main focus of LSVT was to increase phonation, i.e. "improve vocal fold adduction and respiratory support, increase self-monitoring of vocal effort and loudness, and promote carryover of increased loudness into daily speech communication" (Sapir, Spielman, & Ramig, 2003, p. 389). The treatment activities consisted of consecutive repetitions of different tasks, such as sustained vowel phonation and speech productions, using a loud voice.

Acoustic variables were analyzed using a three factor ANOVA (group x gender x time). Results of the sound pressure level of vowel duration indicated that females and males who receive the LSVT increased their SPL from pre-treatment to post-treatment. The females who received the respiratory-only treatment increased their SPL pre- to post-treatment, but the males decreased their SPL from pre- to post-treatment. For reading and conversation, both treatment groups increased their SPL from pre-treatment to post-treatment. In regard to maximum duration of vowels and fundamental frequency while reading, both males and females from each treatment group performed statistically better from pre-treatment to post-treatment. The fundamental frequency of conversation showed no statistically significant improvement from pre- to post-treatment for gender or treatment groups, indicating no increase in the cycles of vocal fold vibration per second. Statistical analysis of rate revealed that both treatment and gender groups statistically reduced their rate of speech from pre- to post-treatment. Perceptual ratings of loudness revealed that males who received LSVT and females who received respiratory-only treatment showed the most statistically significant improvement pre- to post-treatment, but both treatment and gender groups showed improvement after therapy.

The Beck Depression Inventory (BDI) (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) and the Sickness Impact Profile (SIP) (Bergner, Bobbit, Carter, & Gilson, 1981) was administered to the subjects pre-treatment and post-treatment. The individuals who received LSVT expressed a statistically significant improvement in their communication from pre-treatment to post-treatment. The subjects who had better cognitive abilities before receiving LSVT had higher sound pressure level in conversation post-treatment than the subjects who had lower cognitive abilities. Individuals who received LSVT had significantly higher SPL in vowels and reading and rated their communication as being better post treatment.

Results of this study indicated that these treatments produced statistically significant improvement from pre to post treatment, but the changes made in intensity and fundamental frequency after the subjects received LSVT were greater. The respiratory treatment alone was not sufficient to maintain sustained intensity after treatment. The LSVT incorporated vocal fold adduction along with respiratory therapy, which resulted in sustained intensity post treatment.

Sapir et al. (2007) evaluated the effects immediately post-treatment of the Lee Silverman Voice Treatment (LSVT), which targets loudness, on the articulation abilities of PD patients with dysarthria compared to non-treatment control groups. The subjects in the study included three groups of individuals. The treatment group, PD-T, was comprised of seven men and seven women with PD. The non-treatment group was comprised of 8 men and 7 women with Parkinson's disease. The mean age for these participants was 68 years and 77.6 years respectively. The subjects were matched for severity of PD and previous speech and voice problems; cognitive abilities were informally assessed. The researchers reported that the participants were able to follow directions and complete necessary tasks and tests. None of the subjects had received speech services prior to the study. The third group of participants was comprised of seven men and seven women who were spouses of the individuals in the treatment and non-treatment groups. These individuals were screened and found to have no neurological deficit or any other disease that would affect their speech or voice output. The subjects were matched in age to the first two groups.

The therapy was administered four times a week for four weeks with the sessions lasting 50-60 minutes. The therapy focused on loud phonation, but also measured the effect on rate and articulation of speech.

Speech samples of all the participants were taken pre-and post-treatment. The speech samples included the phrases "Buy Bobby a puppy," "The blue spot is on the key," and "The potato stew is in the pot." These were used to analyze the first (F1) and second (F2) formants of the vowels /i/, /u/, and /a/. The frequency of the vowel formants was assessed using a version of Cspeech software, TF32. Perceptual ratings of vowels were performed by two certified speech-language pathologists and four graduate students in speech-language pathology. Each of the individuals assessed the vowels /i /, /u/, or /a/ spoken by the subjects pre- and post-treatment.

Results of the acoustic measures indicated a significant improvement in sound pressure level (SPL) from pre- to post- treatment in the PD-T group. Less significant improvement was shown for the second formants of /u/ and F2i/F2u in the PD-T group indicating increased resonating frequencies post-treatment. There were no significant differences between the PD non-treatment group and the neurologically normal group. The results of perceptual ratings indicated that the perception of vowels was rated better for post-treatment in the PD-T group, and that the perception of vowels did not change pre-treatment to post-treatment in the PD-NT and NN groups. Pearson-product moment correlational analyses were used to analyze the pre- and post- test measurements of acoustic measures and vowel goodness of the PD-T group. These correlations indicated a significant relationship among improvements in SPL, vowel rating, and vowel acoustics.

Huber et al. (2003) examined the effects of the Lee Silverman Voice Treatment (LSVT) on SPL in individuals with PD and on the variability of the respiratory system when compared to normal age-matched controls. The subjects included 6 individuals with idiopathic PD and 3 age-matched normal individuals. The subjects with PD were chosen based on their diagnosis of idiopathic Parkinson's disease along with speech and voice impairments associated with the disease prior to receiving treatment. The age-matched controls had no history of speech and voice disorders.

The PD subjects received LSVT, an intensive voice treatment that is administered four times a week, for 60 minute sessions, over a four week period. The focus of LSVT is increased vocal fold adduction and increased phonatory effort.

To obtain respiratory kinematic data, Respitrace (Ambulatory Monitoring Lab, Inc.), a respiratory inductive plethesmograph, was placed on the rib cage and abdomen of each subject. Sound pressure level (SPL) was obtained using a microphone and sound pressure level meter. The individuals with PD participated in three baseline data collections prior to treatment and two post-treatment data collection sessions immediately following treatment. The age-matched controls participated in three data collection sessions. Each subject in both groups was asked to repeat the phrase "Buy Bobby a Puppy" 25 times at a comfortable level and externally cued to produce a high SPL level, which is twice their normal loudness level. Respiratory calibration maneuvers were completed by each subject. These maneuvers included isovolume maneuver, vital capacity maneuver/maximum rib cage capacity maneuver, maximum abdominal capacity maneuver, and relaxation maneuver. Measures of lung volumes were obtained for each of the PD subjects and 2 of the 3 age-matched individuals.

Results of data collection found that the individuals with PD increased their SPL from normal to high when externally cued pre-LSVT and significantly improved their SPL from pre-to post-LSVT. This confirms that LSVT can improve SPL in PD patients. Individuals with PD had a significantly smaller relative rib cage contribution to lung volume (RVC) than the normal age-matched controls, indicating that the PD group used more abdominal contribution to lung volume than the controls. The PD group also had a significantly higher abdominal volume excursion (ABVE) and expended more vital capacity per syllable than the age-matched controls. When normal speakers have increased vital capacity per syllable, there is a correlation with increased rib cage volume excursion (RCVE) (Huber et al., 2003). However, individuals with PD have a decreased RCVE with increased vital capacity per syllable. This indicates that it may be easier for individuals with PD to rely on abdominal changes for changes in lung volume (Huber et al., 2003). Also, it was found that individuals with PD had more variable movements of the respiratory system when compared to the age-matched controls, and these did not dissipate post-LSVT. The variability of the movements increased when the subjects were asked to increase their SPL from normal to loud. This is contradictory to a study by Kleinow et al. (2001) which found that increased loudness created less variable, more stable lip and jaw movements for speech. This may indicate that it is easier for an individual with PD to maintain stable lip and jaw movements during speech.

Baumgartner, Sapir, and Ramig (2001) compared the immediate effects of respiratory only treatment and the Lee Silverman Voice Treatment (LSVT) on the perceptual ratings of hoarseness and breathiness in individuals with dysarthria secondary to PD. The subjects in the study included 20 individuals, 13 receiving LSVT and 7 receiving the respiratory only (R-only) treatment. The subjects' voices were characterized as being moderately breathy and hoarse in quality prior to treatment.

Data was collected prior to treatment and immediately after treatment. Each subject was recorded reading the "Rainbow Passage" (Fairbanks, 1960) at a comfortable speaking level and at a higher loudness level. Two speech pathologists rated the perceptual characteristics of the subject's voices.

The LSVT group received the standard LSVT techniques in 60 minute sessions, four days a week, for four weeks. The R-only group received treatment that focused on increased respiratory muscle effort in order to increase lung volume and subglottal air pressure. The subjects were asked to produce maximum inspiration and expiration, prolongation of the voiceless fricatives /s/ and /f/, and sustained intraoral air pressure. The subjects were told to "breathe" prior to the breathing tasks and were given visual feedback of their rib cage and abdomen movements.

Results from this study showed statistically significant improvement in the perceptual ratings of breathiness and hoarseness from pre-treatment to post-treatment in the subjects who received LSVT. There was no statistically significant change in the R-only group. Over half of the subjects who received LSVT reduced their hoarseness by 60% and over half the subjects reduced their breathiness by 75%.

Immediate and Long-Term Effects of LSVT

Ramig, Countryman, O'Brien, Hoehn, and Thompson (1996) compared the immediate and long-term effects of the Lee Silverman Voice Treatment (LSVT) and a respiratory only treatment on individuals with voice deficits secondary to PD. The subjects included 35 individuals diagnosed with idiopathic PD with a mean age of 63.23. The subjects were matched based on age, severity of disease, time since diagnosis, cognitive function, level of depression, impact on communication, and severity of speech ratings prior to treatment. The subjects were excluded from the study if they presented with laryngeal pathology not related to PD or did not present with normal hearing. The subjects were randomly assigned to treatment groups with 22 subjects receiving LSVT and 13 subjects receiving the respiratory only treatment. The subjects did not change medication for PD before or during the treatment; however, some started taking medication at the follow-up assessment.

Pre-treatment data was collected the week before treatment; post-treatment data was collected one week after treatment, and follow-up data was collected 6 and 12 months after treatment. To determine the status of cognitive functioning, neuropsychological tests were given prior to treatment. The subjects were also given the Beck Depression Inventory (BDI) (Beck et al., 1961) and Sickness Impact Profile (SIP)

(Bergner et al., 1981) prior to treatment, immediately post-treatment, and 12 months after treatment. Speech data recorded the subjects sustaining a maximum vowel phonation, reading the "Rainbow Passage" (Fairbanks, 1960), and speaking a 25-30 second conversational monologue. Some subjects were unable to complete the monologue due to the inability to produce longer utterances. The subjects' forced vital capacity (FVC) was obtained using a wet spirometer.

The LSVT group received the standard LSVT techniques for 60 minute sessions, four days a week, for four weeks. The R-only treatment focused on increasing respiratory muscle effort during inspiration, expiration, and sustained expiration. This would enable increased subglottal air pressure and loudness. The subjects were cued to "breathe" before each speaking task. No focus was made on vocal fold adduction or increasing loudness.

Results from the study found that the individuals who received LSVT showed a statistically significant increase in vocal intensity during the sustained vowel phonation and Rainbow Passage reading tasks from pre-treatment to post-treatment, and at 6 and 12 months after treatment. There was a statistically significant increase in vocal intensity during the conversational monologue from pre-treatment to post-treatment, but this statistical significance was not maintained at 6 and 12 months after treatment. The R-only group did show a statistically significant increase in vocal intensity for the reading of the Rainbow Passage, but this was not maintained over the 6 and 12 months after treatment. The R-only group showed no statistically significant improvements over time during the sustained vowel phonation and did not increase vocal intensity during the conversational monologue over time. There were no statistically significant changes in the FVC for either of the treatment groups over time.

Theodoros, Thompson-Ward, Murdoch, Lethlean, and Silburn (1999) evaluated the immediate and long-term (6 months) effects of LSVT on an individual with hypokinetic dysarthria secondary to PD following a left thalamotomy and a right pallidotomy. The individual in the study was a 58-year-old female with severe tremors and dyskinesias. A thalamotomy was performed 15 months before the study, while a pallidotomy was performed 8 months before the study to help with the tremors and dyskinesia, but were unsuccessful in their attempts.

Data was collected prior to treatment, immediately after treatment, and 6 months after the conclusion of treatment. Perceptual, acoustic, and physiological evaluations were conducted on the subject's speech and voice pre- and post-treatment. Once pre-treatment data was collected, the subject participated in 16 sessions of the standard LSVT program techniques.

Results from pre treatment to post treatment found improvements in all measures of perceptual, acoustic, and physiological values. However, results from pre-treatment to the 6-month follow up indicated that the perceptual ratings had fallen below baseline values, while the acoustic measures, other than fundamental frequency and duration, had stayed the same or above post-treatment values. The 6-month follow up assessment found that fundamental frequency, duration of phonation, and the physiologic values had fallen below the post-treatment values, but were above the baseline values.

Ramig et al. (2001b) evaluated the immediate and long-term (6-months) effects of LSVT on vocal loudness in individuals with dysarthria secondary to PD compared to non-treatment control groups. Three groups of individuals were included in this study. Two groups consisted of individuals with PD, with one group receiving LSVT (PD-T) and one group not receiving treatment (PD-NT). The third group consisted of neurologically normal individuals with no prior speech or voice issues. The PD groups did not vary significantly in pre-treatment speech and voice deficits or sound pressure level (SPL).

Data was collected two weeks prior to treatment, immediately after treatment, and 6 months after the conclusion of treatment for all three subject groups. The individuals' SPL was recorded while performing four tasks: (a) sustaining the vowel "ah" phonation for six repetitions, (b) reading the "Rainbow Passage" (Fairbanks, 1960), (c) speaking a monologue, and (d) describing the "Cookie Theft" picture (Goodglass & Kaplan, 1983).

Results found that the PD-T groups significantly improved their SPL from pre-to post-treatment and from pre-treatment to the 6-month follow-up treatment. The PD-NT and the neurologically normal group showed no significant difference in SPL from pre-to post-treatment and from pre-treatment to the 6- month follow-up treatment.

Ramig et al. (2001a) evaluated the long-term effects over a 24-month period of the Lee Silverman Voice Treatment (LSVT) compared to a respiratory-only (R-only) treatment. The subjects included 33 individuals with idiopathic Parkinson's disease randomly assigned to the two treatment groups. Subject selection criteria included age, onset of Parkinson's disease, score on the unified Parkinson's disease rating scale (UPDRS), severity of Parkinson's disease, and speech and voice abilities. Patients were excluded from the study if laryngeal pathology was found, such as polyps or lesions on the vocal folds that were unrelated to Parkinson's disease.

One group of 21 individuals received LSVT, while the other group of 12 individuals received a respiratory-only treatment. Each treatment was administered four times a week for 60 minutes a session for four weeks. As previously stated, LSVT is an intensive voice treatment designed to improve vocal fold adduction, and places an emphasis on high phonatory-respiratory effort (Ramig et al., 2001a). The R-only treatment focused on increasing muscle activity during inspiration and expiration.

The individuals in both groups performed sustained vowel /ah/ phonation, reading of the Rainbow Passage (Fairbanks, 1960), and produced a 25-30 second monologue prior to treatment, immediately after treatment, and 24 months after treatment. Additional speech data was obtained 6 and 12 months after treatment. The individual who collected the data did not administer treatment and was unaware of the type of treatment each subject received.

Outcome measures revealed improvement in vocal loudness measured as sound pressure level (SPL), and inflection in voice fundamental frequency as measured in semitone standard deviation (STSD). Results from data collection indicated that the LSVT group significantly improved in SPL and STSD for the three speech tasks immediately post-treatment and the 24-month follow up, in comparison to pre-treatment values. The respiratory-only group showed a significant improvement from pre-treatment to post-treatment in SPL and STSD for the "Rainbow Passage." No other speech tasks showed significant improvement from pre-treatment to post-treatment or from pre-treatment to the follow up. Comparisons between groups found that the LSVT group had a significantly higher mean SPL from pre-treatment to post-treatment and pre-treatment to follow up for the three speech tasks. The LSVT group also showed a significantly higher mean STSD pre-treatment to post-treatment for the "Rainbow passage."

Results from this study indicated that individuals with Parkinson's disease significantly improved their vocal loudness and vocal inflection after receiving the Lee Silverman Voice Treatment. When comparing treatment efficacy, LSVT showed significant improvement in vocal quality compared to a respiratory-only treatment. Follow up study results concluded that the effects of LSVT can extend over a 24 month period and can be attributed to treatment due to the respiratory-only treatment effects not lasting 24 months.

Distance Therapy

ASHA's position statement defines telepractice as "the application of telecommunications technology to deliver professional services at a distance by linking clinician to client, or clinician to clinician for assessment, intervention, and/or consultation" (ASHA, 2010, p. 1). According to ASHA, telepractice is an appropriate form of service delivery to those who are unable to gain access to the necessary speech-language services. The service delivery of telepractice must match the quality of service delivery face to face.

Hill et al. (2006) conducted a pilot study on the effectiveness of a telerehabilitation system on the assessment and evaluation of motor speech disorders secondary to acquired neurological deficits. Results from the study found that no clinically significant difference between the online assessment and the face to face assessment. Mashima et al. (2003) evaluated the efficacy of delivering voice therapy via video teleconference (VTC) compared to voice therapy delivered face to face. The rationale for this research was limited availability of speech and language services in the Pacific Rim. Results of perceptual judgments of speech found that post-treatment voice samples were rated better than pre-treatment voice samples for 90% of the participants. Forty-nine of the participants completed a survey on the improvement of their voice from pre-treatment to post-treatment. There was no statistical difference between the conventional group and video teleconference group on improvement of voice, although each group rated a noticeable improvement in their voice quality.

Lee Silverman Voice Treatment via Distance Therapy

Howell et al. (2009) evaluated the feasibility of administering the Lee Silverman Voice Treatment (LSVT) online to individuals with hypokinetic dysarthria secondary to PD. The results of this study were compared to the results of Ramig et al. (2001b) which found that LSVT significantly improved vocal loudness in individuals with dysarthria secondary to PD when compared to individuals who received a respiratory-only (R-only) treatment. The study completed by Ramig et al. (2001b) found that the effects of LSVT remained over a 24 month period, while the effects of the R-only treatment did not.

Howell's subjects included three males between the ages of 63 and 72 years old who were diagnosed with PD between three and six years prior to the study. In order to be included in the study the individuals had to be familiar with Windows software and own the technological equipment necessary to complete the study. The *Frenchay Dysarthria Assessment* (Enderby, 1983) was used to confirm that the subjects had a communication profile consistent with hypokinetic dysarthia.

The individuals needed to own a computer, have a Windows XP operating system, a webcam with a headset and microphone, and have access to broadband internet.

Treatment also required Windows Media Player, a Skype account, and an e-mail account to connect with the therapist. Sound pressure levels were obtained face to face, but sound pressure levels were unable to be obtained accurately through use of a web camera. Voice recordings were obtained to provide feedback for the subject and provide practice. The subjects' confidentiality was maintained by obtaining assessment information face to face, using the encrypted internet phone Skype, and making all the video recordings the property of the subject.

Data was collected two weeks prior to the start of treatment, at the start and immediate end of treatment, and 2 months after the end of treatment. The subjects were asked to read the "Rainbow Passage" (Fairbanks, 1960), sustain a vowel phonation /ah/, and produce a 25 to 30 second monologue.

Each subject received treatment for 60 minute sessions, four times a week, for four weeks. Three therapy sessions a week were delivered through Skype. One session a week was delivered face to face. This was done to establish relationships with the subjects, collect SPL, and provide support as the therapy progressed.

Results from the study found that the three individuals improved their vocal loudness from pre- to post-treatment. The mean dB sound pressure level for the participants from pre-treatment to post-treatment showed a 14.3 dB increase for /ah/ phonation, a 7.7 dB increase for reading of the rainbow passage, and a 6.6 dB increase for the conversational monologue. In comparison to the study completed by Ramig et al. (2001b), the pre- and post-treatment measurements were similar and within half a standard deviation of the scores of the latter study. The follow-up scores of the present study were higher and this was attributed to the fact that data was collected two months after treatment, while data was collected 6 months after treatment in the study done by Ramig et al. (2001b).

Theodoros et al. (2006) evaluated the efficacy of the Lee Silverman Voice Treatment (LSVT) via an Internet-based telerehabilitation application on individuals with PD. The rationale for this study was distance from the availability of services and lack of speech pathologists in rural areas of Australia.

The subjects in the study included 10 individuals (8 males and 2 females) diagnosed with hypokinetic dysarthria secondary to PD. The participants had no history of speech disorders, laryngeal and respiratory pathology, or neurological deficits prior to the diagnosis of Parkinson's disease. The mean average post-onset disease duration was 5.8 years with a range of 1 to 14 years disease duration. The severity of dysarthria in the subjects ranged from mild to moderately severe. Data was collected prior to treatment and immediately following treatment. The subjects' SPL was measured during sustained phonation of the vowel /ah/, while reading a passage, and during a 30 second speech monologue. The subjects' pitch range was assessed by the eREHAB speech processor and determined by the mean differences between the highest and lowest pitches produced by each subject. Perceptual ratings of the individuals' speech samples were assessed pre- and post-treatment by two trained speech pathologists.

Treatment consisted of each participant receiving the standard LSVT techniques from a certified speech pathologist via the telerehabilitation (eREHAB) system. Two web cameras were situated on each client's computer and were controlled by the speech pathologist administering treatment via teleconference. The web cameras allowed for live video feed and recording of the sessions for assessment and treatment purposes. A speech processor provided continual measurements of sound pressure and pitch to the telerehabilitation system and to the administering clinician. The treatment was administered in 60 minute sessions, four times a week for four weeks.

Results from pre- to post-treatment showed a significant increase in SPL and mean pitch ranges. The subjects mean sound pressure level from pre-treatment to post-treatment showed a 10.8 dB increase for /ah/ phonation, a 7.5 dB increase for reading of the rainbow passage, and a 5.5 dB increase for the conversational monologue. Perceptual ratings showed increased improvement from pre- to post-treatment in the parameters of breathiness in voice, loudness levels, and pitch and loudness variability. Results of the patient satisfaction survey found that 70% of the subjects were more than satisfied with the online treatment, while 30% were very satisfied with the treatment.

Constantinescu et al. (2010) evaluated the efficacy of delivering the Lee Silverman Voice Treatment (LSVT) via remote delivery to an individual with mild hypokinetic dysarthria secondary to PD. The rationale for the study was the client's inability to socialize due to reduced vocal loudness and lack of LSVT services available in his community.

The subject was a 65 year old male diagnosed with PD six years prior to the study. The subject and his wife had noted a breathy vocal quality and a reduction in vocal loudness a few years prior to treatment initiation. His vocal difficulties affected him socially and vocationally, and caused him to avoid talking on the telephone and interacting in communicative situations. The subject had not received speech therapy services previously and exhibited mild hypokinetic dysarthria. A videolaryngoscopic examination revealed bowing of the vocal folds. The subject wore bilateral hearing aids for a mild to moderate hearing loss. Drug cycles were regulated throughout the study. The online treatment was delivered by an LSVT certified speech pathologist via a telerehabilitation system. The equipment needed for this study included two computers, web cameras, and microphones. The speech pathologist delivered the treatment from one computer which was seen by the subject on his computer via webcam. The telerehab system allowed for the speech pathologist to manipulate the subject's web camera via a robot arm. The system also provided reading material for the participant and contained a speech processor which captured sound pressure level and duration and frequency levels. The collection of data was performed pre- and post-treatment via face to face delivery. Acoustic measures were obtained during a sustained vowel phonation /ah/, while reading a passage, and during a conversational monologue. Perceptual measures were obtained while the subject read the "Rainbow Passage" (Fairbanks, 1960) and during a conversational monologue. The subject also completed a satisfaction survey after the deliverance of the online treatment.

The subject received the standard LSVT techniques in 60 minute sessions, four days a week for four weeks. The therapy focused on maximum duration phonation and increased loudness. The subject was mailed materials to complete for homework after treatment sessions.

Results from the acoustic outcomes revealed a 6.6 dB increase in SPL for vowel phonation, a 12.28 dB increase in loudness during reading a passage, and an 11.32 dB increase in loudness during a conversational monologue from pre-treatment to post-treatment. Pitch range did not show improvement from pre-treatment to post-treatment. Perceptual results revealed improvement in breathiness, roughness, and overall intelligibility from pre-treatment to post-treatment. The subject was satisfied with the overall experiences, rated the technological quality as excellent, and preferred future management of his condition via remote therapy.

Purpose of This Study

Previous studies have demonstrated the effectiveness of LSVT on the vocal loudness of individuals with PD. Treatment of voice characteristics in individuals with PD has demonstrated short-term and long-term efficacy (Ramig et al., 1995; Sapir et al., 2007; Baumgartner et al., 2001; Ramig et al., 2001b). Individuals with PD who received LSVT displayed greater vocal intensity and fundamental frequency from pre- to post-treatment when compared to individuals who received a respiratory-only treatment (Ramig et al., 1995). Follow-up studies reported a significant increase in vocal intensity levels post-treatment when compared to pre-treatment levels for up to 6 months (Ramig, et al., 2001b), 12 months (Ramig et al. 1996), and 24 months (Ramig et al., 2001a). Due to the intensive, time consuming aspect of the treatment, most individuals with PD are unable to receive this treatment, especially if they do not live in an urban area. To address this issue, researchers have looked at the effects that LSVT has on the vocal intensity of patients with PD when treatment is delivered via distance therapy. In contrast to the wealth of evidence documenting the efficacy of delivering LSVT in a traditional face to face venue, only three studies with fewer than 15 participants total have been conducted to evaluate LSVT using distance technology (Constantinescu et al., 2010; Theodoros et al., 2006; Howell et al., 2009). All three studies provided treatment only via distance therapy with no direct comparison being made between gains in distance delivery and traditional face to face intervention.

The following research questions were addressed in the current study:

1. Is there a difference in the effect that the Lee Silverman Voice Treatment (LSVT) delivered via distance therapy has on vocal loudness in individuals with Parkinson's disease when compared to traditional face to face delivery based on pre to post gains and weekly probe measures?
2. Is there a difference in satisfaction in individuals with Parkinson's disease who receive the Lee Silverman Voice Treatment (LSVT) via face to face delivery when compared to individuals with Parkinson's disease who receive LSVT via distance therapy?

Chapter III

Methodology

Subject Selection

The five subjects in the study were recruited through the Sarah Bush Lincoln Parkinson's Disease Support Group and Carle Hospital's Central Illinois Parkinson's Awareness Group from January of 2011 through June of 2011. Seven subjects were interested in receiving the treatment; however, one subject passed away before receiving distance treatment and one subject interested in receiving distance treatment was excluded from the study due to an inability to complete the neuropsychological assessment. The *Montreal Cognitive Assessment* (MoCA) (Nasreddine et al., 2005) was administered to the subjects in order to determine their neuropsychological status. The MoCA was designed as a rapid screening tool in order to identify mild cognitive impairment. The test assessed cognitive processes such as attention and concentration, executive functions, memory, language, visuoconstructional skills, conceptual thinking, calculations, and orientation. Some of the tasks included clock drawing, naming pictures, and alternating trail making. The test took 10 minutes to administer. The total points possible were 30 with a score of 26 or above considered normal. The results for the MoCA are in Table 1 for subject descriptions.

The subjects participated in initial interview questions pertaining to neurological and medical information, medication, surgeries, speech symptoms, swallowing, employment status, neuropsychological information, and information about daily communication interactions (see Appendix A). To determine if there was any abnormality of laryngeal function, the researchers viewed the subjects' vocal folds using a rigid or flexible endoscope to determine the presence of any bowing of the vocal folds or other laryngeal abnormalities. To determine the severity of the disease, each subject completed the Unified Parkinson's Disease Rating Scale (see Appendix B). This scale asked the subjects to rate different areas of their disorder such as behavior, activities of daily living, and motor abilities/disabilities. A numerical rating scale was used to assess each of these areas, with "0" indicating the area was normal/absent/none, and "4" indicating the individual needed supervision and could not perform tasks, etc.

Table 1. Subject Selection Criteria

Subject Description	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5
Tx Condition	Face to Face	Face to Face	Face to Face	Distance	Distance
Age	59	80	69	70	61
Time Since Diagnosis (yrs)	2.4	10	2 months	4.9	27
Montreal Cognitve Assessment (greater than 26 normal)	28	27	17	27	25
Unified Parkinsons Disease Rating Scale (higher score, more impaired)	31	29	11	10	37
Medical Tx	Sinemet, Requip	Deep Brain Stimulation (DBS) for Parkinsons; Sinemet, Amandodine	Normal Pressure Hydrocephalus and received a shunt to relieve pressure in his brain; not on Parkinson's meds	Sinemet, Ropinerole, Midodrine	DBS for Parkinsons; Pallidotomy; Sinemet, Mirapex
Voice Handicap Index	46	46	16	17	80

Table 1 displays the subject selection criteria and subject descriptions are detailed below.

Subject 1, a Caucasian female, was 59 years old at the initiation of treatment. She lived 10 minutes from the EIU Clinic and drove herself to face to face treatment. Subject 1 began treatment in February of 2011. Due to time constraints, only three pre-treatment baseline levels were obtained. Subject 1 was diagnosed with Parkinson's disease in September of 2008 and was 2.4 years post-diagnosis at the start of treatment. She received a score of 28 on the MoCa and a score of 31 on the United Parkinson's Disease Rating Scale (UPDRS). Subject 1's medications included Sinemet (carbidopa-levodopa) 25-100 mg tablets three times per day and Requip (ropinirole hcl) 1 mg tablets, 1.5 tablets, three times per day for Parkinson's disease which were regulated throughout therapy. Her hearing was within functional limits for treatment. Her vocal folds were viewed using a flexible endoscope and no abnormality of laryngeal function was noted. Subject 1 stated she first noticed changes in her voice about seven or eight years prior to the start of treatment. She described these changes as her voice being softer and running out of breath before finishing her utterances. Subject 1's complaints at the start of therapy included a soft voice, running out of breath, and having difficulty communicating with others because they could not hear her. Subject 1 stated that Parkinson's disease had caused her to talk less and hindered her ability to continue as a historical interpreter. At the start of therapy, Subject 1 exhibited mild vocal difficulties and was seeking therapy to communicate effectively with others and resume her position as a historical interpreter.

Subject 2, a Caucasian female, was 80 years old at the initiation of treatment. She lived less than five minutes from the EIU Clinic and received the face to face treatment.

Subject 2 began treatment in June of 2011. Six pre-treatment baseline levels were obtained prior to treatment. Subject 2 did not drive and received transportation to the clinic through local friends. She was diagnosed with Parkinson's disease in May of 2001 and was 10 years post-diagnosis at the start of treatment. She received a score of 27 on the Montreal Cognitive Assessment and a score of 29 on the UPDRS. Subject 2's vocal folds were viewed using a rigid endoscope and no abnormality of laryngeal function as noted. Subject 2 underwent deep brain stimulation in October of 2007. She had received speech therapy for Parkinson's disease 6 months prior to the study, in which she worked on exercises for breath control. Subject 2 stated she had difficulty swallowing liquids; however, this was not a daily occurrence. Subject 2's medications included Sinemet (carbidopa-levodopa) 25-100 mg tablets taken every 3 hours and Amantodine 100 mg tablets take once per day for Parkinson's disease. Both these medications were regulated throughout therapy. Subject 2's medications also included Atenolol for high blood pressure and Simvastatin for high cholesterol. Her hearing was within functional limits for treatment. She stated that she noticed changes in her voice upon diagnosis of Parkinson's disease in May of 2001. Her speech symptoms at the start of therapy included reduced volume and slurring of words, with the most significant problem including running out of breath and difficulty taking a deep breath. She stated that her voice was intelligible a majority of the time; however, individuals did ask her to repeat. She also stated that Parkinson's disease caused her to talk a great deal less. At the start of therapy, Subject 2 exhibited mild to moderate vocal difficulties. Subject 2 lived alone, but was seeking therapy in order to communicate effectively when talking to family and friends on the phone.

Subject 3, a Caucasian male, was 69 years old at the initiation of treatment. He lived one hour from the EIU Clinic and drove himself for the face to face treatment. Subject 3 began treatment in June of 2011 and, due to time constraints no pre-treatment baseline levels were obtained. He was diagnosed with Parkinson's disease in May of 2011 and was two months post-diagnosis at the initiation of treatment. He received a score of 17 on the Montreal Cognitive Assessment and a score of 11 on the UPDRS. Subject 3's vocal folds were viewed using a flexible endoscope and no abnormality of laryngeal function was noted. In August of 2010, Subject 3 was diagnosed with Normal Pressure Hydrocephalus and received a Ventriculoperitoneal Shunt to relieve pressure in his brain. Due to the recent diagnosis, Subject 3 was not on medication for Parkinson's disease throughout therapy. His hearing was within functional limits for treatment. Subject 3 noticed that within the year prior to the diagnosis of Parkinson's disease, his vocal quality was softer and he had difficulty recalling words and names of people. He stated his wife reminded him often to speak louder and he talked quite a bit less because he was concerned about not being able to recall the words he needs. Subject 3 was seeking treatment due to concern about losing his ability to communicate. At the start of therapy, Subject 3 exhibited mild vocal difficulties. Subject 3 was a retired football coach and insurance agent who was looking forward to conversing normally with his weekly morning coffee group.

Subject 4, a Caucasian female, was 70 years old at the initiation of treatment. She lived one hour from the EIU Clinic and participated in the distance therapy. Subject 4 began treatment in May of 2011. Six pre-treatment baseline levels were obtained. She was diagnosed with Parkinson's disease in June of 2006 and was 4.9 years post-diagnosis at the initiation of treatment. She received a score of 27 on the Montreal Cognitive Assessment and a score of 10 on the UPDRS. Her medications included Sinemet (carbidopa-levodopa), Ropinerole, and Midodrine hcl for Parkinson's disease which were regulated throughout therapy. Subject 4's medications also included Actonel for osteoporosis. Her hearing was within functional limits for treatment. Subject 4's vocal folds were viewed using a flexible endoscope and no abnormality of laryngeal function was noted. She explained that she first noticed changes in her voice in the months prior to initiation of treatment. She stated she consciously had to speak louder in order for others to hear her. She described her voice as being quiet and stated that she had difficulty speaking loudly enough. Subject 4 stated that Parkinson's disease had caused her to talk less because it was difficult to be heard and interact in social situations. At the start of treatment, Subject 4 exhibited mild vocal difficulties. She sought treatment to learn the vocal techniques in order to continue to communicate effectively and decrease the possibility of developing masked facial expressions associated with Parkinson's disease.

Subject 5, a Caucasian female, was 61 years old at the initiation of treatment. She lived one hour from the EIU Clinic and participated in the distance therapy. Subject 5 began treatment in June of 2011 and, due to time constraints only two pre-treatment baseline levels were obtained. She was diagnosed with Parkinson's disease in the spring of 1984 and was 27 years post-diagnosis at the initiation of treatment. She received a score of 25 on the Montreal Cognitive Assessment and a score of 37 on the UPDRS. Her medications included Sinemet (caridopa-levodopa) 25-100 mg tablets three times per day, Mirapex (pramipexole) .5 mg tablets three times per day for Parkinson's disease which were regulated throughout therapy. Subject 5's medications also included Ditropan (oxybutynin) for overactive bladder. Her hearing was within functional limits for treatment. Subject 5's vocal folds were viewed using a flexible endoscope and no abnormality of laryngeal function was noted. Subject 5 underwent a Pallidotomy in 1996 and deep brain stimulation (DBS) in February of 2006. She stated she had some difficulty swallowing, especially with dry meats. She first noticed changes in her vocal quality in the late 1980's. She stated that the volume of her voice was low and individuals often had difficulty understanding her, even in one on one conversation. She had noticed difficulties with her memory and often lost her train of thought. Subject 5 rated her speech as being 50% intelligible and stated Parkinson's disease had caused her to talk a great deal less. She stated that her relationship with her elderly, hard of hearing mother, had become strained due to an inability to communicate with each other. Due to reduced vocal loudness and difficulty with handwriting, she felt she had no means of communication. She reported that she had given up on all activities and could no longer be employed due to her Parkinson's disease. At the start of treatment, subject 5 exhibited moderate vocal difficulties.

Overall, the subjects receiving face to face therapy and the subjects receiving distance therapy varied in several subject factors. As an overall group, the subjects receiving face to face therapy were younger in age, exhibited shorter disease duration, and were more motivated to receive speech therapy. As an overall group, the subjects receiving distance therapy contained the mildest participant and the most severe participant both in terms of disease duration, the extent of speech difficulties, and medical treatments.

Research Design

In order to compare the efficacy of distance therapy, the current study utilized a single subject multiple baselines across subjects research design. The speech gains of three patients with PD who received the LSVT via face to face delivery were compared with the gains made by two patients with PD who received LSVT via distance techniques. Vocal loudness, speech intelligibility, and patient satisfaction were measured.

During the multiple baselines across subjects research design, a baseline was established with four out of the five subjects prior to application of treatment. A baseline was not established with Subject 3 due to time constraints. Twice weekly probe measures were taken of the subjects receiving treatment, and once weekly or bi-weekly of the subjects who were in extended baseline. The tasks used as probe measures were the duration and intensity of sustaining an "ah' phonation and obtaining an average SPL of a two minute conversation based on a topic that was randomly chosen from a set of 10 topics that remained the same across all probe measures. The extended baseline of varying lengths is one control mechanism within the research design because it required repeated measures of target behaviors. If a behavior change can be demonstrated across all subjects after treatment is initiated and not during extended baseline, then it is reasonable to assert that the treatment resulted in the change.

Independent Variable-LSVT Treatment

The independent variable of distance versus face to face speech therapy for patients with PD employed the LSVT techniques of using correct breath control to project voice, projecting a range of high to low notes, and speaking scripted sentences and words as loud as possible. The treatment was delivered to each subject by the researcher certified in LSVT with supervision by the co-investigator who was a licensed speech-language pathologist in the State of Illinois and certified in LSVT. Treatment in both conditions utilized the recommended one hour per day, four days per week treatment for four weeks. The goals of treatment included helping the subject recognize the need for increased loudness, helping the client understand that the louder voice is within normal limits (WNL), helping the client become comfortable and acquainted with the louder voice and increased phonatory effort, increasing calibration in "daily increments," and developing the ability to self-monitor an adequate loudness level (Ramig & Fox, 2010).

Each session lasted 60 minutes with the first half hour focusing on daily tasks to warm up the loud voice. The second half hour focused on hierarchical speech loudness drills, spontaneous speech using a "loud" voice, and assigning homework and carryover tasks. The first daily task was sustaining an /ah/ phonation for a maximum duration. This was measured in seconds and decibels of sound pressure level (dB SPL) and completed 15 times in a continuous, high effort manner. The second daily task measured the maximum fundamental frequency range from the subject's highest pitch to the lowest pitch. This was be measured in Hertz (Hz) and required the subject to begin at a low pitch and become higher (Highs), and then begin at a high pitch and become lower (Lows) using an /ah/ phonation. Each of the Highs and Lows were practiced 15 times in a continuous, high effort manner. The third daily task was a maximal, continuous drill of the subject's 10 functional phrases. These phrases were chosen based on salience and relevance to the subject's daily communication interactions. The phrases were measured by SPL and practiced 10 times in a continuous, high effort manner.

The hierarchical speech loudness drills were completed each session with a different target for each week. These targets included single words/phrases for week one, sentences for week two, paragraph reading for week three, and conversation for week four. The reading material was selected based on salience and relevance to the subject. The drills were measured in SPL and practiced in a continuous, high effort manner. Homework tasks were assigned daily and consisted of the subject completing 10 to 15 minutes of maximum duration "ah," Highs and Lows, functional phrases, and the hierarchical speech loudness drills at home. On days when the subject did not receive treatment, homework was completed two times per day for 10 to 15 minutes each time. A carryover assignment was assigned for each day and on the days in which the subject did not receive treatment. These carryover tasks were subject driven and fit into the subject's daily living. These were specific tasks in which the client had to use their "loud" voice and were used to address sensory problems and provide specific feedback. The subject provided a situation in which they knew they would have to communicate, and this was assigned as their carryover task. The subject had to provide insight and feedback to the clinician on the outcome of the carryover task.

The focus of week one was on shaping daily tasks through the use of a loud, good quality voice. In order to educate the subject and increase generalization, the subject's conversation and passage reading were audio recorded. These recordings were played back to the subject to provide feedback on how they perceptually sounded. Emphasis was placed on increased loudness in order to display effective communication. The targeted hierarchical speech tasks were words/phrases.

The focus of week two was increasing the subject's confidence in completing daily tasks and encouraging the best performance. Simple questions were used during conversation in order for the subject to generate a response using a loud, good quality voice. There was continued promotion of generalization and self-monitoring of loudness through the use of probing questions and feedback from the clinician. The targeted hierarchical speech tasks were sentences.

The focus of week three was increased level of performance during daily tasks. During this week, 5 to 10 minutes were used to target conversation in which the subject's "loud" voice was closely monitored. The client was continually educated on self-monitoring and generalization using a "loud" voice through probing questions and feedback from the clinician. Towards the end of this week, the subject was taken out of the therapy room to practice their "loud" voice in other settings (i.e., waiting room). The targeted hierarchical speech tasks were paragraph passages.

The focus of week four was improving the client's motivation during daily tasks and focusing on using a "loud" voice in conversations. The patient was moved out of the therapy room in order to generalize the use of a "loud" voice in social situations. The subject's ability to self-monitor and think "loud" were probed through the use of questions and feedback. The targeted hierarchical speech task was conversational speech. Towards the end of the week, the subject and clinician discussed the importance of continued practice of homework assignments in order to maintain the loud, good quality voice.

The face to face treatment occurred at the Eastern Illinois University (EIU) Clinic. The clinician administered the treatment face to face in a private therapy room with minimal distractions.

The distance treatment was delivered via web camera through Skype, which is a peer to peer internet phone video service. In speaking with Dr. Lorraine Ramig and Dr. Cynthia Fox, it was determined that utilizing Skype would be the most appropriate method for delivering LSVT through distance technology. The subjects received therapy within the comfort of their own home on their computer with an internet connection, web camera, and microphone. The clinician obtained probe measure and daily data measurements utilizing the LSVT Companion Software-Clinician Edition and a calibrated microphone. The subjects were provided with a Dynex™ USB external microphone and a Microsoft LifeCam HD-6000 Webcam. The microphone utilized in the subjects' homes was not the same microphone utilized for therapy with face to face subjects. Each subject was asked to utilize an existing Skype account or create an account for therapy purposes.

Dependent Variable

Probe measures (baseline, treatment). The tasks that were used as probe measures were the duration and intensity of sustaining an "ah' phonation, and sustaining a conversation for two minutes based on a topic that was randomly chosen from a set of 10 topics that remained the same across all probe measures. Baseline measures for face to face subjects were obtained within their home and probe measures were obtained in the EIU Clinic utilizing the LSVT Companion Software-Clinician Edition and a calibrated microphone which was provided with the purchase of the LSVT software. The clinician utilized a flexible measuring tape and measured 50 cm between the subject's mouth and microphone. Twice weekly, the subject receiving therapy was asked to sustain a loud /ah/ phonation for as long as they can. Three measures were taken to obtain an average SPL and duration time. The subject was then asked to maintain a conversation for two minutes based on the topic chosen for that day. The subject's average SPL was obtained during the conversational task. The same probe measures were obtained bi-weekly from the subjects in extended baseline and weekly from the subjects who were being prepped to begin therapy. Baseline and probe measures for the subjects receiving distance therapy were obtained through distance technology using Skype and necessary equipment such as a web camera and microphone. The distance subjects were not provided a flexible tape measure, but were asked to utilize a measuring tape or ruler to measure 50 cm between their mouth and the microphone prior to baseline and probe measure collection.

Pre- and post-measures. Video and audio recordings were obtained face to face at the EIU Clinic of the subjects performing various speaking tasks at pre-treatment and immediately post- treatment using the LSVT Companion Software-Clinician Edition. The clinician utilized a calibrated microphone and measured 50 cm between the subject's mouth and the microphone prior to and throughout the evaluations. The post-treatment measurements were obtained the last day of treatment for Subject 3 and Subject 5, four days after completion of treatment for Subject 4, five days after completion of treatment for Subject 2, and 11 days after completion of treatment for Subject 1. The dependent variables of acoustic measures were obtained using the standard LSVT Evaluation Protocol (Constantinescu et al., 2010). This protocol included: (a) obtaining the average SPLs during maximum duration of six 'ah' phonations, obtaining average SPLs during reading of the "Rainbow Passage" (Fairbanks, 1960), and average loudness during a conversational monologue, (b) obtaining the average duration of the six 'ah' phonations and, (c) obtaining highest frequency, lowest frequency, and pitch range during phonation of 'ah.'

The Voice Handicap Index (VHI) (Jacobson et al., 1997) (Appendix C) was used as a pre- and post- measure to determine how the subjects' vocal qualities affect their daily living and the degree to which their voice is problematic. This index asked the subjects' to rate aspects about their voice using a five-point scale ranging from "never" to "always." A lower score on the VHI is indicative of less vocal difficulty. This index was used to determine how much of an impact LSVT had on an individual's quality of life.

Post-treatment only measure. Qualitative measures of participant satisfaction with the treatment techniques, modalities and outcomes were also gathered through survey. This survey was administered immediately after treatment. The subjects were asked to complete the survey at home and mail it back to the clinician who implemented therapy. The subjects who participated in the face to face treatment and the subjects who participated in the distance treatment each received the Participant Satisfaction Survey containing correlated questions (Appendix D). The subjects were asked to rate their satisfaction based on a five point rating scale. The subjects who participated in the face to face treatment were asked to rate their satisfaction in regards to (a) face to face treatment sessions, (b) quality of treatment, (c) the convenience of traveling to the EIU clinic four times a week, and (d) overall satisfaction with the treatment. The subjects who participated in the distance treatment were asked to rate their satisfaction in regards to (a) online treatment sessions, (b) audio and video quality during online treatment sessions,

(c) quality of treatment, (d) the ease of use of distance technology (computer, web camera, microphone), and (e) overall satisfaction with online treatment.

Chapter IV

Results

A total of five subjects, three participating in face to face therapy and two participating in distance therapy, were included in the study.

Analysis of Pre- to Post-Assessment Speech Gains

The LSVT Evaluation Protocol was utilized at pre-treatment and post-treatment to document the speech gains of each subject through sound pressure level, duration, and frequency. To address the research question concerning the difference in the effect that the Lee Silverman Voice Treatment (LSVT) delivered via distance therapy has on vocal loudness in individuals with Parkinson's disease when compared to traditional face to face delivery based on pre to post gains and weekly probe measures, visual inspection of tabled data and descriptive statistics were utilized. Table 2 displays the pre, post, gain, and group mean data for subjects who received face to face therapy and distance therapy.

As Table 2 reveals, all the subjects in the face to face therapy condition made gains in SPL from pre-treatment to post-treatment. Subject 1 demonstrated gains in SPL for all three tasks, with a 17.7 dB improvement for /ah/ phonation, a 5.5 dB improvement for the Rainbow passage, and a 2.2 dB improvement for the monologue task from pre-treatment to post-treatment. She also demonstrated change in pitch range, with a 78.6 Hz improvement in high pitch; however, for the low pitch range, the subject increased her

Table 2. Pre, Post, Gain, and Group Mean scores for Face to Face and Distance Therapy Subjects

Participant and Task	Pre	Post	Gain
FACE TO FACE PARTICIPANTS			
S1			
/ah/ (dB spl)	73.8	91.5	17.7*
Rainbow (dB spl)	71.5	77.0	5.5*
Monologue (dB spl)	68.2	70.4	2.2*
Pitch Range High (Hz)	247.2	325.8	78.6
Pitch Range Low (Hz)	157	184.7	-27.7
VHI	46	15	31**
S2			
/ah/ (dB spl)	68.9	75.4	6.5*
Rainbow (dB spl)	72.3	73.8	1.5*
Monologue (dB spl)	72.0	70.3	-1.7
Pitch Range High (Hz)	335.8	291.3	-44.5
Pitch Range Low (Hz)	201.5	181.2	20.3
VHI	46	37	9
S3			
/ah/ (dB spl)	64.4	85.3	20.9*
Rainbow (dB spl)	69.8	75.1	5.3*
Monologue (dB spl)	67.1	70.2	3.1*
Pitch Range High (Hz)	312	176.5	-135.5
Pitch Range Low (Hz)	95.2	90.5	4.7
VHI	16	16	0
Mean of Face to Face Subjects			
/ah/ (dB spl)	69.03	84.06	15.03*
Rainbow (dB spl)	71.2	75.3	4.1*
Monologue (dB spl)	69.1	70.3	1.2*
Pitch Range High (Hz)	298.3	264.5	-33.8
Pitch Range Low (Hz)	151.2	152.1	-.9
VHI	36	22	14
DISTANCE PARTICIPANTS			
S4			
/ah/ (dB spl)	75.2	68.0	-7.2
Rainbow (dB spl)	71.5	68.1	-3.4
Monologue (dB spl)	66.5	63.9	-2.6
Pitch Range High (Hz)	341.7	275.2	66.5
Pitch Range Low (Hz)	169.3	167.5	1.8
VHI	17	30	-13
S5			
/ah/ (dB spl)	67.1	75.3	8.2*
Rainbow (dB spl)	63.8	66.3	2.5*
Monologue (dB spl)	62.4	63.2	0.8*
Pitch Range High (Hz)	213	190.5	22.5
Pitch Range Low (Hz)	157.5	138.8	18.7
VHI	80	52	28**
Mean of Distance Participants			
/ah/ (dB spl)	71.15	71.65	.5*
Rainbow (dB spl)	67.65	67.2	-0.45
Monologue (dB spl)	64.45	63.55	-0.9
Pitch Range High (Hz)	277.3	232.85	44.45
Pitch Range Low (Hz)	163.4	153.15	10.25
VHI	48.5	41	7.5

*Improvement , ** Change in the Total VHI Score of 18 points or more reflects a shift that is not just a result of VHI variability (Jacobson, et al., 1997).

frequency by 27.7 Hz. Subject 1's Voice Handicap Index decreased 31 points from pre-treatment to post-treatment, which reflects a shift that is not just a result of VHI variability. A decrease in the VHI score is indicative of a decrease in the subject's initial perceived vocal difficulty. Subject 2 demonstrated a 6.5 dB improvement for /ah/ phonation and a 1.5 dB improvement for reading the Rainbow passage from pre-treatment to post-treatment, however she demonstrated a decrease in SPL of 1.7dB for the monologue task from pre-treatment to post-treatment. Subject 2 demonstrated a decrease in high pitch range by 44.5 Hz from pre-treatment to post-treatment, but did decrease her low pitch range by 20.3 Hz. Subject 2's VHI score decreased by 9 points from pre-treatment to post-treatment. Subject 3 demonstrated gains in SPL for all three tasks, with a 20.9 dB improvement for /ah/ phonation, a 5.3 dB improvement for reading the Rainbow passage, and a 3.1 dB improvement for the monologue task from pre-treatment to post-treatment. Subject 3 also demonstrated change in pitch range with a decrease in high pitch by 135.5 Hz and a decrease in low pitch by 4.7 Hz from pre-treatment to post-treatment. Subject 3's VHI score remained the same from pre-treatment to post-treatment. The total mean gains for the face to face subjects for /ah/ phonation, the Rainbow passage, and the monologue task from pre-treatment to post-treatment was 15.03 dB, 4.1 dB, and 1.2 dB respectively for the subjects who participated in face to face therapy.

As Table 2 also exhibits, one of the participants in the distance therapy condition did not make pre to post assessment gains. Subject 4 demonstrated a decrease in SPL from pre-treatment to post-treatment, with a 7.2 dB decrease for /ah/ phonation, a 3.4 dB decrease for the Rainbow passage, and a 2.6 dB decrease for the monologue task. Despite an improvement in loudenss measures, Subject 4 demonstrated a 13 point increase in VHI from pre-treatment to post-treatment. Subject 4 also demonstrated a change in pitch range with a decrease in high pitch by 66.5 Hz and a decrease in low pitch by 1.8 Hz. Subject 5 however, demonstrated a positive response to treatment with an increase in SPL from pre-treatment to post-treatment, with an 8.2 dB improvement for /ah/ phonation, a 2.5 dB improvement for the Rainbow passage, and a 0.8 dB improvement for the monologue task. Subject 5's Voice Handicap Index decreased 28 points from pre-treatment to post-treatment , which reflects a shift that is not just a result of standard VHI variability. She also demonstrated a change in pitch range with a decrease in high pitch by 22.5 Hz and a decrease in low pitch by 18.7 Hz. The mean for the two subjects who participated in the distance therapy demonstrated a 0.5 dB increase in SPL for the /ah/ phonation, a 0.45 dB decrease in SPL for the Rainbow passage, and a 0.9 dB decrease in SPL for the monologue task.

Probe Measures

Baseline and probe measure tasks were obtained by measuring the duration and intensity of sustaining an "ah' phonation and sustaining a conversation for two minutes.

To address the research question concerning the difference in the effect that the Lee Silverman Voice Treatment (LSVT) delivered via distance therapy has on vocal loudness in individuals with Parkinson's disease when compared to traditional face to face delivery based on weekly probe measures, visual inspection of tabled data and descriptive statistics were utilized. Figures 1 and 1.1 display the baseline and probe measures for the intensity of /ah/ phonation for individual subjects who participated in face to face therapy and the subjects who participated in distance therapy. Figures 2 and 2.1 display the baseline and probe measures for the duration of /ah/ phonation for individual subjects who participated in face to face therapy and the subjects who participated in distance therapy. Figures 3 and 3.1 display the baseline and probe measures for the average SPL of conversation for all subjects who participated in face to face therapy and all subjects who participated in distance therapy.

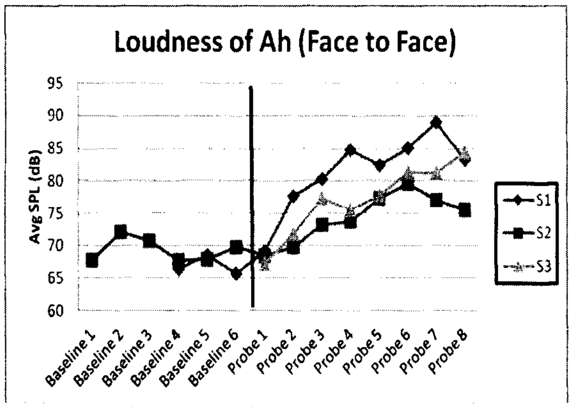

Figure 1. Phonation of ah (Face to Face)

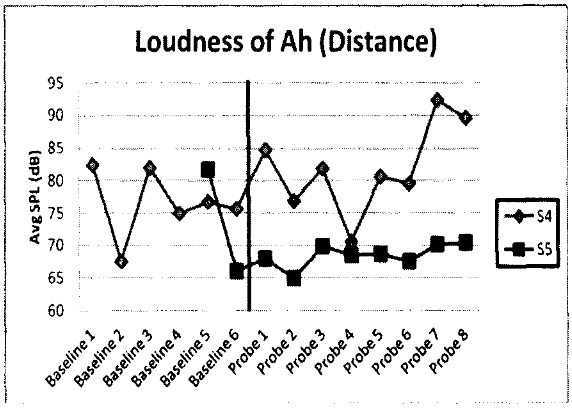

Figure 1.1. Phonation of ah (Distance)

As Figure 1 displays, all subjects in the face to face condition made significant increases during weekly dB SPL probe measures of /ah/ phonation. Subject 1 had three baseline measures prior to treatment which varied between 65 and 70 dB SPL, then over the course of treatment steadily increased to a peak in SPL with an 88.9 dB intensity of /ah/ phonation at probe measure seven, which decreased slightly to an 83.2 dB intensity at probe measure eight. Subject 2 had six baseline measures prior to treatment between 67 and 71 dB , and then increased in treatment to a peak SPL of 79.6 dB of /ah/ phonation at probe measure six, which decreased to a 76.9 dB intensity at probe measure seven, and a 75.4 dB intensity at probe measure eight. Baseline measures were not obtained prior to treatment from subject 3 due to time constraints. Subject 3 began treatment with a 66 dB intensity of /ah/. He demonstrated a steady increase during treatment with a peak in SPL at 77.2 dB of /ah/ phonation at probe measure three, which decreased slightly to 75.5 dB at problem measure four.

As Figure 1.1 displays, the two participants in distance treatment had considerable variability of between approximately 66 and 83 dB SPL during baseline probes. All of Subject 5's treatment probes varied between 65 and 70 dB whereas Subject 4 had two probes above 90 which were significantly above the variable baselines.

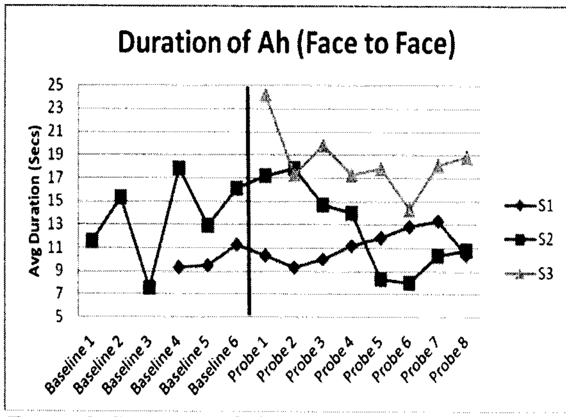

Figure 2. Duration of ah (Face to Face)

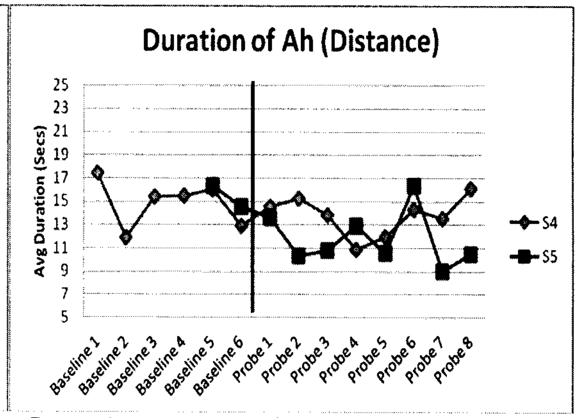

Figure 2.1. Duration of ah (Distance)

As Figure 2 displays, the three face to face subjects exhibited limited improvement in duration of /ah/ phonation from baseline through treatment. Each subject's duration of /ah/ phonation varied from probe to probe with no defining trend. The average duration for the subjects at the end of treatment ranged from 11 seconds to 19 seconds.

As Figure 2.1 displays, there were similar results for the distance subjects as for the face to face subjects, with no defining trend in duration of /ah/ phonation. The average duration for the subjects at the end of treatment ranged from 10 seconds to 16 seconds; however, no subjects exceeded variable baseline measures.

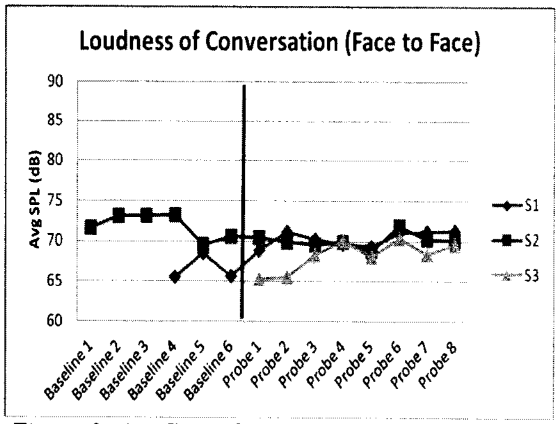

Figure 3. Avg SPL of conversation (Face to Face)

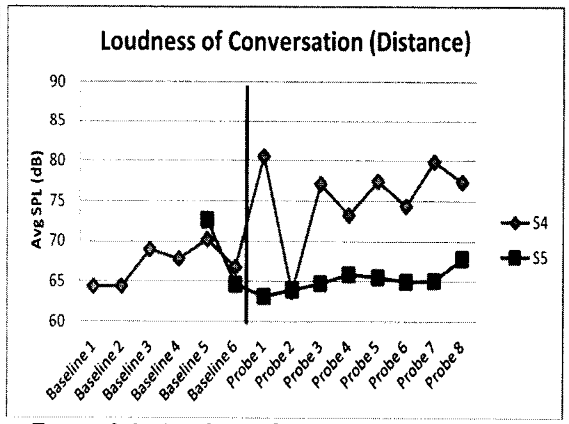

Figure 3.1. Avg SPL of conversation (Distance)

As Figure 3 displays, the three face to face subjects exhibited no defining trend from baseline through treatment. Subject 1 and Subject 3 increased SPL of conversation from baseline and beginning probe measures through the end of treatment by 4 to 6 dB. Subject 2's SPL decreased around 4 dB from baseline through the end of treatment. As Figure 3.1 displays, Subject 4 showed the most defining trend in improvement of conversational loudness from beginning baseline measures through ending probe measures. Subject 5 showed little change in SPL for conversation from baseline through treatment.

Post-Treatment Measures-Participant Satisfaction

To address the research question of the difference in satisfaction in individuals with Parkinson's disease who receive the Lee Silverman Voice Treatment (LSVT) via face to face delivery when compared to individuals with Parkinson's disease who receive LSVT via distance therapy, qualitative measures of participant satisfaction with the treatment techniques, modalities, and outcomes were gathered through survey are described below.

Subject 1 stated that she would participate in face to face treatment sessions again and rated the quality of treatment as 'excellent.' Subject 1 stated that traveling to the EIU Clinic four times a week was 'very convenient' and was 'very satisfied' with the face to face treatment.

Subject 2 stated that she would participate in face to face treatment sessions again and rated the quality of treatment as 'very good.' Subject 2 stated that traveling to the EIU Clinic four times a week was 'somewhat inconvenient' and was 'satisfied' with the face to face treatment.

Subject 3 stated that he would participate in face to face treatment sessions again and rated the quality of treatment as 'excellent.' Subject 3 stated that traveling to the EIU Clinic four times a week was 'somewhat inconvenient' and was 'very satisfied' with the face to face treatment.

Subject 4 stated that she would prefer online session over face to face sessions for future management of Parkinson's disease and rated the quality of treatment as 'excellent.' Subject 4 stated that audio and video quality during the online treatment sessions was 'very good,' but that the ease of use of distance technology (computer, web camera, and microphone) was 'somewhat difficult.' Overall, Subject 4 was 'very satisfied' with the online treatment.

Subject 5 stated that she would participate in online sessions again and rated the quality of treatment as 'excellent.' Subject 5 stated that audio and video quality during online treatment sessions was 'excellent' and the ease of use of distance technology (computer, web camera, and microphone) was 'easy.' Overall, subject 5 was 'somewhat satisfied' with the online treatment.

Chapter V

Discussion

The purpose of this study was to compare vocal loudness gains made in traditional face to face therapy with gains made in distance therapy using the Lee Silverman Voice Treatment (LSVT) for five individuals with Parkinson's disease. The study also compared the satisfaction of subjects who received LSVT through distance and face to face therapy. Previous research has documented that LSVT treatment techniques provide immediate and long term speech improvements in groups of patients with PD (Huber et al., 2003; Ramig et al., 1995; Ramig et al., 2001a; Ramig et al., 2001b; Sapir et al., 2007). Only three studies with fewer than 15 participants total have been conducted to evaluate LSVT using distance technology (Constantinescu et al., 2010; Theodoros et al., 2006; Howell et al., 2009), in which all three studies provided treatment only through distance technology with no direct comparisons being made with traditional face to face therapy.

Summary of Results and Factors That May Have Influenced Results

All five subjects reported being satisfied with the treatment and indicated they would complete the treatment again if necessary. The subjects were rank ordered from most to least gains made in treatment and factors which may have influenced each participant's progress are discussed.

Subject 1 made the greatest gains in treatment. She received face to face therapy and demonstrated improvement in sound pressure level (loudness) for pre-post /ah/, reading, and monologue tasks. She also demonstrated a 16.9 dB improvement for /ah/ loudness level and a 5.8 dB improvement for conversational loudness level probes from beginning baseline measure to ending probe measure. Subject 1 exhibited mild speech difficulties and had only been diagnosed with Parkinson's disease 2.4 years prior to the initiation of treatment. Subject 1 was highly motivated to begin therapy and received positive feedback from family and friends about her voice during the course of therapy. She was consistently seeking out social situations outside of therapy in which she would have to practice using her loud voice. Subject 1's high motivation and positive feedback are possible positive influences on her gains made in vocal loudness.

Subject 3 made the second highest gains in treatment. Subject 3 received face to face therapy and demonstrated loudness gains (improvement in sound pressure level) for all three pre-post tasks (/ah/, monologue, and reading). Baseline measures were not obtained from Subject 3, but he demonstrated a 17.4 dB improvement for /ah/ loudness level and a 4.3 dB improvement for conversational loudness level from beginning probe measure to ending probe measure. Subject 3 was highly motivated to begin therapy after his recent diagnosis of Parkinson's disease. He had been diagnosed with Parkinson's disease only 2 months prior to the initiation of treatment, which was the shortest disease duration time for all the subjects. He was retired from positions as football coach and insurance agent, but was still very active in his daily life. He received daily positive feedback from his wife, as well as positive feedback from his daughter through phone conversations. Subject 3's mild disease progression, his overall positive personality, and positive daily feedback may have contributed to gains made in vocal loudness.

Subject 4 would be ranked as number 3 in terms of treatment progress. Subject 4 received distance therapy, exhibited mild speech difficulties, and her speech did not highly impact her daily life or social interactions based on results from the VHI. At the completion of therapy, Subject 4's pre- to post-treatment outcomes decreased in loudness for all three tasks. Subject 4 did however show the greatest gains in the loudness probe measures made in treatment. Her final treatment probes were more than 10 dB greater than initial probe measures. Subject 4's probe measures for conversational monologue exceeded baseline levels by more than 5 dB. Throughout therapy, Subject 4 received positive feedback from family and friends; however, they reported limited difficulty communicating with the subject prior to therapy. Subject 4's decrease in vocal loudness from pre- to post-treatment assessment measures may have been attributed to the subject having an "off" day at the time of post-treatment measurements. Another reason may be that the subject did not achieve generalization outside the therapy room. In the case of distance therapy, the therapy room would be interaction between the clinician and subject through distance web camera. Generalization may not have been achieved due to Subject 4's mild speech difficulties and decreased awareness of a speech difficulty existing.

Subject 2 ranked fourth in treatment progress. Subject 2 received face to face treatment and demonstrated gains in vocal loudness for two vocal tasks from pre-treatment to post-treatment. She demonstrated a small 7.7 dB improvement in /ah/ loudness in the treatment session probes and a small gain 6.5 dB of /ah/ from the pre- to post-assessment. She made no gains in conversational loudness from beginning baseline measures through ending probe measures. Subject 2 was the oldest participant (age 80), retired, lived alone, and had minimal interaction with others throughout the day. Her minimal positive feedback on a daily basis and low motivation for therapy compared to other subjects suggests a possible reason for smaller gains from pre-treatment to post-treatment. Subject 2 also underwent DBS (Deep Brain Stimulation) surgery 3.5 years prior to the initiation of treatment. Subject 2 had been diagnosed with Parkinson's disease

10 years prior to the initiation of treatment and exhibited the second longest disease duration for all five subjects. The medical procedure, duration of disease process, and extent of motivation may have affected Subject 2's ability to make greater gains in vocal loudness.

Subject 5 was ranked last in treatment progress. Subject 5 received distance therapy and demonstrated small gains in vocal loudness for all three tasks from pre-treatment to post-treatment, but exhibited no gains in /ah/ loudness and conversational loudness throughout probe measures. Subject 5 was highly motivated to receive speech treatment and received positive feedback from family and friends throughout the time treatment was administered. However, Subject 5 underwent a pallidotomy and DBS (Deep Brain Stimulation) surgery. Although Subject 5 was highly motivated, the two medical surgeries may have contributed to Subject 5's small gains in vocal loudness. Subject 5 was also exhibited the longest disease duration with 27 years post-diagnosis at the initiation of therapy and was considered the most severe subject in terms of vocal difficulty.

A summary of factors that may have influenced the results of the current study in addition to the distance or face-to-face treatment modality are discussed below.

Distance versus face-to-face treatment. Although the primary independent variable in the current study was participation in distance or face to face LSVT treatment, treatment modality did not appear to play as strong a role in treatment outcomes as other subject factors. Similar results in distance and face to face treatment would indicate the effectiveness of distance treatment. One of three participants in the face to face therapy made minimal treatment progress while one of two participants in the distance therapy made minimal treatment progress. Based on these results, it appears that the treatment modalities were similarly effective. However, the two participants with the greatest gains across multiple measures (Subjects 1 and 3) both participated in face to face treatment and mean gains for the pre- to post-assessment measures were greater for the face to face than distance participants. These data suggest that face to face treatment may have been slightly more beneficial than distance treatment; however other factors appear to have significantly influenced the results in this small study.

Medical procedures and disease duration/severity. Disease duration/severity and medical procedures seemed to have the biggest impact on treatment outcome. Subjects 1, 3, and 4 had a time since diagnosis of 2 months to less than 5 years, and these subjects made the greatest gain in treatment. Subjects 2 and 5 made the least progress and had been diagnosed with Parkinson's disease 10 and 25 years respectively, prior to initiation of treatment.

Severity of Parkinson's disease was initially rated with the Unified Parkinson's Disease Rating Scale (UPDRS), in which higher scores indicated greater impairment. Subjects 2 and 5 who made the least gains in treatment had the higher initial scores on the UPDRS (29 and 37 respectively) than Subjects 3 and 4 who made better gains (UPDRS = 11 and 10 respectively). Initial severity of the disease is not as strong of a factor as time since diagnosis and medical procedures because Subject 1 had an initially high severity on the UPDRS of 31 and she made the most progress in treatment.

Medical procedures can affect the positive outcomes of LSVT. Tornqvist, Schalen, and Rehncrona (2005) found that the speech intelligibility of individuals with Parkinson's disease can be affected by DBS surgery. Along with speech intelligibility being affected by DBS surgery, Theodoros et al. (1999) found that a pallidotomy can affect a Parkinson's patient's ability to internally cue themselves to increase vocal loudness. Subjects 2 and 5 who made the least treatment progress both underwent Deep Brain Stimulation (DBS) surgery and Subject 5 also underwent a pallidotomy; Subjects 1, 3 and 4 who made better progress had not undergone DBS or pallidotomy.

Motivation and generalization. Those subjects who were motivated to complete therapy and who received positive feedback from family and friends seemed to demonstrate greater improvement in speech gains and satisfaction with treatment. Subject 1 and Subject 3 were highly motivated to receive treatment, received the most positive feedback from family and friends, and ranked first and second, respectively, in treatment progress. Subject 2 was less motivated to receive treatment based on the amount of communicative interaction daily and she ranked fourth in terms of treatment progress. As discussed above however, Subject 5 was very motivated but made the least progress, likely because of greatest severity and most medical procedures. Subject 4 had mild deficits and reported that her speech did not negatively impact her daily life. She made gains in the final treatment probes but not in pre- to post- measures. Although Subject 4 made some gain, it was the investigator's impression that lack of motivation influenced gains being smaller than they could have been. Lack of generalization may have also affected Subject 4's poor pre- to post test gains. A main feature of LSVT is to achieve generalization of therapy techniques outside the therapy room. Lack of generalization of treatment tasks can affect overall therapy outcomes. This suggests that individuals with Parkinson's disease who exhibit mild speech impairment may struggle to generalize the ability to monitor their voice.

Technical difficulties. The use of technology can be accompanied by technical difficulties, and in the case of distance therapy, minor difficulties may have affected treatment measurements or outcomes. During the online sessions, minor technical difficulties occurred which were resolved by the clinician and subject at the time of occurrence. On a few occasions the LSVT software did not record SPL and duration of /ah/. When this occurred, therapy was paused while the clinician's computer was restarted, and therapy resumed. In a few incidents, the visual quality between the clinician and subject became compromised, for which therapy was paused for approximately 3 minutes until visual quality was restored. During one therapy session with Subject 4, the internet connection was disconnected; however, internet connection was restored within minutes and therapy resumed. The distance subjects were not provided with a flexible measuring tape, but were asked to utilize a measuring tape or ruler to measure 50 centimeters between the microphone and their mouth prior to each therapy session. However, the distance between the subject's mouth and the microphone could have affected the probe measure outcomes if the subjects did not sit still or did not measure the distance correctly. If audio quality became compromised, therapy was paused and resumed once the subjects readjusted their microphone.

Clinician experience. In addition to subject factors and technical difficulties, clinician experience may have affected the outcomes of the current study. The clinician who implemented the LSVT therapy sessions was a 1st year graduate student certified in LSVT. The clinician was supervised by a licensed speech-language pathologist in the State of Illinois who was also certified in LSVT; however, the clinician did not have experience prior to the study implementing the LSVT protocol. Although the clinician was a trained LSVT provider, a more experienced clinician may have been more experienced at getting the subjects to assume accountability for their therapy outcomes.

Satisfaction with LSVT Delivered via Face to Face Therapy vs. Distance Therapy

All five subjects were satisfied with the Lee Silverman Voice Treatment and highly rated the quality of treatment. Two of the three subjects who received traditional face to face therapy stated transportation to the clinic four times per week was somewhat inconvenient. This suggests that individuals with Parkinson's might be discouraged from receiving LSVT at a treatment clinic due to the time commitment and cost associated with travel. The subjects who received distance therapy stated they would use online sessions for therapy in the future; however, subject 4 stated that the ease of use of distance technology was somewhat difficult. This suggests that difficulties associated with the use of distance technology may not discourage someone from using online sessions for future treatment management. Individuals may be willing to learn new technology in return for the convenience of receiving therapy within their home.

The decision for the method of delivery for each subject was based on the distance the subject lived from the EIU clinic. The subjects who lived more than an hour away from the clinic received the distance therapy. Subject two did not drive and was interested in receiving treatment within her home; however, this study did not support in-home therapy. Subject two received transportation to the clinic from local friends, but she still stated that travel to the clinic was somewhat inconvenient. This suggests that the inconvenience of traveling to a clinic to receive therapy may affect the outcomes of LSVT.

Relationship to Previous Research

Loudness gains made in /ah/ phonation for Subject 1 and Subject 3 were similar to results in loudness gains for face to face subjects reported in studies by Ramig et al. (1996) and Ramig et al. (2001b). In Ramig et al. (1996) the mean average for loudness gains made in /ah/ phonation was 14.03 dB, while the mean average for loudness gains in /ah/ phonation in Ramig et al. (2001b) was 13.3 dB. Loudness gains made in /ah/ phonation for Subject 5 were similar to results in loudness gains for distance subjects reported in studies by Constantinescu et al. (2010) and Theodoros et al. (2006). In Constantinescus et al. (2010), the single subject exhibited a 6.6 dB increase in SPL for /ah/ phonation from pre-treatment to post-treatment, while the Theodoros et al. (2006) study showed a mean average 10.8 dB increase in SPL from pre-treatment to post-treatment. The current study had several subject factors that may have affected gains made in vocal loudness. Previous research studies provided limited subject description or discussion of subject factors affecting treatment outcomes. Therefore it is difficult to compare the current study's results to past research due to limited subject description included in previous studies.

For this study, Subject 4 stated that the use of distance technology was somewhat difficult; however, she stated she would prefer online sessions for future treatment management, suggesting that the convenience of distance therapy outweighs the fear of technology. This trend is similar to results found in Howell et al. (2009) in which subjects were motivated to complete treatment based on the convenience of therapy received online.

The high satisfaction with online treatment sessions reported by distance subjects in Theodoros et al. (2006) and Constantinescu et al. (2010) were similar to the overall satisfaction with online sessions reported by subjects in this study. In Theodoros et al. (2006), results of a patient satisfaction survey found that 70% of the subjects were more than satisfied with the online treatment, while 30% were very satisfied with the treatment.

Clinical Implications

Some conclusions may be drawn from this study. Subject factors such as time since diagnosis, extent of vocal severity, medical treatments, age, and motivation had a greater impact on post-treatment outcomes than did distance factors. As with any behavioral treatment, motivation is a key factor in whether or not improvement is gained. Individuals completing speech treatment who are more motivated may make more gains in improvement regardless of the mode of treatment delivery.

Additionally, the cost and travel associated with traditional face to face therapy has a major impact on whether individuals who are in need are receiving beneficial treatment options. Individuals located in rural areas may not have the time or money to travel to a clinic for needed therapy. The convenience of distance therapy allows individuals to receive beneficial treatment for less cost and time. Also, the difficulty associated with learning new technology may be outweighed by the convenience of distance therapy.

Limitations of Study and Need for Future Research

The subjects in the study were all located within 50 miles of the EIU Clinic. The researchers did not control for subject factors such as disease duration, extent of communication difficulty, medical treatments, and client motivation. The small number of subjects in this study cannot be used to generalize the findings to a larger population of individuals with Parkinson's disease. Future studies should focus on group designs, with a larger number of participants, in which subjects are matched in severity of initial speech and general physical symptoms, and neuropsychological status associated with Parkinson's disease.

A limitation of the current study is that distance subjects did not utilize the same microphone as the face to face subjects. The microphone utilized by the face to face subjects was utilized by the clinician on her computer during the distance sessions to obtain SPL measures from the subjects. The subjects were not provided with a measuring tape, but were asked to utilize a measuring tape or ruler to measure 50 cm between their mouth and the microphone. The clinician reminded the distance subjects to re-measure the mouth-to-microphone distance during therapy; however, consistent mouth-to-microphone measurement was done more frequently during face to face sessions since the clinician was the one measuring the distance. Future studies should utilize higher quality visual and audio equipment with the subjects being fitted with a headset microphone to reduce the interference of external noise and to provide consistency of microphone position.

An additional limitation of the study was potential subject bias in regards to reporting satisfaction with treatment. The subjects completed a satisfaction survey and were aware that the treating clinician would see their responses. The subjects may have wanted to please the clinician and thus reported high satisfaction. Future studies should take steps to avoid subject bias when determining satisfaction with treatment such as utilizing surveys that do not require the subjects to include their identifying information.

Future studies could also consider having a non-biased clinician interview the subjects after completion of treatment.

Future studies should also consider utilizing a clinician with more experience implementing LSVT in face to face sessions before beginning online sessions. LSVT Global, Inc. has created an LSVT eLOUD online training course which would teach clinicians how to implement LSVT through distance technology. This course became available 7 months after data collection for the current study and would be a valuable resource to have when conducting online sessions.

A perceptual rating scale could be utilized in future studies in which trained speech-language pathologists rate randomized voice samples of subjects for breathiness, loudness, and overall speech intelligibility based on a unified scale. This would offer insight into the other benefits of LSVT in addition to acoustic outcomes. In addition to subject satisfaction surveys, future studies should consider providing the family members of subjects with surveys to determine their insight the subject's speech difficulties as well as their opinions about the LSVT outcomes after completion of treatment.

Future studies should also consider studying the effects of distance therapy when implementing LSVT with subjects presenting with other types of dysarthria, or central nervous system disorders such as multiple sclerosis and cerebral palsy. The high intensity treatment tasks associated with LSVT may benefit vocal difficulties associated with other disorders. Extending distance therapy to individuals with a wide range of disorders would provide treatment to those individuals who may not otherwise be able to receive treatment.

Conclusions

The Lee Silverman Voice Treatment (LSVT) has been shown to increase loudness and phonatory efforts in individuals whose voice is reduced in loudness secondary to Parkinson's disease or other related disorders, as well as increase self-monitoring and awareness of vocal abilities when delivered via traditional face to face therapy. Individuals with Parkinson's disease living in rural areas may be unable to access LSVT services due to distance or lack of LSVT certified clinicians. Distance therapy is a relatively new means of treatment delivery in the profession of speech pathology. Providing LSVT through distance therapy would allow individuals to access treatment without the burden of travel.

The current study examined the feasibility of delivering the Lee Silverman Voice Treatment via distance therapy when compared to delivering the Lee Silverman Voice Treatment via face to face therapy. Two subjects who received face to face therapy and one subject who received distance therapy demonstrated the greatest improvements in progress. Subject factors such as motivation, positive feedback from others, and extent of disease process and medical procedures appeared to have a greater impact on LSVT outcomes than did face to face or distance factors. All five subjects were satisfied with the quality of treatment and method of delivery. Research should continue to focus on the feasibility of distance therapy and the convenience it offers to those individuals who are unable to receive beneficial treatment due to the time and cost associated with travel.

References

American Speech-Language-Hearing Association (ASHA). (2010). *Professional Issues in Telepractice for Speech-Language Pathologists* [Professional Issues Statement]. www.asha.org/policy.

Aarsland, D., Zaccai, J., & Brayne, C. (2005). A systematic review of prevalence studies of dementia in Parkinson's disease. *Movement Disorders, 20,* 1255-1263. doi: 10.1002/mds.20527.

Baumgartner, C. A., Sapir, S., & Ramig, L. O. (2001). Voice quality changes following phonatory-respiratory effort treatment (LSVT) versus respiratory effort treatment for individuals with Parkinson disease. *Journal of Voice*, *15*(1), 105-114.

Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry*, *4*, 561-571.

Bellenir, K. (1999). *Brain Disorders Source Book.* Detroit, Michigan: Omnigraphics, Inc..

Bergner, M., Bobbit, R. A., Carter, W. B., & Gilson, B. S. (1981). The sickness impact profile: Development and final revision of a health status measure. *Medical Care, 19*, 787-805.

Boone, D. R., McFarlane, S. C., Von Berg, S. L., & Zraick, R. I. (2010). *Voice and Voice Therapy (8th Edition)* (8 ed.). Boston, MA: Allyn & Bacon.

Constantinescu, G. A., Theodoros, D. G., Russell, T. G., Ward, E. C., Wilson, S. J., & Wootton, R. (2010). Home-based speech treatment for Parkinson's disease delivered remotely: A case report. *Journal of Telemedicine and Telecare*, *16*, 100-104.

Darley, F.L., Aronson, A.E., Brown, J.R. (1969). Differential diagnostic patterns of dysarthria. *Journal of Speech and Hearing Research, 12:246.*

Darley, F.L., Aronson, A.E., Brown, J.R. (1975). *Motor speech disorders*. Philadelphia, Pennsylvania: WB Saunders.

Dromey, C. (2000). Articulatory kinematics in patients with Parkinson disease using different speech treatment approaches. *Journal of Medical Speech-Language Pathology, 8,* 155-161.

Duffy, J. R. (2005). *Motor speech disorders: Substrates, differential diagnosis, and management* (2 ed.). St Louis, Missouri: Mosby.

Enderby, P. M., 1983, *Frenchay Dysarthria Assessment,* Windsor, Berkshire, England: NFER-Nelson.

Fairbanks, G. (1960). *Voice and articulation drillbook.* New York, New York: Harper & Bros.

Fox, C.M, Morrison, C.E., Ramig, L.O., Sapir, S. (2002). Current perspectives on the Lee Silverman Voice Treatment (LSVT) for individuals with idiopathic Parkinson disease. *American Journal of Speech-Language Pathology*, *11*, 111-123.

Fox, C. M., & Ramig, L. O. (1997). Vocal sound pressure level and self-perception of speech and voice in men and women with idiopathic Parkinson disease. *American Journal of Speech-Language Pathology*, *6*, 85-94.

Fox, C.M., Ramig, L.O., Ciucci, M.R., Sapir, S., McFarland, D.H., & Farley, B. (2006). The science and practice of LSVT/LOUD: Neural plasticity-principled approach of treating individuals with Parkinson disease and other neurological disorders. *Seminars in Speech and Language, 27,* 283-299.

Goodglass, H., & Kaplan, E. (1983). *The assessment of aphasia and related disorders* (2nd ed.). Philadelphia, Pennsylvania: Lea & Febiger.

Hartelius, L., & Svensson, P. (1994). Speech and swallowing symptoms associated with Parkinson's disease and multiple sclerosis: A survey. *Folia Phoniatrica et Logopedica, 46*(1), 9-17.

Hill, A. J., Theodoros, D. G., Russell, T. G., Cahill, L. M., Ward, E. C., & Clark, K. M. (2006). An internet-based telerehabilitation system for assessment of motor speech disorders: A pilot study. *American Journal of Speech-Language Pathology, 15*, 45-56.

Howell, S., Tripoliti, E., & Pring, T. (2009). Delivering the Lee Silverman Voice Treatment (LSVT) by web camera: A feasibility study. *International Journal of Language and Communication Disorders, 44*(3), 287-300.

Huber, J. E., Stathopoulos, E. T., Ramig, L. O., & Lancaster, S. A. (2003). Respiratory function and variability in individuals with Parkinson disease: Pre- and post-Lee Silverman Voice Treatment. *Journal of Medical Speech-Language Pathology, 11*, 185-201.

Jacobson, Johnson, Grywalski, Silbergleit, Jacobson, Benninger, & Newman (1997). The Voice Handicap Index (VHI). *American Journal of Speech Language Pathology, 6,* 66-70.

Kleim, J., & Jones, T. (2005). *Principles of experience-dependent neural plasticity: Implications for rehabilitation after brain damage*. Presented at the Neurorehabilitation Workshop Innovation and Evolution Workship, Gainsville, Florida.

Kleim, J. & Jones, T. (2008). Principles of experience-dependent neural plasticity: Implications for rehabilitation after brain damage. *Journal of Speech, Language, and Hearing Research, 51,* S225-S239

Kleim, J., Jones, T, & Schallert, T. (2003). Motor enrichment and the induction of plasticity before or after brain injury. *Neurochemical Research, 11,* 1757-1769.

Kleinow, J., Smith, A., & Ramig, L. O. (2001). Speech motor stability in IPD: Effects of rate and loudness manipulations. *Journal of Speech, Language, and Hearing Research, 44,* 1041- 1051.

Logemann, J., Fisher, H., Boshes, B., & Bionsky, E. (1978). Frequency and co-occurrence of vocal tract dysfunctions in the speech of a large sample of Parkinson individuals. *Journal of Speech and Hearing Disorders, 42,* 47-57.

Marsden, C.D. (1982). The mysterious motor function of the basal ganglia: The Robert Wartenburg lecture. *Neurology, 32,* 514-539.

Mashima, P. A., Birkmire-Peters, D. P., Syms, M. J., Holtel, M. R., Burgess, L. P., & Peters, L. J. (2003). Telehealth: Voice therapy using telecommunications technology. *American Journal of Speech-Language Pathology, 12,* 432-439.

Nasreddine, Z.S., Phillips, N.A., Bédirian, V., Charbonneau, S., Whitehead, V., Collin, I., Cummings, J.L., Chertkow, H. (2005). The Montreal Cognitive Assessment, MoCA: A brief screening tool for mild cognitive impairment. *Journal of the American Geriatrics Society, 53,* 695–699.

National Center for Voice and Speech. (n.d.). The National Center for Voice and Speech. *National Center for Voice and Speech.* Retrieved November 30, 2010, from http://www.ncvs.org/research/lsvt-history.html.

Pitcairn, T.K., Clemie, S., Gray, J.M., & Pentland, B. (1990). Impressions of Parkinsonism patients from their recorded voices. *International Journal of Language and Communication Disorders, 25*:1, 85-92.

Ramig, L., Countryman, S., Thompson, L., & Horii, Y. (1995). Comparison of two forms of intensive speech treatment for Parkinson disease. *Journal of Speech & Hearing Research, 38*(6), 1232-1251.

Ramig, L. O., Countryman, S., O'Brien, C., Hoehn, M., & Thompson, L. (1996). Intensive speech treatment for patients with Parkinson's disease: Short-term and long-term comparison of two techniques. *Neurology, 47*, 1496-1504.

Ramig, L.O. & Fox, C. (2010, November). *LSVT LOUD training and certification workshop* [PowerPoint slides]. Presented at the LSVT LOUD Training and Certification Workshop, St. Louis, Missouri.

Ramig, L. O., Sapir, S., Countryman, S., Pawlas, A., O'Brien, C., Hoehn, M., Thompson, L.L. (2001a). Intensive voice treatment (LSVT) for patients with Parkinson's disease: A 2 year follow up. *Journal of Neurology, Neurosurgery, & Psychiatry, 71*, 493-498.

Ramig, L. O., Sapir, S., Fox, C., & Countryman, S. (2001b). Changes in vocal loudness following intensive voice treatment (LSVT) in individuals with Parkinson's disease: A comparison with untreated patients and normal age-matched controls. *Movement Disorders, 16*(1), 79-83.

Sapir, S., Spielman, J.L, & Ramig, L. O. (2003). Effects of intensive voice treatment (the Lee Silverman Voice Treatment [LSVT]) on ataxic dysarthria: Case study. *American Journal of Speech-Language Pathology, 12*, 387-399.

Sapir, S., Spielman, J. L., Ramig, L. O., Story, B. H., & Fox, C. (2007). Effects of intensive voice treatment (Lee Silverman Voice Treatment [LSVT]) on vowel articulation dysarthric individuals with idiopathic Parkinson disease: Acoustic and perceptual findings. *Journal of Speech, Language, and Hearing Research, 50,* 899-912.

Schultz, W. (2007). Behavioral dopamine signals. *Trends in Neurosciences, 30*(5), 203-210.

Scott, S., Caird, F. I., & Williams, B. O. (1985). *Communication in Parkinson's disease.* Rockville, Md.: Aspen Systems Corp.

Theodoros, D. G., Constantinescu, G., Russell, T. G., Ward, E. C., Wilson, S. J., & Wootton, R. (2006). Treating the speech disorder in Parkinson's disease online. *Journal of Telemedicine and Telecare, 12*(S3), 88-91.

Theodoros, D. G., Thompson-Ward, E. C., Murdoch, B. E., Lethlean, J., & Silburn, P. (1999). The effects of the Lee Silverman Voice Treatment program on motor speech function in Parkinson disease following thalamotomy and pallidotomy surgery: A case study. *Journal of Medical Speech-Language Pathology, 7*(2), 157-160.

Tornqvist, A.L., Schalen, L., Rehncrona, S. (2005). Effects of different electrical parameter settings on the intelligibility of speech in patients with Parkinson's disease treated with subthalamic deep brain stimulation. *Movement Disorders, 20* (4): 416-423.

Torp, J.N. & Hammen, V.L. (2000). Perception of Parkinson speech rate. *Journal of Medical Speech-Language Pathology, 8: 323.*

Trail, M., Fox, C.M., Ramig, L.O., Sapir, S., Howard, J., & Lai, E.C. (2005). Speech treatment for Parkinson's disease. *NeuroRehabilitation, 20*, 205-221.

Verbaan, D., Marinus, J., Visser, M., van Rooden, S.M., Stiggelbout, A.M., Middelkoop, H.A.M, & van Hilten, J.J. (2007). Cognitive impairment in Parkinson's disease. *Journal of Neurology, Neurosurgery, and Psychiatry*, *78,* 1182-1187. doi: 10.1136/jnnp.2006.112367.

Yorkston, K.M., Hakel, M., Beukelman, D.R., & Fager, S. (2007). Evidence for effectiveness of loudness, rate, or prosody in dysarthria: A systematic review. *Journal of Medical Speech-Language Pathology, 2,* xi-xxxvi.

Appendix A

LSVT® LOUD Initial Interview

Identifying Information

Name: email address:

Address:

City: State: Zip: Phone:

Fax: Age: Date of Birth:

Date and Time of Day of Initial Interview:

Diagnosis/Stage: Date of Initial Diagnosis:

Time of Last Park med: Time of Next Park med:

Neurologist: Phone:

Address:

Neurosurgeon: Phone:

Address:

Otolaryngologist: Phone:

Address:

Physical Therapist: Phone:

Address:

Neurological and Other Medical Information

What were your initial symptoms of Parkinson disease?

Do you have any tremor? Yes No If yes, please describe:

Do you have any other medical problems? Yes No If yes, please describe:

Medication Information:

Medication for Parkinson disease:

Other Medications:

How is it helpful?

Does your Parkinson medication affect your voice or speech? Yes No If yes, please describe:

Do you experience "on/off" symptoms? Yes No If yes, please describe:

Do you experience any dyskinesias: Yes No If yes, please describe:

Surgical Information:

Have you had neurosurgery or laryngeal surgery? If yes, what procedure, when, where, by whom?

Speech Symptoms:

Have you ever used your voice professionally (i.e., radio, television, acting, singing, etc.)? Yes No

If yes, please describe:

When did you first start to notice communication symptoms (i.e., changes in your speech and/or voice) that you associate with Parkinson disease?

What are your current symptoms?

What is your most significant problem communicating today?

How do you typically use your voice during the day?

How many hours of speaking do you do in a day?

Right now does your voice sound like it usually does?

Do people ask you to repeat?

What do you do when you want to be as easy to understand as possible?

What percent of your speech do you think is intelligible (i.e., people can understand you)?

Has Parkinson disease caused you to talk less? How much less?

Why has Parkinson disease caused you to talk less?

Do you think you run out of breath during speech?

Is it difficult for you to take a deep breath?

Have you noticed if your voice is monotone in pitch?

Have you noticed if your **speaking** voice is higher or lower in pitch now compared to before you were diagnosed

with Parkinson disease?

Have you noticed pitch breaks in your voice?

Have you noticed changes in your singing voice?

Have you noticed changes in the quality of your voice?

If yes, please describe the changes you have noticed in quality. (Probe patient to determine if patient thinks voice

quality is hoarse, wet, breathy, rough, strained, etc.)

Have you noticed changes in the steadiness of your voice?

Does your voice feel fatigued at the end of the day?

Have you noticed if your voice is reduced in loudness?

Have you noticed any slurring or mumbling in your speech?

Has the rate of your speech changed?

If yes, please describe how your rate has changed. (Probe patient to determine if patient thinks rate is faster, slower,

variable, etc.)

Have you noticed any stuttering in your speech?

Do you experience food or liquid coming through your nose when you eat?

Do you think your voice sounds nasal (i.e., hyper or hyponasal)?

Have you previously had speech treatment?

If yes, how long ago and what did you do?

Was your previous speech treatment beneficial?

If yes, what changes did you notice? Describe

Swallowing Information:

Have you noticed any problems with eating, chewing, and/or swallowing?

If yes, please describe (types of foods, frequency of problem, etc.)

Have you noticed any change in taste or smell? If yes, what type of change?

Employment Information

Are you employed?

Type of employment?

Describe how you use your voice at your job.

Does Parkinson disease affect your employment?

How?

Neuropsychological Information

Have you noticed any difficulty with your memory?

What have you noticed?

Does your medication affect your memory?

If yes, how does it affect your memory?

What aspect of your Parkinson disease bothers you the most?

Other comments:

Questions to help determine/create "Magical Calibration Moments"

Communication Situations:

If you had one situation in which you wanted to communicate well, what would it be?

Describe your day in terms of speaking situations (i.e., elicit from the patient information about **who** the patient communicates with, **when** the communication is done, and **what** may be said).

AM

PM

When do you find it most difficult to communicate?

Why is it difficult to communicate in these situations/times that you mentioned?

Appendix B

UNIFIED PARKINSON'S DISEASE RATING SCALE (UPDRS)

I. MENTATION, BEHAVIOR AND MOOD

1. Intellectual Impairment

0 = None.
1 = Mild. Consistent forgetfulness with partial recollection of events and no other difficulties.
2 = Moderate memory loss, with disorientation and moderate difficulty handling complex problems.
Mild but definite impairment of function at home with need of occasional prompting.
3 = Severe memory loss with disorientation for time and often to place.
Severe impairment in handling problems.
4 = Severe memory loss with orientation preserved to person only. Unable to make judgements or solve problems. Requires much help with personal care. Cannot be left alone at all.

2. Thought Disorder (Due to dementia or drug intoxication)

0 = None.
1 = Vivid dreaming.
2 = "Benign" hallucinations with insight retained.
3 = Occasional to frequent hallucinations or delusions; without insight; could interfere with daily activities.
4 = Persistent hallucinations, delusions, or florrid psychosis. Not able to care for self.

3. Depression

0 = None.
1 = Periods of sadness or guilt greater than normal, never sustained for days or weeks.
2 = Sustained depression (1 week or more).
3 = Sustained depression with vegetative symptoms (insomnia, anorexia, weight loss, loss of interest).
4 = Sustained depression with vegetative symptoms and suicidal thoughts or intent.

4. Motivation/Initiative

0 = Normal.
1 = Less assertive than usual; more passive.
2 = Loss of initiative or disinterest in elective (nonroutine) activities.
3 = Loss of initiative or disinterest in day to day (routine) activities.
4 = Withdrawn, complete loss of motivation.

***II. ACTIVITIES OF DAILY LIVING** (for both "on" and "off")*

5. Speech

0 = Normal.
1 = Mildly affected. No difficulty being understood.
2 = Moderately affected. Sometimes asked to repeat statements.
3 = Severely affected. Frequently asked to repeat statements.
4 = Unintelligible most of the time.

6. Salivation

0 = Normal.
1 = Slight but definite excess of saliva in mouth; may have nighttime drooling.
2 = Moderately excessive saliva; may have minimal drooling.
3 = Marked excess of saliva with some drooling.
4 = Marked drooling, requires constant tissue or handkerchief.

7. Swallowing

0 = Normal.

1 = Rare choking.
2 = Occasional choking.
3 = Requires soft food.
4 = Requires NG tube or gastrotomy feeding.
8. Handwriting
0 = Normal.
1 = Slightly slow or small.
2 = Moderately slow or small; all words are legible.
3 = Severely affected; not all words are legible.
4 = The majority of words are not legible.
9. Cutting food and handling utensils
0 = Normal.
1 = Somewhat slow and clumsy, but no help needed.
2 = Can cut most foods, although clumsy and slow; some help needed.
3 = Food must be cut by someone, but can still feed slowly.
4 = Needs to be fed.
10. Dressing
0 = Normal.
1 = Somewhat slow, but no help needed.
2 = Occasional assistance with buttoning, getting arms in sleeves.
3 = Considerable help required, but can do some things alone.
4 = Helpless.
11. Hygiene
0 = Normal.
1 = Somewhat slow, but no help needed.
2 = Needs help to shower or bathe; or very slow in hygienic care.
3 = Requires assistance for washing, brushing teeth, combing hair, going to bathroom.
4 = Foley catheter or other mechanical aids.
12. Turning in bed and adjusting bed clothes
0 = Normal.
1 = Somewhat slow and clumsy, but no help needed.
2 = Can turn alone or adjust sheets, but with great difficulty.
3 = Can initiate, but not turn or adjust sheets alone.
4 = Helpless.
13. Falling (unrelated to freezing)
0 = None.
1 = Rare falling.
2 = Occasionally falls, less than once per day.
3 = Falls an average of once daily.
4 = Falls more than once daily.
14. Freezing when walking
0 = None.
1 = Rare freezing when walking; may have starthesitation.
2 = Occasional freezing when walking.
3 = Frequent freezing. Occasionally falls from freezing.
4 = Frequent falls from freezing.
15. Walking
0 = Normal.
1 = Mild difficulty. May not swing arms or may tend to drag leg.
2 = Moderate difficulty, but requires little or no assistance.
3 = Severe disturbance of walking, requiring assistance.

4 = Cannot walk at all, even with assistance.

16. Tremor (Symptomatic complaint of tremor in any part of body.)

0 = Absent.

1 = Slight and infrequently present.

2 = Moderate; bothersome to patient.

3 = Severe; interferes with many activities.

4 = Marked; interferes with most activities.

17. Sensory complaints related to parkinsonism

0 = None.

1 = Occasionally has numbness, tingling, or mild aching.

2 = Frequently has numbness, tingling, or aching; not distressing.

3 = Frequent painful sensations.

4 = Excruciating pain.

III. MOTOR EXAMINATION

18. Speech

0 = Normal.

1 = Slight loss of expression, diction and/or volume.

2 = Monotone, slurred but understandable; moderately impaired.

3 = Marked impairment, difficult to understand.

4 = Unintelligible.

19. Facial Expression

0 = Normal.

1 = Minimal hypomimia, could be normal "Poker Face".

2 = Slight but definitely abnormal diminution of facial expression.

3 = Moderate hypomimia; lips parted some of the time.

4 = Masked or fixed facies with severe or complete loss of facial expression; lips parted 1/4 inch or more.

20. Tremor at rest (head, upper and lower extremities)

0 = Absent.

1 = Slight and infrequently present.

2 = Mild in amplitude and persistent. Or moderate in amplitude, but only intermittently present.

3 = Moderate in amplitude and present most of the time.

4 = Marked in amplitude and present most of the time.

21. Action or Postural Tremor of hands

0 = Absent.

1 = Slight; present with action.

2 = Moderate in amplitude, present with action.

3 = Moderate in amplitude with posture holding as well as action.

4 = Marked in amplitude; interferes with feeding.

22. Rigidity (Judged on passive movement of major joints with patient relaxed in sitting position. Cogwheeling to be ignored.)

0 = Absent.

1 = Slight or detectable only when activated by mirror or other movements.

2 = Mild to moderate.

3 = Marked, but full range of motion easily achieved.

4 = Severe, range of motion achieved with difficulty.

23. Finger Taps (Patient taps thumb with index finger in rapid succession.)

0 = Normal.

1 = Mild slowing and/or reduction in amplitude.

2 = Moderately impaired. Definite and early fatiguing. May have occasional arrests in movement.

3 = Severely impaired. Frequent hesitation in initiating movements or arrests in ongoing movement.
4 = Can barely perform the task.
24. Hand Movements (Patient opens and closes hands in rapid succesion.)
0 = Normal.
1 = Mild slowing and/or reduction in amplitude.
2 = Moderately impaired. Definite and early fatiguing. May have occasional arrests in movement.
3 = Severely impaired. Frequent hesitation in initiating movements or arrests in ongoing movement.
4 = Can barely perform the task.
25. Rapid Alternating Movements of Hands (Pronation-supination movements of hands, vertically and
horizontally, with as large an amplitude as possible, both hands simultaneously.)
0 = Normal.
1 = Mild slowing and/or reduction in amplitude.
2 = Moderately impaired. Definite and early fatiguing. May have occasional arrests in movement.
3 = Severely impaired. Frequent hesitation in initiating movements or arrests in ongoing movement.
4 = Can barely perform the task.
26. Leg Agility (Patient taps heel on the ground in rapid succession picking up entire leg. Amplitude
should be at least 3 inches.)
0 = Normal.
1 = Mild slowing and/or reduction in amplitude.
2 = Moderately impaired. Definite and early fatiguing. May have occasional arrests in movement.
3 = Severely impaired. Frequent hesitation in initiating movements or arrests in ongoing movement.
4 = Can barely perform the task.
27. Arising from Chair
(Patient attempts to rise from a straightbacked chair, with arms folded across chest.)
0 = Normal.
1 = Slow; or may need more than one attempt.
2 = Pushes self up from arms of seat.
3 = Tends to fall back and may have to try more than one time, but can get up without help.
4 = Unable to arise without help.
28. Posture
0 = Normal erect.
1 = Not quite erect, slightly stooped posture; could be normal for older person.
2 = Moderately stooped posture, definitely abnormal; can be slightly leaning to one side.
3 = Severely stooped posture with kyphosis; can be moderately leaning to one side.
4 = Marked flexion with extreme abnormality of posture.
29. Gait
0 = Normal.
1 = Walks slowly, may shuffle with short steps, but no festination (hastening steps) or propulsion.
2 = Walks with difficulty, but requires little or no assistance; may have some festination, short steps,
or propulsion.
3 = Severe disturbance of gait, requiring assistance.
4 = Cannot walk at all, even with assistance.
30. Postural Stability (Response to sudden, strong posterior displacement produced by pull on shoulders

while patient erect with eyes open and feet slightly apart. Patient is prepared.)
0 = Normal.
1 = Retropulsion, but recovers unaided.
2 = Absence of postural response; would fall if not caught by examiner.
3 = Very unstable, tends to lose balance spontaneously.
4 = Unable to stand without assistance.
31. Body Bradykinesia and Hypokinesia (Combining slowness, hesitancy, decreased armswing, small
amplitude, and poverty of movement in general.)
0 = None.
1 = Minimal slowness, giving movement a deliberate character; could be normal for some persons.
Possibly reduced amplitude.
2 = Mild degree of slowness and poverty of movement which is definitely abnormal.
Alternatively, some reduced amplitude.
3 = Moderate slowness, poverty or small amplitude of movement.
4 = Marked slowness, poverty or small amplitude of movement.
***IV. COMPLICATIONS OF THERAPY** (In the past week)*
A. DYSKINESIAS
32. Duration: What proportion of the waking day are dyskinesias present?
(Historical information.)
0 = None
1 = 1-25% of day.
2 = 26-50% of day.
3 = 51-75% of day.
4 = 76-100% of day.
33. Disability: How disabling are the dyskinesias?
(Historical information; may be modified by office examination.)
0 = Not disabling.
1 = Mildly disabling.
2 = Moderately disabling.
3 = Severely disabling.
4 = Completely disabled.
34. Painful Dyskinesias: How painful are the dyskinesias?
0 = No painful dyskinesias.
1 = Slight.
2 = Moderate.
3 = Severe.
4 = Marked.
35. Presence of Early Morning Dystonia (Historical information.)
0 = No
1 = Yes
B. CLINICAL FLUCTUATIONS
36. Are "off" periods predictable?
0 = No
1 = Yes
37. Are "off" periods unpredictable?
0 = No
1 = Yes
38. Do "off" periods come on suddenly, within a few seconds?
0 = No

1 = Yes

39. What proportion of the waking day is the patient "off" on average?

0 = None
1 = 1-25% of day.
2 = 26-50% of day.
3 = 51-75% of day.
4 = 76-100% of day.

C. OTHER COMPLICATIONS

40. Does the patient have anorexia, nausea, or vomiting?

0 = No
1 = Yes

41. Any sleep disturbances, such as insomnia or hypersomnolence?

0 = No
1 = Yes

Appendix C

Voice Handicap Index (VHI)

VOICE HANDICAP INDEX: as developed and validated by Barbara H. Jacobson et al. *American Journal of Speech-Language Pathology* 6(3), 66-70, 1997.
This index is a way for us to assess how you would describe the way you use your voice. It also allows you to explain to us how your voice affects your life. Please circle the response that indicates how frequently you have these experiences.

0=Never 1=Almost never 2=Sometimes 3=Almost always 4=Always

Part I

1) My voice makes it difficult for people to hear me	0 1 2 3 4
2) People have difficulty understanding me in a noisy room	0 1 2 3 4
3) May family has difficulty hearing me when I call them through the house	0 1 2 3 4
4) I use the phone less often than I would like to	0 1 2 3 4
5) I tend to avoid groups of people because of my voice	0 1 2 3 4
6) I speak with friends, neighbors, or relatives less often because of my voice	0 1 2 3 4
7) People ask me to repeat myself when speaking in person	0 1 2 3 4
8) My voice difficulties restrict personal and social life	0 1 2 3 4
9) I feel left out of conversations because of my voice	0 1 2 3 4
10) My voice problem causes me to lose income	0 1 2 3 4

Part II

1) I run out of air when I talk	0 1 2 3 4
2) The sound of my voice varies throughout the day	0 1 2 3 4
3) People ask, "What's wrong with your voice?"	0 1 2 3 4
4) My voice sounds creaky and dry	0 1 2 3 4
5) I feel as though I have to strain to produce voice	0 1 2 3 4
6) The clarity of my voice in unpredictable	0 1 2 3 4
7) I try to change my voice to sound different	0 1 2 3 4

8) I use a great deal of effort to speak 0 1 2 3 4

9) My voice is worse in the evening 0 1 2 3 4

10) My voice "gives out" on me in the middle of speaking 0 1 2 3 4

Part III

1) I am tense when talking to others because of my voice 0 1 2 3 4

2) People seem irritated with my voice 0 1 2 3 4

3) I find other people don't understand my voice problem 0 1 2 3 4

4) My voice problem upsets me 0 1 2 3 4

5) I am less outgoing because of my voice problem 0 1 2 3 4

6) My voice makes me feel handicapped 0 1 2 3 4

7) I feel annoyed when people ask me to repeat 0 1 2 3 4

8) I feel embarrassed when people ask me to repeat 0 1 2 3 4

9) My voice makes me feel incompetent 0 1 2 3 4

10) I am ashamed of my voice problem 0 1 2 3 4

Appendix D

Participant Satisfaction Survey

Face to face Therapy

Please rate your satisfaction in regards to:

- Face to face treatment sessions
    1. Would not participate again
    2. Would consider participating again
    3. Would participate again
    4. Has no preference between face to face sessions or online sessions for future management of PD
    5. Would prefer face to face sessions over online sessions for future management of PD
- Quality of treatment
    1. Poor
    2. Fair
    3. Good
    4. Very Good
    5. Excellent
- The convenience of traveling to the EIU Clinic four times a week
    1. Very inconvenient
    2. Somewhat inconvenient
    3. Convenient with some disturbances (i.e. traffic, parking, etc.)
    4. Convenient
    5. Very convenient
- Overall satisfaction with the face to face treatment
    1. Not at all satisfied
    2. Less than satisfied
    3. Somewhat satisfied
    4. Satisfied
    5. Very satisfied

Participant Satisfaction Survey

Distance Technology

Please rate your satisfaction in regards to:

- Online treatment sessions
  1. Would not participate again
  2. Would consider participating again
  3. Would participate again
  4. Has no preference between online sessions or face to face sessions for future management of PD
  5. Would prefer online sessions over face to face sessions for future management of PD
- Audio and video quality during online treatment sessions
  1. Poor
  2. Fair
  3. Good
  4. Very Good
  5. Excellent
- Quality of treatment
  1. Poor
  2. Fair
  3. Good
  4. Very Good
  5. Excellent
- The ease of use of distance technology (computer, web camera, microphone)
  1. Very difficult
  2. Somewhat difficult
  3. Easy with some difficulties
  4. Easy
  5. Very easy
- Overall satisfaction with online treatment
  1. Not at all satisfied
  2. Less than satisfactory
  3. Somewhat satisfied
  4. Satisfied
  5. Very satisfied