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Treatment effect of maximum performance speech therapy for individuals with Parkinson's disease and dysarthria

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TREATMENT EFFECT OF MAXIMUM PERFORMANCE SPEECH THERAPY FOR
INDIVIDUALS WITH PARKINSON'S DISEASE AND DYSARTHRIA

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Arts

in

The Department of Communication Disorders

by
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ABSTRACT

The Lee Silverman Voice Treatment (LSVT™) has received much attention in the past decade for its use in the treatment of individuals with Parkinson's disease (Jones, 2005; Ramig, Countryman, O'Brien, Hoehn, & Thompson, 1996; Ramig, Sapir, Countryman et al., 2001; Wohlert, 2004). This intensive program requires therapy four times a week for four weeks in order to improve perceptual characteristics of the voice, such as loudness. However, since LSVT™ was introduced, the rehabilitation industry has experienced systematic reductions in allowable frequency and duration of covered services. The result has been that individuals often cannot qualify for the rigorous LSVT™ protocol (Centers for Medicare and Medicaid Services, 2008).

The present study followed the standard treatment protocol but manipulated the dose of treatment to determine if a reduced dose of treatment would be effective for individuals with PD (IwPD) and dysarthria. Our treatment schedule used frequency, intensity, and duration variables that more closely mirrored the current state of clinical practice (e.g., 45 minutes, 2 times per week for 8 weeks). Two IwPD participated in the study and demonstrated improvements in maximum vocal SPL, but these gains were not maintained at a 6-month follow-up. Treatment outcomes indicated improvement in body structure/function as evidenced by increased vocal SPL by both participants across all three speech tasks. Speech intelligibility scores and communicative effectiveness ratings also improved for one participant. Results, though preliminary, indicated a reduced dosage of the LSVT™ protocol does exhibit treatment efficacy and treatment outcomes comparable to the original, intensive LSVT™ protocol, thus moving this treatment closer to determining the most clinically feasible and client-friendly version of LSVT™.

LITERATURE REVIEW

Parkinson's disease (PD) is a chronic and progressive neurological condition that is associated with the depletion of dopaminergic cells in the substantia nigra. Dopamine plays a crucial role in the production of smooth, purposeful movements, and deficiency of it results in the disinhibition of motor movements, including motor speech movements (Bhatnagar, 2008). The most common speech complaints described by individuals with Parkinson's disease (IwPD) include quiet or weak voice, speaking rate that is too fast, difficulty getting speech started, or speech that is indistinct. These symptoms are typically labeled as hypokinetic dysarthria, which is the most common motor speech disorder of PD (Duffy, 2005). Hypokinetic dysarthria not only affects basic properties of the individual's speech, but it can also impact the ability to engage in daily activities or participate successfully in social situations. Historically, however, only 3-4% of IwPD presenting with voice or speech problems receive speech therapy (Fox, Morrison, Ramig, & Sapir, 2002) even though approximately 50% of IwPD develop speech difficulties (National Institute of Neurological Disorders and Stroke, 2006). In the past decade, evidence has begun to build around a treatment known as the Lee Silverman Voice Treatment (LSVT™) that is suggested to directly target voice and speech difficulties in IwPD (Ramig, Bonitati, Lemke, & Horii, 1994). Since the emergence of the LSVT™ findings, multiple other studies have attempted to refine the key principles, therapy targets, and definite outcomes of this treatment (Baumgartner, Sapir, & Ramig, 2001; El Sharkawi et al., 2002; Ramig, Sapir, Fox, & Countryman, 2001; Sapir, Spielman, Ramig, Story, & Fox, 2007). However, the original LSVT™ protocol, four times per week for four weeks, has remained unchanged since its inception. With the rules and regulations imposed by third party payers, alterations in the therapy protocol must be made so that more individuals may benefit from this treatment. Recently, researchers have attempted to alter the dosage of LSVT™ to discover a protocol that maintains

original treatment effects while providing a regimen that is more closely aligned with current clinical practices than the original LSVT™ protocol (Spielman, Ramig, Halpern, & Gavin, 2007; Wohlert, 2004).

The current study's purpose was to analyze the effect of a dosage variable on the treatment efficacy of LSVT™ in an effort to find the most clinically feasible and client-friendly treatment protocol. The study was founded on several areas of research that follow. I will first discuss the importance of the World Health Organization's (WHO) International Classification of Functioning, Disability, and Health (ICF) as it pertains to PD and the treatment of this disease. In the second and third sections, I will describe PD and discuss the characteristics of the dysarthria that typically accompany PD. In the final two sections, I will discuss LSVT™ and the modifications that have been made to the original protocol.

ICF Model of Rehabilitation

The World Health Organization's International Classification of Functioning, Disability, and Health (ICF) provides a unified framework for rehabilitation therapists to utilize for assessment and treatment of individuals with motor speech disorders. The ICF advocates for clinicians and researchers to shift focus from cause of the disorder to impact of the disorder on various aspects of the client's life (World Health Organization, 2001). Furthermore, the ICF delineates multiple types of disabilities that an individual with a motor speech disorder may encounter. More specifically, the ICF focuses on three domains, body structure and function, activity limitations, and participation restrictions. The body structure/function domain incorporates the current level of structure/function post-onset of disease or injury, and as it applies to dysarthria, it includes the "slow, weak, imprecise, and/or uncoordinated movements of the speech musculature" that may affect respiration, phonation, resonance, and/or articulation (Yorkston, 1996, p. S46). Activity limitations include the individual's difficulties in executing

specific tasks/actions (WHO, 2001), and as it relates to dysarthria, it includes the production of abnormal prosody and a reduction of speech intelligibility and speaking rate (Yorkston, 1996). “Problems an individual may experience in involvement in life situations” (WHO, 2001, p. 121) are addressed under participation restrictions, and as it relates to dysarthria, it includes difficulties communicating effectively in social or vocational activities. In addition to these domains, the ICF also considers environmental and personal factors, such as the physical features of the environment, family, gender, and personal habits, which represent the individual’s background and may impact the individual’s state of health. Research has shown that rehabilitation is a complex, dynamic, and multifactor phenomena, and as such, improvement in one domain of the ICF does not always generalize to other domains (Brandt & Pope, 1997). Therefore, it is crucial for treatments to target each of the domains and for outcomes to measure abilities within those respective domains. However, most studies of dysarthria, including the studies that will be reviewed here, have not incorporated this model into their treatment outcome measures. Furthermore, in this era of managed care, it is becoming increasingly important to not only address impairment level issues but also to address activity and participation limitations for reimbursement purposes (Donovan, Kendall, Young, & Rosenbek, 2008; Yorkston, 1996).

Parkinson’s Disease

The impairment, activity limitations, and participation restrictions that IwPD face are due to the loss of dopaminergic cells in the substantia nigra. This alteration in neurotransmitter availability has been found to also affect structures that are connected to the substantia nigra, such as the globus pallidus, putamen, and frontal lobe (Murray & Clark, 2006). Although PD is typically considered a disorder of movement, impaired cognition and dementia manifest in 72% and 10-30% of cases, respectively, because of connections between the substantia nigra and these other structures (Duffy, 2005; Morris & Iansek, 1996). PD often presents with a host of

other impairments such as dysphagia in 40-80% of cases and depression in 40-60% of cases (Duffy, 2005).

The characteristic movement impairments of IwPD include hypokinesia, bradykinesia, tremor, rigidity, and postural instability. Hypokinesia is the reduction in overall amplitude and speed of movements; bradykinesia refers to the difficulty and slowness in initiating movements; tremors manifest as trembling hands, legs, arms, or head; rigidity refers to the characteristic stiffness of the trunk and limbs or resistance to movement; and postural instability is characterized by difficulty sustaining balance and by a stooped posture (Bhatnagar, 2008; Murray & Clark, 2006; Watts & Koller, 2004). These motor impairments, especially hypokinesia and bradykinesia, are often exaggerated in well learned movement patterns, such as speaking and walking, or in complex, coordinated movements (Morris & Iansek, 1996). In the majority of cases, etiology is unknown, though some cases appear to be due to genetic mutations, via either inheritance or environmental toxins (Murray & Clark, 2006). Prevalence rates estimate that PD currently affects over half a million individuals in the United States (NINDS, 2006).

Hypokinetic Dysarthria

The motor impairments caused by PD often affect verbal output resulting in speech that is characteristic of hypokinetic dysarthria. This type of dysarthria is a motor speech disorder associated with pathology of the basal ganglia control circuit, which results in problems with verbal communication because of weakness or incoordination of the speech musculature. In fact, PD is the prototypic disease associated with hypokinetic dysarthria (Duffy, 2005). Voice, articulation, and prosody are the components of speech that are most affected in hypokinetic dysarthria. Perceptual characteristics include breathiness, short rushes of speech, variable speaking rate with an increased overall speaking rate, reduced stress and loudness, monotonicity, and imprecise consonants; all of which reflect the effects of impaired movement associated with

PD on speech (Duffy, 2005; Weismer, 2007). These speech characteristics often affect speech intelligibility, which is “the extent to which a listener understands the speech produced by individuals with motor speech disorders” (Yorkston, Beukelman, Strand, & Bell, 1999, p. 486). In fact, in a retrospective review performed by the Mayo Clinic from 1969-1990 and 1999-2001, over 75% of IwPD and hypokinetic dysarthria had reduced speech intelligibility (Duffy, 2005).

Lee Silverman Voice Treatment

In an attempt to remediate some of the deficits prevalent in IwPD and dysarthria, Ramig and colleagues have developed a treatment targeting the respiratory and phonatory impairments common to PD (Countryman & Ramig, 1993; Countryman, Ramig, & Pawlas, 1994; Ramig et al., 1994; Ramig et al., 1996). The approach, Lee Silverman Voice Treatment (LSVT™), focuses on “increasing vocal intensity by increasing phonatory effort” (Ramig, Countryman, Thompson, & Horii, 1995, p. 1233). Lee Silverman Voice Treatment aims to remediate the common speech characteristics in hypokinetic dysarthria, such as breathiness, reduced loudness, and monotonicity, through activities designed to reduce rigidity of the laryngeal and/or respiratory muscles, to increase respiratory support, and to increase vocal fold adduction (Ramig, Countryman et al., 1995). Essential principles of this treatment include specific focus on increasing vocal loudness, multiple repetitions of high effortful productions, intense dosage of treatment (i.e., 4 sessions per week for 4 weeks), calibration of sensory awareness for self-monitoring of vocal loudness, and behavior quantification (Ramig, Pawlas, & Countryman, 1995). Researchers have built an extensive body of evidence for LSVT™ over the past 15 years that provides Level I evidence (i.e., “strong evidence from at least one systematic review of multiple well-designed randomized controlled trials”; Moore, McQuay, & Gray, 1995, p. 1) for both short-term and long-term treatment outcomes (Sapir et al., 2007). Treatment effects include increased phonatory loudness during sustained vowel phonation, reading of a standardized

passage, production of a short monolog, and a picture description task; increased subglottal pressure; improved vocal fold adduction; increased duration of maximum sustained vowel; increased fundamental frequency range; increased fundamental frequency variability in speech; increased vowel space; and improved oropharyngeal swallow function (El Sharkawi et al., 2002; Jones, 2005; Ramig, Countryman et al., 1995; Spielman, Ramig, Story, & Fox, 2000). Additional effects of LSVT™ include perceptual reports of increased vocal loudness and speech intelligibility (Ramig, 1992) and anecdotal reports of reduced impact of the disorder on the ability to communicate (Ramig, Countryman et al., 1995).

Although a large base of scientific evidence has formed in support of LSVT™, this therapy is not without criticisms. Weaknesses in regards to the methodology of previous LSVT™ studies include small sample sizes of participants, a lack of randomized participant selection, and poorly matched experimental and control groups (Deane, Whurr, Playford, Ben-Shiomo, & Clarke, 2004a, 2004b). Because of these weaknesses, critics argue that the efficacy of this treatment cannot be made with complete confidence. Additionally, in order to provide LSVT™ to clients, clinicians are required to become certified by attending LSVT™ workshops, and thus, “only those who have paid their fees are in a position to add to the database” of LSVT™ clinical outcomes research (Peach, 2004, p. 2). Inherent in this arrangement are biases of the clinical researcher that can only be addressed by implementing external controls into the study, a solution that has not been documented in previous LSVT™ research (Deane et al., 2004a).

Another criticism revolves around the intensity, frequency, and duration of therapy sessions as outlined in the LSVT™ protocol. As is noted in the essential principles of LSVT™, treatment effects come by way of an intensive therapy regimen of 4 sessions per week for 4 weeks, totaling 16 sessions. This rigorous protocol is consistent with principles of exercise,

learning of motor patterns/movements, and acquisition of skills (Brown, McCartney, & Sale, 1990; Maas et al., 2008; Schmidt & Lee, 1999). However, the question of optimal procedures of LSVT™ has yet to be fully answered by the existing body of research. Modifications of the LSVT™ protocol's intensity of treatment dosage "will help to elucidate the best mode of administration for optimal treatment results" (Fox et al., 2002, p. 114). Not only are changes in intensity of treatment protocol important for determining optimal treatment procedures, but the rehabilitation industry has experienced systematic reductions in allowable frequency and duration of covered services (Centers for Medicare and Medicaid Services, 2008). However, the original LSVT™ protocol was developed prior to current reimbursement practices (e.g., payers may limit treatment to 45-minute sessions, two times per week for eight weeks), which has resulted in fewer individuals qualifying for treatment and in a lack of reimbursement for the practicing clinician.

Modifications to LSVT™ Protocol

In an attempt to address questions about the efficacy of LSVT™ with modified intensity, frequency, and duration, Wohlert (2004) varied LSVT™ schedules for 11 IwPD and hypokinetic dysarthria to determine if treatment outcome variables were affected by altering frequency and duration of the therapy sessions. Participants were placed into one of three treatment schedules: four times per week for four weeks (i.e., normal LSVT™ protocol), two times per week for eight weeks (i.e., same frequency; doubled duration), and two times per week for four weeks (i.e., frequency reduced by half; same duration). While treatment schedules differed among participants, all participants were assigned 40 homework sessions of an unspecified length (see Table 1). The therapy protocol followed the original LSVT™ program (Ramig, Pawlas et al., 1995). Outcome measures were taken prior to therapy, at the conclusion of therapy, and 3-months after therapy ceased. Measures included forced vital capacity, vocal sound pressure level

(SPL) and duration of sustained phonation, vocal SPL during reading of “The Grandfather Passage” (Darley, Aronson, & Brown, 1975), pitch range, and Sickness Impact Profile (SIP). Results indicated that all participants, regardless of treatment schedule, increased in average vocal SPL during reading of “The Grandfather Passage” and 9 of the 11 increased in maximum vocal SPL during sustained phonation. At the 3-month follow-up, 9 of the 11 showed a slight decrease in vocal SPL, but it remained above pre-treatment levels for 8 of those 9 participants. Seven of the 11 participants showed a decrease in duration of sustained phonation from pre- to post-treatment, and pitch range did not increase for 9 of the 11 participants. Additional variables such as depression scores, hearing and memory acuity, years post-onset, and Hoehn & Yahr stage (Hoehn & Yahr, 1967) had no consistent or significant effect on treatment outcomes. The results from this study were in agreement with previous studies analyzing the effect of LSVT™ under original protocol intensities (Ramig, Countryman et al., 1995). From these results, the author suggested that the total amount of practice is more significant in producing treatment effects than the amount of time spent in one-on-one individual therapy sessions.

However the issue of homework that was required of the participants in this study was not fully addressed. The author reported that all participants were assigned an equal amount of homework sessions across the three groups, yet the amount of homework assigned, as well as the amount of homework actually completed by each participant was not revealed. Differences in amount of homework time completed among participants could have led to drastic differences in actual amount of practice time. If the author’s argument is that LSVT™ is effective because of the total amount of practice time completed by the participant, that time should have been clearly defined.

Furthermore, Spielman and colleagues (2007) analyzed the effect of LSVT™ under the following extended conditions (LSVT-X): two times per week for eight weeks with 96

Table 1

Comparison of treatment and homework schedules between LSVT™ (Ramig, Pawlas et al., 1995) and Wohlert (2004).

| Treatment | Frequency | Duration | Total treatment hours | Homework |
|----------------|-----------|----------|-----------------------|--|
| LSVT™ | 4x/week | 4 weeks | 16 hours | 40 assignments ranging from 5-30 minutes |
| Wohlert (2004) | | | | |
| Group 1 | 4x/week | 4 weeks | 16 hours | 40 assignments of unspecified length |
| Group 2 | 2x/week | 8 weeks | 16 hours | |
| Group 3 | 2x/week | 4 weeks | 8 hours | |

homework assignments. This study differed from the original LSVT™ protocol in two ways, the duration of the program was doubled and the amount of homework assigned to each participant was more than doubled (i.e., LSVT™: 40 homework assignments; LSVT-X: 96 homework assignments) (see Table 2). Participants included 12 individuals with idiopathic PD and speech characteristics “typical of PD,” as determined by three experienced speech-language pathologists. The therapy protocol followed the original LSVT™ program (Ramig, Pawlas et al., 1995). Outcome measures were averaged across two days of evaluation at three points: pre-therapy, immediately post-therapy, and at 6-months following therapy cessation. Measures included average vocal SPL of sustained phonation, reading of the Rainbow Passage (Fairbanks, 1960), description of a picture, and production of a spontaneous speech sample, as well as listener perception of quality of voice, clarity of articulation, and production of rate, intonation, and naturalness during the paragraph reading task. Results indicated a significant increase in vocal SPL on all tasks across all participants from pre-therapy to post-therapy and from pre-therapy to follow-up, with an insignificant decrease from post-therapy to follow-up. These

results were compared to results from a previous LSVT™ study (Ramig, Sapir, Fox et al., 2001) and revealed no statistically significant differences in vocal SPL among the tasks, except for the picture description task (i.e., higher average vocal SPL for LSVT-X). Additionally, there was no statistically significant difference in functional communication improvement, as indicated on the Voice Handicap Index (Jacobson et al., 1997). In regards to the listener perception measure, results indicated that speech post-therapy was “better” than speech pre-therapy. In conclusion, the authors noted that LSVT-X results in significant changes, comparable to LSVT™, because it allows for more time to learn and perfect new motor programs associated with this treatment program and to practice newly acquired skills for longer periods of time, thereby increasing opportunities for generalization. These conclusions conform to motor learning theory in regards to distributed practice, large practice amount, variable practice contexts, and external attentional focus (Maas et al., 2008).

However, this LSVT-X protocol places a burden on clinicians and clients alike because of the tremendous, long-term workload created by the homework assignments (Spielman et al., 2007). These assignments are not only work for the clients, but each assignment results in more unbillable time a clinician must spend in creating carryover tasks.

LSVT™ was originally developed based on principles of motor learning, but it did not investigate a minimal optimum dosage for treatment effect. While still using principles of motor learning (i.e., distributed practiced, large practice amount, variable practice contexts, and external attentional focus), the aim of the current study was to follow the standard treatment protocol of LSVT™ but to manipulate the dose of treatment to determine if a reduced dose of treatment would be effective for IwPD and dysarthria. The modifications that were made to the original LSVT™ protocol included the use of frequency, intensity, and duration variables that more closely mirror the current state of clinical practice as well as a reduction in homework

Table 2

Comparison of treatment and homework schedules among LSVT™ (Ramig, Pawlas et al., 1995), Wohlert (2004), and LSVT-X (Spielman et al., 2007).

| Treatment | Frequency | Duration | Total treatment hours | Homework |
|----------------|-----------|----------|-----------------------|--|
| LSVT™ | 4x/week | 4 weeks | 16 hours | 40 assignments ranging from 5-30 minutes |
| Wohlert (2004) | | | | |
| Group 1 | 4x/week | 4 weeks | 16 hours | 40 assignments of unspecified length |
| Group 2 | 2x/week | 8 weeks | 16 hours | |
| Group 3 | 2x/week | 4 weeks | 8 hours | |
| LSVT-X | 2x/week | 8 weeks | 16 hours | 96 assignments ranging from 5-30 minutes |

assignments, perhaps yielding the most clinically feasible and client-friendly protocol of this treatment. The research questions to be answered were:

1. Is there a change in vocal sound pressure level (SPL) following an 8-week bout of a maximum performance speech therapy (a modified version of LSVT™)?
2. Is treatment effect maintained at 6 months post-treatment?
3. Does this dosage produce changes in vocal SPL comparable to increases observed in previous LSVT™ studies?
4. Is there a change in speech intelligibility scores following this treatment protocol?
5. Is there a change in communicative effectiveness ratings following this treatment protocol?

METHODS

This was a multiple single-subject study on the treatment effect of maximum performance speech therapy for IwPD and dysarthria. The Louisiana State University (LSU) Institutional Review Board for the protection of human subjects approved the study proposal prior to enrollment of subjects and data collection. Informed consent was collected from all participants.

Subjects

Two subjects, one male (P01) and one female (P02), presenting with Parkinson's disease and dysarthria were recruited for this study from the Baton Rouge Parkinson's Disease Support Group based on the following inclusion criteria: (1) PD diagnosis (as diagnosed by a neurologist), (2) dysarthria (as confirmed by a speech-language pathologist), (3) no history of or evidence of neurologic or neurodegenerative disease other than PD, (4) a Mini Mental State Examination (Folstein, Folstein, & McHugh, 1975) score > 24, (5) an Apathy Scale (Starkstein et al., 1992) rating > 14, (6) a Geriatric Depression Scale (GDS) Short Form (Sheikh & Yesavage, 1986) score of >10, (7) a Hoehn & Yahr Rating of Parkinson's disease (Hoehn & Yahr, 1967) between 1 and 4, (8) a Dysarthria Severity Rating (Yorkston et al., 1999) between 1 and 4, and (9) adequate hearing as determined by patient report and conversational interaction. Subjects were excluded from the current study due to (1) dementia, (2) apathy, or (3) depression.

Design

The present study utilized a single-subject A-B-A-A repeated-probe design for each of the participants to examine the effects of a reduced dose of LSVT™ in IwPD and dysarthria. In order to answer the experimental questions, the study investigated the effect of reduced treatment dosage on vocal SPL during sustained phonation, paragraph reading, and monologue, as well as speech intelligibility and communicative effectiveness. The dependent variable was maximum

vocal SPL during sustained vowel phonation. Pre-test, post-test, and follow-up primary outcome measures included average vocal SPL during sustained vowel phonation, reading of “The Grandfather Passage” (Darley et al., 1975), and two-minute monologue. Administered concomitantly with primary outcome measures, the secondary outcome measures included the Sentence Intelligibility portion of the *Assessment of Intelligibility of Dysarthric Speech* (AIDS; Yorkston, Beukelman, & Traynor, 1984) and the Communicative Effectiveness Survey (CES; Donovan et al., 2008).

The secondary outcome measures that were used in this study have established validity and reliability. The AIDS is a widely used tool for determining speech intelligibility in connected speech and provides a measure that effectively addresses the activity domain of the ICF model (Yorkston et al., 1984). The CES is an 8-item, 4-unit rating scale used to assess functional communication in individuals with dysarthria, and research provides evidence of face validity, content validity, and construct validity (Donovan et al., 2008). Additionally, the CES provides a measure that effectively addresses the participation domain of the ICF model (Donovan et al., 2008). Along with the primary outcome measures, which address the body structure/function domain, the present study allowed for a comprehensive analysis of treatment effects by utilizing measures that span the ICF model.

Procedures

The assessment and treatment phases of this study were conducted at the Louisiana State University (LSU) Speech, Language, and Hearing Clinic. Development of the current protocol was completed by the primary investigator under the direction of a certified speech language pathologist (SLP) with over 20 years of experience. Administration of the treatment was completed by second-year SLP graduate clinicians, under the supervision of a certified SLP with over 30 years of experience. The study was conducted in the following manner.

During pre-treatment (A1), participants were administered the primary and secondary outcome measures (described above). Additionally, four baseline data points were established over two sessions for maximum vocal SPL and duration of sustained phonation of vowel /a/ and for the control task, which was diadochokinetic rate (i.e., /pʌtʌkʌ/). As is typical in single-subject designs, a control task was included and was expected to remain unchanged throughout all of the phases of the study to assure that changes seen in the dependent variable were effects of the treatment and not effects of extraneous variables (Spielman et al., 2007). During the “B” phase (i.e., treatment), the same probes were administered at the end of each therapy session, yielding a total of 16 data points. Participants completed 45 minutes of therapy, two times per week for eight weeks, for a total of 12 hours of therapy. Participants were stable on their medications with data collection occurring during an “on” medication cycle. The time of data collection was kept consistent throughout the assessment and treatment phases to reflect the same time in the medication cycles of the participants. Also, participants were instructed to complete 15 minutes of homework on days that therapy was not received for a total of 10 hours over the course of the study. Homework included carryover activities that had been addressed in the previous therapy session. The treatment phase was immediately followed by one session of post-testing (A2) in which the dependent variable, as well as the primary and the secondary outcomes were re-administered. During the 6 months following post-testing (A3), the participants did not receive therapy, but were encouraged to continue implementing skills and techniques learned during treatment. Postcards were mailed to the clients once every other week during the 6-month follow up phase as a reminder to use their newly acquired “loud voice”. After 6 months post treatment cessation, follow-up testing, identical to post-testing protocol, occurred (see Appendix A).

The LSVT™ protocol outlined in Spielman et al. (2007) was followed. Each session began with drill on maximum loudness of vowel prolongation, followed by increasingly more difficult speech tasks (e.g. words, phrases, sentences, reading paragraphs, conversation). An SLP, certified in LSVT™ (Ramig, Pawlas et al., 1995), oversaw the training of the graduate clinicians. See Appendix B for complete therapy protocol.

Data Analysis

Assessment and treatment was completed in a quiet room at the LSU Speech, Language, and Hearing clinic. All primary outcomes measures were audio-recorded using a headset noise-resistance microphone positioned 2 cm from the participants' mouths and connected to a Dell Optiplex 745 Desktop Computer, which saved the recordings at 48 kHz as a .wav file. To measure average vocal SPL of sustained vowel phonation, the participant was instructed to "hold /a/ for as long as you can using your normal loudness and voice". The participant then read "The Grandfather Passage" and generated a two-minute monologue using normal loudness. For the monologue, participants were given the following instructions: "Talk to me for two minutes about the place where you were born and grew up. Please keep talking until I tell you to stop." Analysis of average vocal SPL on all of these tasks was completed using PRAAT software (Boersma & Weenink, 2006). Calibration of the software setup was conducted prior to each voice recording session by comparing PRAAT values to sound level meter values of generated speech noise. All values were within +/- 1.5dBSPL.

To measure speech intelligibility, participants read ten 14-word sentences from the Sentence Intelligibility Test (SIT) from the AIDS. Different sets were used for pre-treatment, post-treatment, and follow-up testing to control for listener familiarity during transcription. To analyze participants' productions, an undergraduate student, blind to the study's purpose, transcribed the data in a quiet environment. The transcriber was seated two feet from high-

quality external speakers, with a desktop computer located directly in front of the transcriber. The transcriber received the AIDS transcription instructions to listen to the sentences only two times; first listen to the sentence in its entirety, second transcribe while listening, stopping the recording as needed. Thereafter, an experienced SLP will score the SIT according to the AIDS manual (Yorkston et al., 1984).

To measure functional communication, participants completed the CES after being provided verbal and written instructions from the PI. Each of the eight items on the CES were rated by the participants on a 1-4 scale. The summed CES ratings for each participant were converted to interval scores on a 0-100 scale based on Rasch analysis (Donovan et al., 2008).

Intra-rater reliability was established by the PI reanalyzing the average SPL of three randomly selected voice recordings (Urbaniak & Plous, 2009), which reflected 16% of the data from primary outcome measures. Inter-rater reliability was established on the intelligibility measure. An undergraduate research assistant, blind to the purpose of the study, reanalyzed the Sentence Intelligibility Test and three randomly selected scores (Urbaniak & Plous, 2009) were compared, which reflected 33% of the data.

The current study's research questions were answered by analyzing changes in outcome measures and by using visual analysis of the repeated-probe data. Visual analysis was chosen because it is not dependent upon the stability of the baseline data points, which is a limitation of statistical analysis (Kendall et al., 2008). For visual analysis, the baseline data point stability was determined by the PI and was then compared to the relative slope of the treatment data points. Due to a small sample size, changes in primary and secondary outcome measures were reported descriptively.

RESULTS

Two participants with PD and dysarthria were recruited for this study. The first participant, P01, was a 75-year-old Caucasian male. He had received a diagnosis of PD five years prior to the start of the current study. The second participant, P02, was a 72-year-old Caucasian female. She had received a diagnosis of PD one year prior to the start of the current study. Relevant characteristics of the two participants are summarized in Table 3.

Table 3
Descriptive characteristics of participants.

| | P01 | P02 |
|----------------------------|-----|-----|
| Age in years | 75 | 72 |
| Years post-diagnosis | 5 | 1 |
| MMSE score | 30 | 30 |
| Apathy Scale rating | 9 | 7 |
| GDS score | 2 | 0 |
| Hoehn & Yahr Rating | 1 | 1 |
| Dysarthria Severity Rating | 2 | 1 |

Overall, P01 and P02 attended 14 out of 16 therapy sessions, resulting in 10.5 out of a possible 12 hours of therapy, due to illness-related absences. Out of the 10 hours of homework that was to be completed throughout the course of the study, P01 completed 11 hours of homework (44 homework assignments), and P02 completed 8 hours and 45 minutes of homework (35 homework assignments).

Experimental Questions

1. Is there a change in vocal sound pressure level (SPL) following an 8-week bout of a maximum performance speech therapy (a modified version of LSVT™)?

Visual analysis was used to analyze change in vocal SPL. For P01, the baseline was falling throughout the four baseline measures. The first therapy day data point continued to decline at an even more rapid rate. On the second therapy day, the decline stopped and was followed by three therapy days with significant increases in vocal SPL. Over the last nine therapy sessions, vocal SPL plateaued around the mean of the baseline and remained stable (mean: 94.1; range: 92.7-96.5dBSPL). Results from visual analysis indicated an effect was observed following this treatment protocol as the falling pattern of the behavior seen in the baseline phase was reversed and then stabilized.

As a control task, diadochokinetic (DDK) rates were also taken at pre-testing, during treatment, at post-testing, and at follow up. P01's baseline DDK rates exhibited random variation around a mean of 2.9 syllables/second. The clinician failed to obtain DDK rates on therapy day 5, and thus, only 13 data points were obtained. Performance over those 13 therapy sessions exhibited a stable, random variation around a mean of 3.0 syllables/second. As was expected, results indicated therapy was not effective in improving DDK rates.

The same analysis was used with data from P02. Visually, for P02, the four baseline data points exhibited a stable, random variation around a mean of 89.3dBSPL. The baseline period was followed by a steady and significant increase in maximum vocal SPL. On the final six days of therapy and one day of post-testing, performance plateaued around a mean of 95.9dBSPL (range: 94.9-96.7dBSPL). Results indicated a significant effect for improvement of maximum

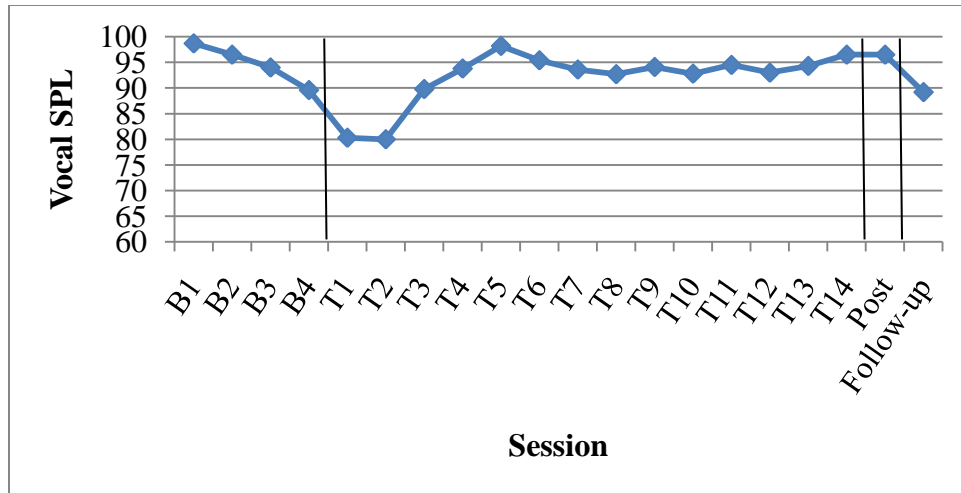


Figure 1
P01's maximum vocal SPL from pre-testing, through treatment sessions, post-testing, and follow-up.

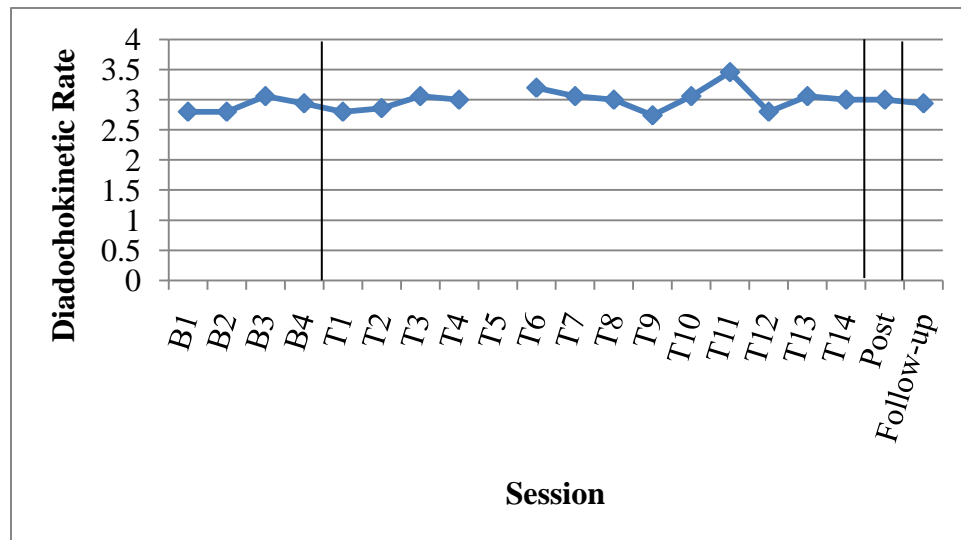


Figure 2
P01's average DDK rate from pre-testing, through treatment sessions, post-testing, and follow-up.

vocal SPL following this treatment protocol as thirteen of the fourteen treatment sessions resulted in a vocal SPL higher than the baseline average.

DDK rates were also obtained for P02 as a control task. P02's baseline DDK rates exhibited random variation around a mean of 2.7 syllables/second. Performance over the 14 therapy sessions also exhibited a stable, random variation around a mean of 3.1 syllables/second. As was expected, results indicated therapy was not effective in improving DDK rates.

2. Is treatment effect maintained at 6 months post-treatment?

Visual analysis was also used to determine if treatment effects were maintained six months after treatment ceased. Visually, P01's performance declined significantly, even below the baseline mean, and P02's performance declined to baseline levels. These results indicated treatment effects were not maintained six months after therapy was removed. However, the fact that the targeted skill (i.e., vocal SPL) declined when therapy was removed speaks to the efficacy of the treatment in improving vocal SPL.

3. Does this dosage produce changes in vocal SPL comparable to increases observed in previous LSVT™ studies?

Similar to previous LSVT™ studies, average vocal SPL of sustained vowel prolongation, reading of "The Grandfather Passage" (Darley et al., 1975), and two-minute monologue was obtained at pre-testing, post-testing, and follow-up. Average vocal SPL increased from pre-test to post-test, and from pre-test to follow-up, for both participants across all SPL outcome measures. From pre-test to post-test, P01's average vocal SPL increased by 83% for sustained vowel prolongation, by 35% for Grandfather Passage reading, and by 25% for monologue. From pre-test to follow-up, P01's average vocal SPL increased by 47% for sustained vowel prolongation, by 17% for Grandfather Passage reading, and by 12% for monologue. When

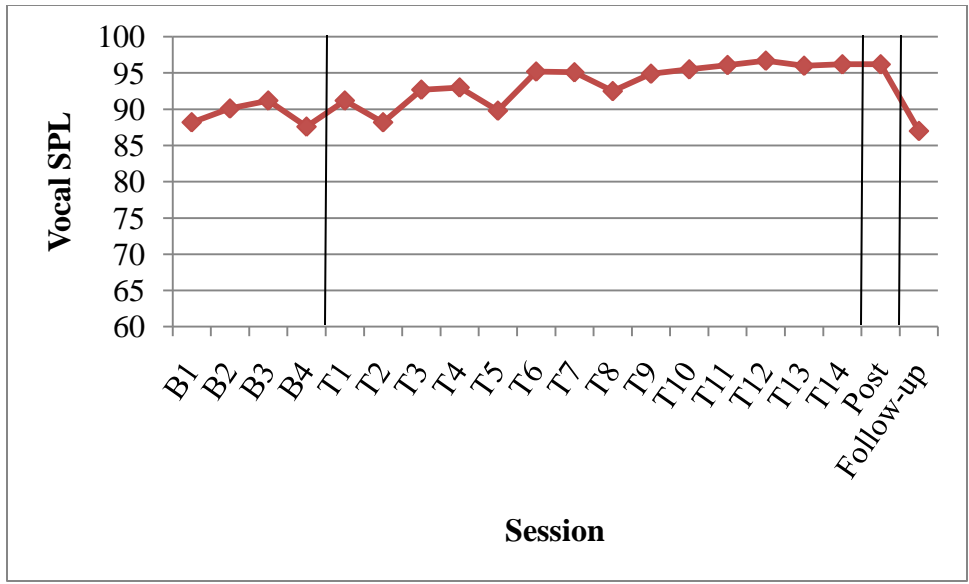


Figure 3
 P02's maximum vocal SPL from pre-testing, through treatment sessions, post-testing, and follow-up.

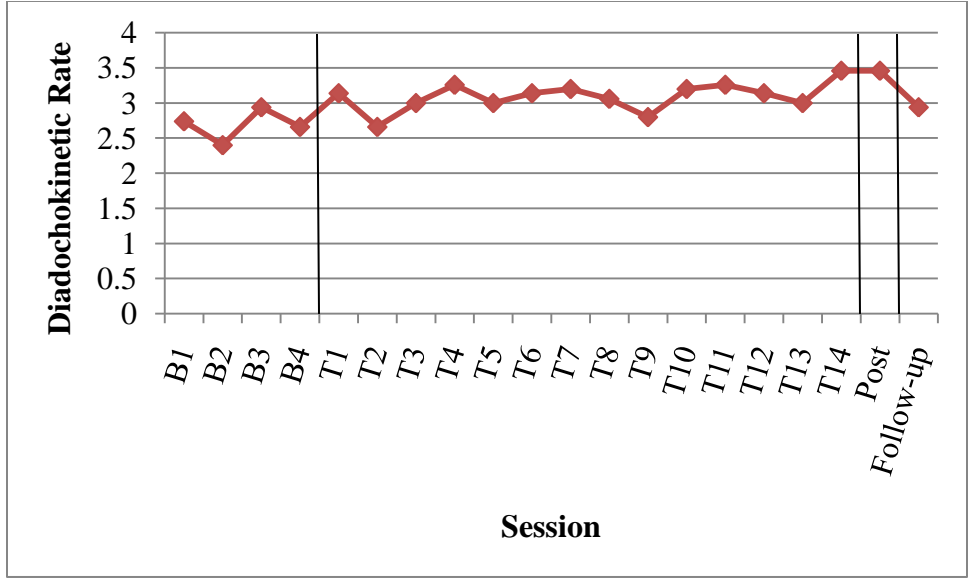


Figure 4
 P02's average DDK rate from pre-testing, through treatment sessions, post-testing, and follow-up.

comparing post-testing to follow-up, all three SPL measures slightly decreased but remained above pre-testing levels.

From pre-test to post-test, P02's average vocal SPL increased by 20% for sustained vowel prolongation, by 18% for Grandfather Passage reading, and by 27% for monologue. From pre-test to follow-up, P02's average vocal SPL increased by 3% for sustained vowel prolongation, by 0.5% for Grandfather Passage reading, and by 7% for monologue. When comparing post-testing to follow-up, all three SPL measures decreased but remained above pre-testing levels.

Outcome measures from the current study were directly compared to results from the study conducted by Spielman and colleagues (2007). As discussed in the literature review, Spielman et al. altered the original LSVTTM protocol to one hour sessions, two times per week for eight weeks and termed it LSVT-X. Results from that study were from the average performance of 12 participants with idiopathic PD. Comparisons were made to determine how the performance of the participants in the current study would compare to the performance of the participants in LSVT-X (see Table 4).

At pre-testing, P01's performance was statistically lower than the LSVT-X results across all three tasks. This indicated P01 exhibited more impairment at the start of the study than did the average LSVT-X participant. At post-testing, P01's scores continued to fall below the mean and standard deviation of the LSVT-X results. However, his performance did show a statistically significant increase from pre-testing measures that exceeded the increases observed in the LSVT-X study. As aforementioned, P01's performance from pre-to-post-testing increased by 83% for sustained vowel prolongation, by 35% for Grandfather Passage reading, and by 25% for monologue. In comparison, the participants receiving LSVT-X increased by 15% for sustained vowel prolongation, by 9% for reading passage, and by 9% for monologue. For P02, her

performance was at or below the performance of the LSVT-X participants at pre-testing. At post-testing, her performance increased to levels at or above that of LSVT-X participants. Results indicated a greater increase in therapy outcomes for participants following the current study's protocol than for participants following LSVT-X (Spielman et al., 2007).

A similarity exists between participants in the current study and participants in the LSVT-X study in regards to the difference between pre-test and post-test as compared to follow up. In both protocols, participants' performance decreased from post-testing to follow-up, but remained above pre-treatment levels.

Table 4
Comparison of P01 and P02's average vocal SPL to Spielman et al. (2007) results.

| | P01 | P02 | Spielman et al. (2007) LSVT-X |
|---------------------|-------|-------|----------------------------------|
| <u>Pre-test</u> | | | |
| /a/ | 42.32 | 72.45 | 72.0 (6.3) |
| Grandfather Passage | 49.7 | 63.94 | 72.7 (3.5) |
| Monologue | 50.51 | 57.91 | 69.6 (2.5) |
| <u>Post-test</u> | | | |
| /a/ | 77.59 | 87.28 | 83.0 (3.9) |
| Grandfather Passage | 67.28 | 75.46 | 79.6 (3.3) |
| Monologue | 63.18 | 73.26 | 75.7 (2.6) |
| <u>Follow-up</u> | | | |
| /a/ | 62.33 | 74.84 | 82.7 (4.7) |
| Grandfather Passage | 58.34 | 64.23 | 78.7 (3.5) |
| Monologue | 56.52 | 61.90 | 73.7 (2.6) |

4. Is there a change in speech intelligibility scores following this treatment protocol?

The Sentence Intelligibility Test from the AIDS (Yorkston et al., 1984) was used to measure speech intelligibility. This tool yields a percentage of intelligibility from participants' reading of ten 14-word sentences. From pre-testing to post-testing to follow-up, speech intelligibility ratings for P01 were 92%, 99%, and 97.1%, respectively, exhibiting an increase from pre-testing to post-testing with a decrease from post-testing to follow-up while remaining above pre-testing levels. Speech intelligibility for P02 remained at 100% from pre-testing to post-testing and decreased to 98.6% at follow-up (see Table 5). Results indicate this treatment protocol positively impacts speech intelligibility for at least one of the participants.

Table 5
Speech intelligibility measures for P01 and P02.

| | P01 | P02 |
|---------------|-------|--------|
| Pre SIT | 92.0% | 100.0% |
| Post SIT | 99.0% | 100.0% |
| Follow-up SIT | 97.1% | 98.6% |

5. Is there a change in communicative effectiveness ratings following this treatment protocol?

CES ratings were converted from an ordinal to interval scale using Rasch analysis (Donovan et al., 2008). In this study, the interval scale was converted to a 0-100 interval score because logit scores may prove difficult for the untrained individual to understand (N. Donovan, personal communication, September 7, 2009). The conversion does not change the measurement properties of the instrument or the item difficulty hierarchy. From pre-testing to post-testing to

follow-up, CES ratings for P01 were 52, 69, and 55, respectively, exhibiting an increase from pre-testing to post-testing, but a decrease from post-testing to follow-up, although follow-up rating remained above pre-testing levels. For P02, CES ratings were 100, 61, and 66 (see Table 6). Results indicated this treatment protocol positively impacts communicative effectiveness for at least one of the participants. The unexpected finding of a decrease from pre-testing to post-testing for P02 will be discussed in the next section.

Table 6
Communicative effectiveness measures for P01 and P02.

| | P01 | P02 |
|---------------|-----|-----|
| Pre CES | 52 | 100 |
| Post CES | 69 | 61 |
| Follow-up CES | 55 | 66 |

Reliability

Intra-rater reliability was established by the PI reanalyzing the average SPL of three randomly selected voice recordings (Urbaniak & Plous, 2009), which reflected 16% of the data from primary outcome measures (see Table 7).

Table 7
Intra-rater reliability.

| | Actual Score | Reviewed Score | % Agreement |
|--------------|--------------|----------------|-------------|
| Recording 6 | 57.91 | 58.01 | 99.83% |
| Recording 7 | 77.59 | 77.56 | 99.96% |
| Recording 15 | 56.52 | 56.52 | 100.0% |

Inter-rater reliability was established on the intelligibility measure. An undergraduate research assistant, blind to the purpose of the study, reanalyzed the Sentence Intelligibility Tests, and two randomly selected scores (Urbaniak & Plous, 2009) were compared, which reflected 33% of the data (see Table 8).

Table 8
Inter-rater reliability.

| | Actual Score | Reviewed Score | % Agreement |
|-------|--------------|----------------|-------------|
| SIT 2 | 99.00 | 100.00 | 99.00% |
| SIT 4 | 100.00 | 98.57 | 98.57% |

DISCUSSION

These preliminary results demonstrate the potential for obtaining a treatment effect using a reduced intensity, frequency and duration of the LSVT™ protocol. We achieved these mixed, but promising results in less than 12 hours of direct intervention and 40 homework assignments, compared to Spielman and colleagues (2007) who demonstrated treatment effects in 16 hours of direct intervention and 96 homework assignments, and compared to the original LSVT™ studies where results were achieved in 16 hours of direct intervention and 40 homework assignments. Both IwPD in the current study exhibited improvement on all primary outcome measures and at least one secondary outcome measure.

Two approaches were taken to examine the effect of treatment on the participants in this study, namely treatment efficacy and treatment outcome. There has been much discussion regarding the differences and similarities between these two approaches, but as described by Olswang (1998), “treatment efficacy research proves treatment benefits; treatment outcome research identifies treatment benefits” (pg. 135). Thus, if a treatment is efficacious, one would argue that any changes in behavior were the direct result of the treatment administered, which come by way of well-controlled studies and rigorous data collection. Outcomes of treatment, on the other hand, are measured prior to, during, and after the treatment. The outcomes include clinical variables and the benefits of the treatment such as functional improvements the participant exhibits.

The first two research questions of the current study addressed the efficacy of this modified LSVT™ protocol. For treatment efficacy in this study, a repeated-probe design was used to determine if systematic changes were seen in the participant’s behaviors as the treatment was introduced and later withdrawn. As was seen with P01, the treatment protocol not only ceased the declining nature of the behavior, but also reversed the behavior to maximum vocal

SPLs within normal limits (Ptacek, 1966). More specifically, the decrease in the baseline data points suggested that if no treatment had begun, this declining pattern could have continued. At the first therapy data point, the behavior continued to fall even further. It must be noted that data points were taken at the end of each therapy session, after the treatment protocol had been completed. One explanation for the continued decline on the first therapy day for P01 was that since it was the first day during which the participant was required to complete high effort activities for a full 45-minute session, fatigue set in (as indicated by the low maximum vocal SPL). This fatigue factor was slowly eliminated as sessions continued and the participant's ability to complete high effort activities without becoming significantly fatigued increased. P01's maximum vocal SPL, thereafter, increased to and stabilized at a level that fell within normal limits for geriatric men (100.5(5.9)dBSPL) (Ptacek, 1966).

Significant improvements were not visualized for maximum vocal SPL for P01; however, a possible explanation for this could be the phenomenon of "ceiling effects." As is observed in studies identifying the normative data on maximum vocal SPL, there is a physiological maximum loudness level that under most circumstances cannot be surpassed. An individual can get only so loud due to physiological limitations. According to Ptacek et al. (1966), this level for healthy geriatric men is 100.5(5.9)dBSPL. P01's performance fell within this range or within 2dB of this range for the final 10 therapy sessions, which suggests the treatment moved him to his physiological limits and maintained the behavior throughout the remaining course of the treatment. The notion that P01's behavior was maintained at levels within normal limits despite the progressive nature of his diagnosis speaks to the efficacy of this treatment. Additionally, when treatment was stopped, P01's maximum vocal SPL six months later decreased. This indicated that treatment positively impacted vocal SPL and that effects of this protocol were due to the treatment and not extraneous participant variables. These changes in maximum vocal SPL

were observed along side an unchanging DDK rate, the control variable, indicating improvements in vocal SPL did not come by way of overall participant improvements or by chance. Because of this relationship, the data suggests this treatment is efficacious for maximum vocal SPL following the current study's modified LSVT™ protocol.

From visual analysis, P02's results indicated treatment efficacy. Stable baseline data points gave way to improvement in behavior once treatment was initiated. "Ceiling effects" also played a role in the extent to which P02 showed improvement. Ptacek et al. (1966) reported the maximum vocal SPL for geriatric women was 98.6(4.5)dB SPL. P02's performance fell within this range or within 2dB of this range for the final 10 therapy sessions, which suggests the treatment moved her to her physiological limits and maintained the behavior throughout the remaining course of the treatment. As was seen with P01, P02's performance dropped when treatment had been removed for six months, which indicated treatment positively impacted vocal SPL and effects of this protocol were due to the treatment and not extraneous participant variables. The control variable for P02 also remained relatively unchanged throughout the course of the treatment and follow-up testing periods. This indicated that changes in maximum vocal SPL were not due to overall participant improvement, chance, or the passage of time.

More specifically, the second research question, which considers behaviors at a 6-month follow-up testing period, presented with mixed results. While the dependent variable, maximum vocal SPL, did not demonstrate maintenance of treatment effect after 6-months, the outcome measures of this study did. The outcome measure data, which will be discussed next, exhibited a significant increase from pre-testing to post-testing and a slight decline from post-testing to follow-up. However, follow-up scores remained above pre-treatment levels. These mixed results indicated that while the isolated behavior targeted during therapy did not maintain effects once

treatment stopped, the functional impacts that this behavior made on the outcome measures remained.

The third research question, with regard to treatment outcomes, examined the benefits of the current study's treatment protocol. Outcome measure results of this study were indeed comparable to results from previous studies examining the effects of the LSVT™ protocol on vocal SPL. Similar to the results of LSVT-X (Spielman et al., 2007), all three primary outcome measures of the current study exhibited substantial increases in vocal SPL from pre-testing to post-testing, with slight decreases from post-testing to follow-up. The main difference between LSVT-X and the current protocol was the length of individual treatment sessions and the amount of assigned homework. Both protocols followed a treatment schedule of sessions twice a week for eight weeks. These two protocols are different from the original LSVT™ protocol which requires 1-hour sessions four times per week for four weeks (Ramig, Pawlas et al., 1995). While the protocol of the current study was designed to require four fewer hours of direct therapy than LSVT™ and LSVT-X, actual amount of therapy was even less due to illness-related absences of the participants. This resulted in the current study's protocol having 10.5 hours of direct intervention compared to 16 hours of direct intervention following the LSVT™ and LSVT-X protocols. Another substantial difference between the protocols was in regards to the amount of homework assigned to participants. LSVT™ requires participants to complete 40 assignments, and LSVT-X requires participants to complete 96 assignments. Assignments include 5-10 minutes of practice on days treatment is received and 20-30 minutes on days treatment is not received (Ramig, Pawlas et al., 1995; Spielman et al., 2007). In the current protocol, participants were asked to complete 40 homework assignments. More specifically, participants were assigned 15 minutes of practice on days treatment was not received (10 hours total). P01 completed all assigned homework, but P02 only completed 35 assignments despite the close monitoring and

consistent encouragement to complete the homework. Although the current protocol required less direct intervention and less homework, results of the outcome measures were comparable to the LSVT-X protocol, which Spielman and colleagues (2007) found was comparable to the original LSVT™ protocol. The current study supports Spielman et al.'s (2007) argument that extending practice, both in the clinic and at home, over a longer period of time allows for greater consolidation of new motor programs and generalization. Results of this study suggest promising results can be achieved following a less intensive treatment protocol that is more in line with reimbursement and scheduling issues in a clinical/rehabilitation setting.

One caveat to the current study and LSVT-X's protocol is that feedback on homework assignments does not occur as often as it does in the original LSVT™ protocol. This lack of feedback, especially at the start of intervention, may affect the quality of homework completed by the participants. According to the specificity of practice hypothesis, the repeated movement patterns an individual practices creates a sensory representation of that specific task (Coull, Tremblay, & Elliot, 2001). Thus, if the participant is not provided with enough feedback in the early stages of treatment to perform homework assignments in the accurate manner, sensory representations different from those created during direct intervention may form, which could negatively affect treatment outcomes.

While the first three research questions address the body structure/function domain of the ICF model, the fourth research question targets the activity limitations domain. The secondary outcome measure used to address this portion of the ICF was the Sentence Intelligibility Test from the AIDS (Yorkston et al., 1984). P01 demonstrated a 9% increase in speech intelligibility from pre-testing to post-testing, with a 1.9% decrease from post-testing to follow-up. P02 demonstrated perfect to near-perfect speech intelligibility at pre-testing, post-testing, and follow-

up. Where there was room for improvement, this treatment protocol lead to improvements in the activity limitations domain of the ICF model.

To more closely analyze the changes in P01's speech intelligibility, this data was compared to his other behaviors measured during the course of this study (i.e., maximum vocal SPL and DDK rate). The pattern of change for speech intelligibility mirrored the pattern of change for P01's maximum vocal SPL while his DDK rate remained stable throughout the study. More specifically, both speech intelligibility and maximum vocal SPL exhibited an increase from pre-testing to post-testing, with a decrease from post-testing to follow-up. These results suggest that an increase in maximum vocal SPL could alone, without improvements in articulatory rate, lead to enhanced speech intelligibility. An explanation for this observation is that to increase loudness, an individual must move the mandible to a greater extent and thus the vocal tract shape would be altered. This change in vocal tract shape would change vowel formants, especially the F2 slope, leading to maximized acoustic distinctiveness and, thus, increased speech intelligibility (Tjaden & Wilding, 2004). Some researchers claim that the LSVT™ protocol results in improved articulatory function as measured by increases in formant slope and rate (Fox et al., 2002). However, results from this study and previous studies suggest improvements in speech intelligibility can come solely by way of the effects of increased loudness on the vocal tract in the absence of improvements in articulation measures (Halpern et al., 2007; Tjaden & Wilding, 2004).

Another explanation of these results could be that DDK rate does not provide an accurate reflection of articulatory function. A great debate exists in regards to whether or not quasi-speech tasks, such as DDK, can be used as an accurate measure of speech production skills and intelligibility. The two perspectives are one, speech production is a motor behavior similar to any other motor behavior that can be broken into component parts and studied, and two, speech

production, as a motor behavior, is task specific and tied to tactile and acoustic feedback as well as contexts and targets of motor acts (Weismer, 2006). Results of this study are in agreement with the latter perspective because P01's speech intelligibility exhibited improvement in the absence of an increase in DDK rate. If, on the other hand, DDK was an accurate measurement of speech production skills, DDK rate would be expected to show improvements along side improvements in speech intelligibility, which was not the case in the current study.

With two of the three ICF domains addressed in the first five research questions, the final research question focused on the last ICF domain, participation restrictions. The Communicative Effectiveness Survey (Donovan et al., 2008) was used to assess this area and showed that this treatment protocol lessened participation restrictions in one of the two participants as evidenced by an increase in P01's CES scores from pre-testing to post-testing. P02's results, on the other hand, were an unexpected finding. As mentioned in the results section, her CES rating decreased drastically from 100 to 61 from pre-testing to post-testing. It must be noted that P02 explained during the post-testing session that the therapy she had completed made her more aware of her speech deficits that prior to treatment she had not noticed, as evidenced by her perfect self-rating of communicative effectiveness at pre-testing. P02 reported at post-testing that the therapy made her more aware of the areas that needed to be improved and the situations in which she needed to use her communication strategies in order to be more effective. It must be noted that P02's CES rating increased from post-testing to follow-up, which could indicate this treatment protocol did indeed result in an improvement in participation restrictions in P02 as well.

Limitations

The current study was completed during an academic semester at the LSU Speech, Language, Hearing Clinic (LSU SLHC). Because of this, the therapy protocol was subject to the schedule of the SLHC. Four weeks into the therapy protocol, the SLHC observed a week long

break. Thus the 8-week therapy protocol took place over nine weeks. During the one-week break, participants were given homework to complete; however there was no direct therapy occurring during that week. Also, illness-related absences of the participants resulted in only 14 sessions of the maximum output speech therapy. In a different setting, the two additional sessions could have been made up; however, the SLHC schedule did not allow for the make-up sessions.

Since the LSU SLHC is a teaching facility, another possible limitation of the study was the inexperience of the student-clinicians administering the modified LSVT™ therapy protocol. The clinicians were second-year graduate students who had not participated in the LSVT™ training conference but were only trained and supervised by an LSVT™-certified SLP. This may have affected the daily treatment procedures and techniques that were provided to the participants. However, despite the lack of official LSVT™ training, treatment was efficacious and outcome measures exhibited increases comparable to previous LSVT™ studies (Spielman et al., 2007).

Upon analyzing the data, it appeared as though the participants in this study were perhaps not severe enough to allow for large gains to be made in treatment. Initial outcome measures indicated that both participants were highly intelligible (i.e., P01: 92%; P02: 100%) and were able to produce and to sustain speech within acceptable loudness limits (i.e., P01: 42.43-50.51dBSPL; P02: 57.91-72.45dBSPL). Because the participant's abilities were in the mild severity range, significant improvements in abilities were unlikely to occur because there was not a significant amount of room for improvement.

Another limitation was that this study obtained four baseline measures but only one post-testing and one follow-up measure of maximum sustained vowel prolongation in an attempt to be more clinically feasible. Although Beeson & Robey (2006) note that only one post-testing and

one follow-up measure is mathematically necessary to calculate effect sizes, three data points at each of those testing periods would have allowed for a more reliable measure of abilities and controlled for variations in participant responses.

As an additional caveat, the current study's data are preliminary findings that suggest potential treatment efficacy; however, due to the single-subject nature of this study, the results lack generalizability.

Future Studies

While this was a small single-subject design study, we believe that the preliminary results, though mixed, demonstrated the potential for obtaining a treatment effect using a reduced LSVT™ protocol. Therefore, it is recommended that the current study be repeated with more participants ranging in severity of PD and dysarthria. This would also address the issue of “ceiling effects.” IwPD who rate more severe on the Hoehn & Yahr Rating of Parkinson's disease (Hoehn & Yahr, 1967) and the Dysarthria Severity Rating (Yorkston et al., 1999) may prove to be better candidates for demonstrating significant improvements following treatment.

To address the issue of variability of responses at post-testing and follow-up, future studies should obtain at least three data points at each of the testing periods.

SUMMARY

In conclusion, a reduction in the intensity, frequency, and duration of the well-known LSVT™ protocol to levels more conducive to and realistic in a clinical setting exhibits the potential for treatment effects comparable to the original, intensive LSVT™ protocol. The results of this preliminary study, though mixed, indicate an increase in vocal SPL during sustained vowel prolongation, paragraph reading, and monologue. Additionally, improvements in speech intelligibility scores and communicative effectiveness ratings were observed in one of the two participants. In regards to the three domains of the ICF model, the reduced levels of the current study's protocol led to improvements in all three domains for P01 and two of the three domains for P02.

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APPENDIX A

CMOST OUTCOME MEASURES PROTOCOL

1. Obtain Informed Consent
 2. Record Baseline Data Set 1**
 - a. Maximum SPL /a/
 - b. Duration /a/
 - c. Diadochokinetic rate
 3. Record avg SPL of sustained /a/ at normal loudness and pitch
 4. Record avg SPL of reading of “Grandfather Passage”
 5. Record avg SPL of 2 minute monologue of “Where I grew up”
 6. Record Baseline Data Set 2
 7. Record AIDS Sentence Intelligibility measure
 8. Have Client complete CES
 9. Record Baseline Data Set 3
- For baselines, have sound level meter 8 cm from mouth. Use the correct sound level meter for that client.
 - Duration of /a/ (This measure and the maximum SPL of /a/ measure can be taken simultaneously.)
 - Directions: hold /a/ for as loud and as long as you can.
 - Using a stopwatch, record from voicing onset to offset.
 - Throw out the minimum and maximum duration. Take an average of the remaining 8 attempts. Repeat the 10 attempts 3 times (Data Set 1, 2, and 3) for a total of 30 attempts.

- Maximum SPL of /a/
 - Directions: hold /a/ for as loud and as long as you can
 - Using the sound level meter positioned 8 cm from the client’s mouth, record the **maximum** SPL.
 - Throw out highest maximum SPL and circle the second highest maximum SPL of the 10 attempts. Repeat the 10 attempts 3 times (Data Set 1, 2, and 3) for a total of 30 attempts.
- Diadochokinetic rate
 - Count the number of times the client can produce “pataka” in 5 seconds.
 - Only count complete productions (i.e., “pata” does not count).
 - Take an average of 3 attempts. Repeat the 3 attempts 3 times (Data Set 1, 2, and 3) for a total of 9 attempts.
- For PRAAT recordings (i.e., **normal loudness** while doing the following tasks: sustained /a/, Grandfather passage, 2 minute monologue):
 - Need **average** SPL for each of these
 - Directions:
 - Place the noise-resistant microphone on the client with microphone at 2 cm from participant’s mouth.
 - Double click on **praat**
 - On the “Praat objects” screen, under **New** select **Record Stereo Sound**
 - In the **Name** box, fill in with participant number and task (i.e., 01a, 01GP, 01mono, 01SI)
 - After the directions are given to the client for a particular task, click **Record** and signal the client to begin the task.

- Click **Stop** when the task is complete.
- Click **Save to list**.
- Repeat these steps for each task (i.e., sustained /a/, grandfather passage, etc.)
- Prior to closing the “Praat objects” screen, you will need to **Write** these files to a folder on the desktop labeled **CMOST Data**.
 - Click on **Write**
 - Select **Write to WAV file...**
 - Select the **CMOST Data** folder located in the desktop
 - Save as participant number and task (i.e., 01a, 01GP, 01mono, 01SI)
- Assure that we control for:
 - Noise reducing microphone
 - Distance from mouth to microphone
 - In lab with door closed
 - Signal input level

**4 baselines will be taken at pre-testing. 1 baseline will be taken at post-testing and 1 at follow-up testing.

APPENDIX B

CMOST THERAPY PROTOCOL

Outcomes Measure Day

- Establish rapport and complete initial interview. Obtain likes/dislikes to be used for therapy materials (i.e., single words, phrases, and sentences).
- Primary investigator will administer outcome measures (see above protocol).

Therapy Day 1

- Another set of *baselines* must be taken FIRST thing (see *baselines* procedures above).
 - **10** attempts of /a/
 - Duration (average)
 - Maximum SPL
 - **3** diadochokinetic attempts
- Follow the daily protocol as normal.

Daily Protocol

- Look over homework form and answer/address any concerns the client had with the homework. Place completed homework form in work folder.
- Complete daily tasks. Coaching should be completed during these tasks. A sound level meter can be used during these activities to provide client feedback. Refer to your packet for detailed information, but use the following number of attempts.
 - Loud, sustained /a/ (**15 repetitions**)
 - High and low pitch glides (**15 repetitions of each**)

- 10 Functional sentences (**5 repetitions of each**)
- Additional repetitions of any of the above can be completed if there is “extra” time.
- Loud voice should be carried over into the speech hierarchy task. The amount of loudness that the patient established in the daily tasks should be transferred to the speech hierarchy tasks. A sound level meter can be used throughout these activities to allow for client feedback.
 - Week 1 and 2: Single words and phrases
 - Week 3 and 4: Sentences
 - Week 5 and 6: Paragraph Reading
 - Week 7 and 8: Conversation
- Record Daily data points on CMOST data sheet. See *baselines* procedures.
 - Elicit 10 productions of a loud, sustained /a/. Record maximum SPL and duration.
 - Directions: hold /a/ for as loud and as long as you can
 - Elicit 3 productions of diadochokinetic activity. Record the number the client can produce in 5 seconds. Take an average of the 3 attempts.
- Assign/review homework. Give client the new homework form (fill in their 10 sentences) and a copy of the items you worked on in the speech hierarchy task.

VITA

Heidi Huckabee Michiels was born in Shreveport, Louisiana. Upon graduating valedictorian from Southwood High School in Shreveport, Louisiana, in 2004, she enrolled in Louisiana State University Agricultural and Mechanical College of Baton Rouge to pursue a Bachelor of Arts degree in communication sciences and disorders. Throughout her undergraduate career, she participated in the Chancellor's Future Leaders in Research Program during which her interest in research flourished. She completed an undergraduate honors thesis, and in May of 2008, she graduated Summa Cum Laude with Upper Division Honors Distinction and was awarded the University Medal. She began her master's program in communication sciences and disorders in the following August and began work on a master's thesis in partial fulfillment of the requirements for a Master of Arts degree, to be awarded in May of 2010. Upon graduation, Mrs. Michiels plans to reside in Baton Rouge, Louisiana, where she hopes to complete the necessary clinical fellowship requirements in a public school system to become a licensed speech-language pathologist.