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Feasibility of group voice therapy for individuals with Parkinson's disease

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Abstract

Purpose: The primary purpose was to demonstrate the feasibility of executing treatment tasks focused on increasing loudness in a group format for individuals with Parkinson's disease (PD). A second purpose was to report preliminary pre-to-post treatment outcomes for individuals with PD immediately after they complete the group program.

Methods: The group intervention is described. Fifteen adults with PD who participated in the group and three clinicians leading the group provided feedback about the execution of the intervention. The participants also provided voice samples and self-ratings of voice handicap once before completing the 8-week voice group and once immediately after completing the voice group. Outcome measures included voice intensity, fundamental frequency (Fo) mean, standard deviation and range, maximum phonation time, and listener judgment of loudness.

Results: Feedback from the clinicians suggested that many, but not all, of the voice activities could be executed within a group setting. Participants with PD indicated they understood the focus of the group and that subjectively they felt the group was helpful for increasing loudness. Statistically significant increases occurred for voice intensity, Fo maximum, and Fo range. Voice handicap scores decreased significantly and 80% of the participants were judged louder post intervention.

Conclusions: Clinician and participant feedback indicated that it was feasible to execute most LSVT® tasks in a group format with some modifications. The preliminary outcome data indicate that the targeted behavior (voice dB and loudness) did change in the predicted direction as did several other measures. Future studies comparing outcomes of group intervention to the gold standard LSVT®, and exploring retention of treatment gains over time, are needed.

Learning outcomes: After reading the manuscript, readers will be able to: (1) Describe previous attempts at group intervention to improve voice for individuals with Parkinson's disease. (2) List three ways that the group intervention tried in this study differed from LSVT®. (3) Identify three limitations to this study that must be addressed before advocating implementation of the group approach in clinical situations.

Keywords: Group therapy, Voice therapy, Parkinson's disease

1. Introduction

Voice and speech disorders are common in individuals with Parkinson's disease (PD) (Hartelius & Stevens, 1994; Logemman, Fisher, Boshes, & Blonsky, 1978) and reduced loudness is frequently reported (Ramig, Fox, & Sapir, 2004). Unfortunately, pharmacological and surgical treatments that are often effective in managing PD symptoms in the limbs do not consistently facilitate speech, and therefore, cannot be relied upon as a primary treatment approach for the hypokinetic dysarthria in this population (De Letter, Santens, De Bodt, Boon, & Van Borsel, 2006; Kompoliti, Wang, Goetz, Leurgans,

& Raman, 2000; Quaglieri & Celesia, 1977; Skodda, Flasskamp, & Schlegel, 2010; Tripoliti et al., 2011; see Trail et al., 2005 for review). Until the early 1990s, individual speech therapy for voice deficits associated with PD often yielded disappointing results with therapeutic gains sometimes limited in terms of the magnitude of change or the ability to retain improvements outside the therapeutic situation (e.g., Downie, Low, & Lindsey, 1981; Erb, 1973; Sarno, 1968). However, over the past 15 years, the Lee Silverman Voice Treatment® (LSVT®) has been tested via randomized controlled trials which have provided evidence of both immediate voice and speech changes and long-term retention of gains up to 2 years post-completion of the therapy (Fox et al., 2006; Ramig, Sapir, Fox, & Countryman, 2001). LSVT® is intended to increase voice loudness in individuals with PD, although improvements to communication extending beyond loudness have been documented, including voice quality (Baumgartner, Sapir, & Ramig, 2001), prosody (Ramig et al., 2001), and articulation (Sapir, Spielman, Ramig, Story, & Fox, 2007).

Several unique aspects of the LSVT® program are likely responsible for successful outcomes, including the intensity and frequency of the treatment (60 min, high effort sessions; 4 times/week for 4 weeks), and a focus on both sensory (i.e., recognizing appropriate effort and loudness level) and motor training (i.e., using increased effort and loudness). The intensity and frequency of the treatment are believed to be important, along with a simple and singular focus on being loud. The therapy is designed to facilitate the learning of a new motor task to the point where the higher effort and louder voice becomes an automatic behavior not requiring external cuing (Spielman, Ramig, Mahler, Halpern, & Gavin, 2007).

To offer therapy using the name LSVT®, a speech-language pathologist (SLP) must complete a certification course and administer the program as prescribed. This is done, in part, to help assure the individual with PD that they are receiving the therapy upon which the outcome research has been completed. However, the developers of the LSVT® program, and others, have recognized that the treatment schedule may limit how many SLPs offer, and how many individuals with PD receive LSVT® (Spielman et al., 2007). Scheduling a patient for four therapy sessions a week for 4 weeks in a row may be difficult for many SLPs unless they have specific time set aside to deliver LSVT®. The intense schedule may be problematic for the individuals with PD if they are working, live far from a licensed and LSVT®-certified SLP, or rely on others for transportation. These therapy access concerns have prompted a search for ways to increase accessibility to the program or to alter its delivery. In this study we describe the feasibility of executing group intervention on a less frequent treatment schedule than LSVT®.

1.1. Altered treatment schedules for loud-focused voice therapy

Spielman and colleagues (2007) have examined an extended version of LSVT® that they referred to as LSVT®-X. Twelve individuals with idiopathic PD received two 1-h sessions of treatment weekly for 8 successive weeks. The total face-to-face time between the patient and the SLP was equal between traditional LSVT® and LSVT®-X. The main difference between the two was the amount of home practice, which was significantly increased for LSVT®-X. Additionally, the amount of time between treatment sessions was doubled in LSVT®-X. The results indicated that individuals who underwent LSVT®-X did have a statistically significant increase in SPL that was comparable to traditional LSVT®. The SPL increase was documented immediately after the treatment block and 6 months later (with a non-significant drop in SPL at the 6-month mark compared to immediately post-treatment). VHI scores improved pre to post treatment (immediate and 6 months), although this was not statistically significant. Listener ratings also indicated improved speech post-treatment. The authors did highlight some potential issues with the extended program, including increased time required by the clinician for homework preparation, increased time by the client for homework completion, less billable time available since material preparation cannot be reimbursed, potential reduction in direct therapy during the twice weekly visits in order to review the increased homework load, and possible inefficiency in learning the target loud voice early in the therapy program.

Wohlert (2004) evaluated three different treatment schedules: 4 times per week for 4 weeks (n = 3), 2 times per week for 8 weeks (n = 2), and 2 times per week for 4 weeks (n = 6). They reported an increase in voice SPL during reading for all subjects immediately after treatment. There was a trend for dB during reading to drop at 3 months post-treatment compared to immediately after treatment (7/10[1] decreased, 2/10 increased, 1/10 essentially unchanged). However, even with the drop in dB at 3 months, 9 of 10 still had a positive change in SPL during reading (mean = 6.6 dB).[2] Wohlert concluded that, overall, the majority of subjects demonstrated a positive gain in SPL post treatment (immediate and 3 months); she also noted that the schedule of treatment did not appear to have a predictable impact on outcomes although statistical comparisons among the 3 treatment schedules were not attempted. Clearly the small N per treatment schedule and non-random assignment to treatment protocols necessitates caution in generalizing results. However, the results are intriguing because a positive change in the therapeutic target did occur for the majority of patients and was retained for a time period.

The results from Wohlert and from Spielman et al., suggest that altering the LSVT® schedule of treatment may be possible although much more work is needed to answer questions such as whether expectations about the magnitude and retention time of speech gains should be altered for the modified approaches, whether the schedule advantages are negated by increased planning and homework time, and so forth. Despite such questions, Spielman et al. concluded, "There is a clear need for more and varied ways to administer LSVT®, or any other efficacious treatment, so the greatest number

1 One subject was lost to follow-up after the immediate post-treatment data collection reducing the total N from 11 to 10.

2 Note that Wohlert also included dB for maximum sustained /a/ as an outcome measure. However, the instructions used differed from those in the LSVT literature.

of people can benefit from speech-language pathology services'' (p. 104). Toward that goal, Ramig and colleagues have been exploring supplements to LSVT® such as a ''virtual therapist'' and a personal digital assistant device to provide feedback regarding SPL (cited in Spielman et al., 2007). Still others have been exploring use of web-based audio-video provision of LSVT services with promising results (e.g., Howell, Tripoliti, & Pring, 2009; Tindall, Huebner, Stemple, & Kleinert, 2008), with clinical trials still needed.

1.2. Loud-focused group voice therapy

One approach to help alleviate SLP caseload and scheduling concerns that has been used in other areas of the communication disorders field is group intervention. Group treatment has been utilized for a broad range of communication deficits (e.g., Elman & Bernstein-Ellis, 1999; Goldblum, Mulder, & von Gruenewaldt, 2001; Williams & Dugan, 2002) including three reports for individuals with PD (de Angelis et al., 1997; Robertson & Thomson, 1984; Sullivan, Brune, & Beukelman, 1996). Robertson and Thomson (1984) enrolled 12 individuals with PD in an intensive group treatment done over the course of 2 weeks. Therapy focused on respiration, vocal production (including loudness and pitch variation), articulation, rate of speech, variation of intonation, and overall speech intelligibility. Although the authors did not report details, they indicated that there were improvements in respiration, phonation, articulation, prosody, swallowing, facial expressiveness, and overall speech intelligibility that were maintained for up to 3 months.

In another group voice therapy study, de Angelis et al. (1997) focused on increasing loudness in 20 individuals with PD. Participants were divided into groups of five and each group completed 13 therapy sessions in 1 month. All subjects had increased vocal intensity immediately after completing the course of treatment, as well as a decrease in perceived monotonous speech and strain-strangled voice quality. Additionally, all participants self-reported that others could understand them better post-treatment, suggesting an improvement in speech intelligibility or audibility. No long-term follow-up was reported. Finally, Sullivan et al. (1996) focused on increased loudness and breath support in a group treatment approach with 6 individuals with PD. Five of six subjects had improved speech intelligibility as well as loudness, pitch variability and voice quality, with gains maintained for up to 10 months.

Although not necessarily the sole focus, increased loudness was addressed in each of the three studies of voice groups for individuals with PD. None attempted to closely parallel LSVT® in terms of the singular focus on loudness or the treatment stimuli and tasks used. If a group approach to improving voice loudness in PD is to be considered in the future, significantly more needs to be done to determine the wisdom of the approach, particularly in light of the strong outcome data that is available for LSVT®. More stringent outcome studies could be pursued for the group approach, but unfortunately, there is insufficient detail in the three prior studies to allow replication of the work. Perhaps more importantly though, is that if group intervention is to be tried, it makes intuitive sense to model it after LSVT® to the extent possible given the success of that intervention. For individuals with PD, the group approach may have appeal because: (1) access to therapy may increase, (2) therapy cost might be reduced for the participants, and (3) the group setting could allow significant opportunities for practicing the trained voice behaviors in relatively natural communication exchanges with peers, perhaps facilitating generalization.

1.3. Study purpose

The current study had two purposes. The first was to demonstrate the feasibility of executing LSVT® treatment tasks in a group format. A description of the group tasks and format, and assessment of the execution from the perspective of the participants with PD and the clinicians leading the group was deemed prudent early in this line of investigation in order to help refine a program that can then be scrutinized in subsequent work regarding efficacy, cost/benefit relative to the standard of care, and so forth. We also report preliminary pre-to-post treatment outcomes for individuals with PD immediately after they complete the group program. Outcomes were tracked in terms of voice SPL, perceptual ratings of loudness, acoustic measures, and voice-related quality of life. These data are not considered as confirming or refuting the value of the group approach, but rather as an early indicator to further encourage or discourage commitment of resources for completing rigorous outcome studies.

2. Method

2.1. Participants

Fifteen individuals with PD volunteered for this study. Individual participant information regarding gender, age, time since diagnosis, and medications is provided in Table 1. All participants signed a written consent form before initiating participation in the study which was approved by the Human Subjects Committee at the University of Kansas Medical Center. Participants were not paid.

Inclusion criteria were: >18 years of age (by nature of PD all were above age 40), diagnosis of PD by a board certified neurologist, physically and cognitively able to participate in weekly 90-min voice group sessions, ability to understand standard American English in order to follow directions within the group, and optimal pharmacological management of

Table 1. Participant characteristics.

Subject	Sex	Age	Years since diagnosis	PD medications[1]	UPDRS speech rating[2]	SLP speech rating[3]
1	M	83	16	c	3	5
2	M	66	13	a, b	2	7
3	F	71	11	c, d	2	6
4	M	75	15	b	1	9
5	M	82	8	c	1	8
6	F	82	29	a	2	6
7	F	79	1	a	1	7
8	M	65	14	b	2	6
9	F	83	9	a, c	2	6
10	M	56	6	c	1	9
11	M	44	7	c	1	9
12	M	64	3	a, d	2	6
13	F	64	2	c, d	1	8
14	F	71	6	a, c	1	8
15	M	71	15	d	1	9
Summary	M = 9 F = 6	Mean: 70.4 SD: 11.1	Mean: 10.3 SD: 7.1		Mean: 1.5 SD: 0.6	Mean: 7.3 SD: 1.4

1. a = Requip, b = levodopa, c = Sinemet, d = amantidine
2. UPDRS scaling 0 = normal, 1 = mild, 2 = mod, 3 = severe, 4 = unintelligible
3. Provided by the treating therapist; 10 = normal, 0 = does not vocalize; as printed in Yorkston, Miller and Strand (1995)

PD symptoms as determined by the patient's neurologist. Exclusion criteria were: comorbid diagnoses that could contribute to speech or communication deficits (e.g., stroke, Alzheimer's disease, significant respiratory disease), prior surgery that may have altered speech production (e.g., resections of facial structures, tongue, pharynx, larynx, or lungs, cardiothoracic surgery with known damage to the recurrent laryngeal nerve, etc.), significant hearing loss that was not currently managed with hearing aids, prior completion of individual LSVT® or other speech therapy focused on loudness, and neurosurgical procedures to address PD symptoms (e.g., deep brain stimulation, pallidotomy, etc.).

Based on information from the history form, this was a relatively healthy group of middle age and older adults. A range of other medical conditions besides PD were reported including: acid reflux (40%), high blood pressure (33%), high cholesterol (33%), osteoporosis (20%), diabetes (13%), and prostate cancer (13%). In terms of motor and cognitive function, participants reported as follows: tremor (67%), problems with legs/walking (60%), low energy level (53%), balance problems (40%), dyskinesia (40%), memory loss (40%). In terms of speech and voice, 12 of 15 reported that they now have a softer voice (80%) and 13 of 15 (87%) reported talking less than they used to. Additional voice and speech related reporting was as follows: asked to repeat regularly (87%), slurring (67%), hoarse or breathy voice (53%), voice fatigue (47%), decreased pitch (47%), monotone (40%), stuttering (13%), and nasal sounding (7%).

2.2. Description of the voice group

The voice group was designed to mimic LSVT® as much as possible in terms of the treatment focus, therapy activities, reinforcement, and instructions, but the frequency of treatment, duration of sessions, and amount of homework were altered. The group of 15 individuals with PD met for a 90-min session once a week for 8 consecutive weeks resulting in 720 therapy minutes (compared to 960 therapy minutes [16 sessions × 60 min] in LSVT®). Each week, participants were given ''homework'' activities that were to be completed on a daily basis (described below). Participants were required to keep a log of homework completion each day.

An LSVT®-certified SLP led the group with two graduate students. The SLP had over 15 years of experience treating speech and voice complaints of individuals with neurological disorders and routinely saw individuals with PD on a weekly basis for individual evaluation and therapy. The two graduate students had a course in voice disorders and in dysarthria; they underwent a 3-h orientation to the group treatment led by the LSVT-certified therapist. The group met in a conference room at an outpatient medical building. Participants sat around a U-shaped conference table and they generally were oriented in their chair so that they faced toward the front of the room where the clinicians stood. A large dry-erase board as well as a drop-down screen for LCD projection were also at the front of the room.

At the opening session, and then regularly throughout all sessions, participants were instructed that increasing loudness was the focus of the group. Each session began with voice warm-up exercises as described in the LSVT® training and literature. These consisted of sustained vowel productions with increased loudness and effort modeled and then prompted by the clinician (15 repetitions as a group). In the first session, the clinician called upon each participant in turn to produce sustained vowels until the clinician had identified the target loudness and effort level for each individual. At the start of subsequent sessions, each participant also was required to produce his or her target loud voice ''ah''; if needed, the clinician prompted louder voice to help establish the therapeutic target. During the 15 group repetitions of ''ah'' using the louder voice, the SLP and graduate clinicians watched participants and wandered the room to help identify whether individuals were using a loud voice during this choral responding. Warm-ups also included upward and downward pitch glides at the increased effort and loudness level. Again, individual responding was elicited to help judge

individual participant performance and to help individuals feel and hear their target loudness. As a group, the participants then repeated the ''high'' pitch sustained vowel 15 times and the ''low'' pitch sustained vowel 15 times. Finally, the warm-ups included repetition of 20 phrases/sentences. Rather than having each individual generate their own individualized list of phrases as is done in LSVT®, the 20 stimuli were common social phrases/responses that the clinician generated. This allowed coral responding from the group at the phrase/sentence level during warm-ups. These 20 stimuli were kept constant across sessions. To facilitate this portion of the warm-up, the phrases were projected onto the screen at the front of the room in large font for the group to see. The warm-ups took approximately 30–40 min (longer in the initial sessions when establishing individual target loudness levels).

Following the warm-up exercises, three to five activities that lasted 10–15 min each were completed during each therapy session. Activities were constructed and sequenced in a manner that required longer and more complex responses as the therapy progressed within and across sessions. For the first 2 weeks, the activities focused at the word/phrase level. Examples of activities included reading recipes, poetry with short lines, and classified ads as suggested in LSVT® training. Stimuli were projected onto the screen and choral responding from the group was used for 75% of responding; the other 25% consisted of either individual responding (clinician singling out one person, usually to see if they were still performing at the target loudness level) or small group responding (e.g., ''this half of the table say it … now the other half!''). The third through fifth weeks had activities with longer responses required (choral reading was the primary activity). The final 3 weeks consisted primarily of more spontaneous and conversational activities such as describing hobbies, favorite travels, family stories, etc. For these tasks, individual responding within the group setting was used (and naturalistic feedback from the clinicians as well as group participants occurred) as was subdividing participants into diads (or triads) within the room to increase the opportunities for responding.

Throughout the activities, the clinicians modeled a louder voice and verbally reinforced and encouraged the participants' use of a louder voice. The clinicians also frequently identified when a group or individual response was not produced at the target loudness level. In such cases, the clinician requested an individual to repeat the response until the target loudness and effort level were attained. A brief ''re-energizer'' activity was interspersed throughout the sessions, usually after each activity, but occasionally an activity was interrupted by the clinician who prompted the ''re-energizer'' if, as a group, they were not using sufficient loudness. The re-energizer activity consisted of saying 5–10 loud ''ahs'' as is done during warm-ups. Upon completion of all of the activities, a final energizer activity (15 loud ''ahs'' and 20 sentences) was completed to end the treatment session.

The therapy activities targeted functional application for participants and, as with LSVT®, the focus was on maximizing the quantity and duration of participant responses while maintaining the high effort and loudness. Reminders about completing homework were given at the end of each session and a new daily log for keeping track of homework completed was handed out. Homework was not optional and the clinician made it clear that completing the homework was an essential part of the therapy program. The homework activities were intended to provide additional practice using the louder/more effortful voice. The homework was expected to take approximately 30–45 min to complete each day (split into two intervals) and participants were required to log the total minutes of actual practice completed each day other than on the group therapy day on which they completed a 20–30-min practice at home later that day. The first half to three quarters of the homework time was spent doing the warm-up activities (sustained vowels, hi vowels, low vowels, social phrases). The remaining time involved activities that paralleled the face-to-face group work that was completed that week (e.g., reading recipes, short poems, etc.). An outline for practice was provided, including any printed stimuli that they would need.

2.3. Participant feedback

Within 3 days after the last group therapy session, participants were given a paper pencil questionnaire to gather their feedback on the group and their perception of their own voice and speech changes that may have occurred. The questionnaire asked whether voice or speech changes have occurred (if so, what were the changes), if others had commented about voice/speech changes (if so, what types of comments), are they asked to repeat (if so, is it more, less or the same as before the intervention), if they talk more/less since completing the intervention, overall was the program effective, what was the main focus of the intervention, and what did they not like about the intervention.

2.4. Speech-language pathologist and graduate student feedback

The LSVT-certified SLP and both graduate students maintained field notes throughout the 8-week intervention time period. Immediately following each group they independently wrote down their own reflections on the group session that was just completed with specific instruction to note what was difficult and what worked well for that day. Following the completion of the 8th session, a meeting was arranged between the three clinicians and the PI. During this group meeting, each clinician did the following: (1) provided a verbal recounting of their overall impressions of strengths, weaknesses, difficulties and other observations from the group, and (2) read their weekly field notes for the group to hear. The intent of both of these was to potentially stimulate further thoughts and discussion and to determine whether there was group consensus on points that were being raised. The PI had copies of all the field notes during the meeting and took additional notes as discussion was carried out.

2.5. Preliminary outcomes: data collection and measures

All subjects participated in pre-group therapy data collection that involved gathering history, voice recordings, and participant self-ratings of the degree of voice handicap. This data collection was done within the week prior to the start of the voice group. Details of the data collection are offered below. Participants then completed the 8-week voice group. Posttreatment data collection paralleled the pre-treatment protocol (minus the history questionnaire). This post-treatment data collection was done within 3 days of the last group treatment session. Participants also completed the post-study questionnaire to gather feedback on the group and possible changes to voice and communication. At a later date, pre- and post-therapy voice recordings were played to listeners in a paired comparison task to evaluate whether there were perceptible changes in loudness.

2.5.1. History

Each participant completed a history form that assessed demographics, medical history, and speech and communication history. Family members or research personnel were allowed to help the participant complete the form as needed.

2.5.2. Participant report of voice handicap

The *Voice Handicap Index (VHI)* was completed by the individual with PD to gauge the impact of their voice and communication on daily living and quality of life. Family members or research personnel were allowed to assist in the completion of the form as needed if checking off scale items was problematic, but the ratings were from the subject. For this study, the VHI Total score was calculated for analysis (scores could range from 0 to 120 with lower scores reflecting less handicap related to the voice).

2.5.3. Voice recordings for sound pressure level and acoustic measurement

Voice recordings were obtained by placing a Shure SM 100 headset microphone on the participant and routing the microphone signal to a portable CD-recorder (Marantz CDR300). The microphone was positioned 8 cm away from the corner of the mouth (windscreen foam in place; microphone at 45° angle from the midline of the face); this distance was confirmed at each recording using a ruler. Just prior to completing the voice recording, the headset microphone was calibrated using a sound level meter and calibration tone following the equipment arrangement described by Winholtz and Titze (1997) for SPL calibration of a headset microphone. For the calibration, the participant was seated in a chair in a quiet room with sound treated walls. A 200 Hz calibration tone was generated using Cool Edit Pro v1.2 and played through a small portable speaker held as close to the mouth as possible (just under the chin). A Galaxy Audio CM-140 sound level meter was positioned with its microphone 30 cm away from the mouth and portable speaker. The intensity of the calibration tone played through the speaker was adjusted to read 65 dB by the sound level meter at 30 cm while recording a 4-s sample of the tone with the Shure microphone and CD-recorder. The gain on the CD recorder was held constant for the subsequent speech sample recording. In this manner, the intensity of the speech samples was referenced to the dB of the calibration tone as measured by the sound level meter at 30 cm. This calibration procedure was repeated for each subject prior to the speech recording done following completion of the 8-week group program.

The speech recording included: (1) reading of the *Grandfather Passage*, (2) 30-s monologue, (3) maximum phonation time (MPT) on sustained/a/(3 trials), (4) 5-s sustained/a/at highest pitch (3 trials), and (5) 5-s sustained/a/at lowest pitch (3 trials). The recorded sample was analyzed using the Intensity subroutine of PRAAT (v5.2.05, 4 December 2010) for the mean dB SPL from the *Grandfather Passage* (first paragraph) and the monologue (10 s from the middle of the 30-s sample). Using PRAAT's intensity subroutine, the mean dB of the calibration tone was measured (recall that this calibration tone was set to register 65 dB on a sound level meter placed 30 cm from the calibration tone generator during the recording procedure for each subject). A conversion factor was calculated that related the dB value as measured in PRAAT to the known dB of the tone from the sound level meter during the recording. This conversion factor was applied to the subsequent dB values derived from PRAAT for that particular speaker. *PRAAT* was also used to obtain the following measures using the Pitch subroutine: (1) mean F0 from the *Grandfather Passage* and the monologue, (2) standard deviation of F0 (F0 *SD*) from the *Grandfather Passage* and the monologue, (3) maximum F0 from sustained/a/(mean of 3 trials), and (4) minimum F0 from sustained/a/(mean of 3 trials). MPT was measured using cursor placements at the start and stop of each MPT trial in *PRAAT* (mean of 3 trials).

2.5.4. Listener ratings of loudness

The listeners for this study were 10 female volunteers between the ages of 22 and 26 years. The listeners were graduate students in speech-language pathology with limited to no exposure to individuals with PD (most had either had a class in phonation disorders or had some limited clinical or personal exposure to individuals with PD). All listeners passed a hearing screening on the day of the listening experiment.

For the listening experiment, audio editing software (Cool Edit Pro v.1.2) was used to extract the second sentence of the *Grandfather Passage* and a 10-s sample of the monologue (from the middle of the 30-s monologue) for each speaker. The extracted segments were saved as individual wave files. PRAAT allows normalization of intensity between two audio files via the 'Scale Intensity' script. For this normalization, the calibration tone that was recorded onto the pre- and the post-recordings, respectively, for a given subject were bracketed in PRAAT and the Scale Intensity script was executed to normalize the two wav files (always normalized to the more intense calibration tone). The listening experiment was completed in two blocks: one for the sentence reading and one for the monologue clip. *Alvin* experiment-control

software was utilized to construct and run the perceptual experiment. The experiment was a forced-choice task in which a listener heard a pair of wave files from a given speaker (pre and post treatment); the listener then had to indicate via a mouse click which of the audio samples in a pair was louder. Each block of the listening experiment (reading and monologue) included both pre-post and post-pre ordering of wave files for all speakers so that intra-listener agreement could be evaluated. The order of speaker presentation within a block was randomized by the software; the order of block presentation was randomized for each listener. Both listening blocks were completed back-to-back on the same day.

The listening experiment was carried out one listener at a time in a quiet room. The listener was seated in front of a laptop computer with high quality external speakers. Before running the listening experiment, the listener heard a few samples of voices that were not part of the experimental set but were of varied loudness levels similar to those of the experimental set. Listeners adjusted the computer speaker volume so that they could hear all the examples. The computer speaker loudness level could not be adjusted once the actual perceptual experiment was initiated. Listeners were not informed that the speakers they were about to hear had PD.

For data analysis purposes, if 8 of 10 listeners (80%) identified a given speakers as louder post-treatment, that speaker was classified as being perceived as louder after the intervention. This 80% criterion was set somewhat arbitrarily but it ensured that a sizeable majority was needed in order for us to categorize a subject as louder. Intra-listener agreement was assessed by evaluating within listener agreements for the choice of the louder sample when played ''pre-post'' versus ''post-pre''.

2.6. Statistical considerations

The participant, SLP and graduate student feedback was reviewed by the PI and two other investigators. Reporting of this information is done descriptively as a reporting of common themes, trends and representative statements from the paper pencil surveys, field notes, and group discussion.

For the preliminary outcome data, mean voice dB, Fo mean and Fo *SD* were each evaluated using three separate 2 × 2 ANOVAs for repeated measures. The factors in the ANOVAs were Time (pre vs. post) and Task (reading vs. monologue). A series of *t*-tests for related measures were used to evaluate the pre- and post-treatment changes in VHI Total score, MPT, Fo maximum, Fo minimum, and Fo range. Given the number of statistical procedures being calculated, a more conservative alpha level of 0.01 was used to determine statistical significance for the ANOVA and *t*-tests. For the perceptual listening experiment, a χ^2 goodness-of-fit test was used to evaluate whether a significant difference existed between the observed listener responses and expected listener responses. The null hypothesis tested in the χ^2 test was that the post-intervention clip would be judged louder than the pre-intervention clip 50% of the time (i.e., 0.5 expected frequency, or chance level). Separate χ^2 tests were calculated for the Grandfather passage and for the monologue responses.

Within listener agreement for decisions about which sample was louder for a subject, either the pre- or the post-treatment, was calculated as the percentage of time that a given listener's decisions on the pre-post and the post-pre order of stimulus presentation agreed. For the reading passage there were 150 possible decisions (10 listeners × 15 participants) and 132 were in agreement (88%). For the monologue samples, there was agreement on 141 of 150 decisions (94%). These high percent agreement rates suggested that listeners were consistent in the loudness decision they made.

2.7. Results

2.7.1. Participant feedback about the group

Table 2 provides a summary of the participants' response to the post-study questionnaire. Overall, these were positive comments with all but two subjects indicating they felt their voice and speech had improved. They were asked to indicate in what way their speech or voice had improved. Some offered more than one comment to this open ended question therefore the percentages in Table 2 exceed 100%. The majority of responses were related to loudness (speaking louder, knowing or remembering to be louder more often, more aware of loudness). A second item asked if others had commented on changes to the subject's voice or speech. Two-thirds of the group reported they had received such comments and the majority of these related to use of a louder voice or being able to hear the subject better. Sixty percent reported having to repeat less often than before the intervention. When asked what they do to be understood, nearly three quarters responded that they used a louder voice. Of the 15 subjects 9 stated that they talk more now than they did before the group. All of the participants identified the focus of the group to be on increasing loudness although some reported more than one focus on this open ended question (e.g., extending the voice range, speaking more clearly, etc.). Finally, when asked what they did not like about the group, 11 of them either did not respond or indicated that they liked everything. There was not a common answer among the four who identified something that they did not like.

2.7.2. Clinician feedback about the group

Table 3 provides a summary of the issues that were raised by the SLP and the two graduate students who led the group. The table includes comments or issues that were identified by at least two of the three clinicians in their field notes or in the post-study discussion group with the PI. There were a core set of issues that were independently raised by all three leaders in their written logs and, based on the discussion, were considered to be of most importance. On the negative side, these included: (1) difficulty paying attention to all participants during choral responding; (2) suspicion that some participants might be 'mouthing' responses some times, but not sure enough to offer firm feedback to an individual

Table 2. Participant feedback about the voice group.

Item	Summary	Comments
Voice/speech improved post-intervention?	Yes – 87% No – 13%	• Speak louder now – 47% • More aware of my loudness – 20% • Can be louder/remember to be louder more often – 33% • More confident when talking – 7% • Voice lasts longer – 7% • Don't have to push so hard to be loud – 7% • Sound less whispery – 7% • Use more expression in my voice – 7% • Decreased mumbling – 7%
Have others commented on changes to voice or speech?	Yes – 67% No – 33%	• Louder now/can hear me better – 53% • Easier to understand – 27% • Better on the telephone – 13% • Voice is better/sound good – 13%
Asked to repeat less often than before the group?	Yes – 60% No – 40%	–
What do you do to be understood?	–	• Use a loud voice – 73% • Repeat with a louder voice – 20% • Slow down – 13% • Speak more clearly/annunciate – 13% • Take a breath – 13% • Concentrate harder – 7% • Use more expression – 7%
Talk more now than before the group?	Yes – 60% No – 40%	–
What was the focus of the group?	–	• Talk louder – 100% • Speak more clearly – 40% • Extend the voice range – 7% • Use more expression – 7% • Increase lung capacity – 7% • Raise awareness of voice loudness – 7% • Open your mouth more – 7% • Strengthen speech – 7%
What did you not like about the group?	–	• Nothing/liked everything – 73% • Sentences were tiring – 7% • The loud 'ahs' – 7%' • Too far to drive – 7% • It wore me out – 7%

(tended to err on the side of providing the feedback in such cases); and (3) too much non-speaking time for individual participants when doing group activities. On the positive side, the unanimous comments revolved around the following issues: (1) comfortable judging group loudness during most choral responding activities (but see #2 in the list of unanimous negatives above); (2) dyads worked well for practicing louder voice and these situations were easy for clinicians to judge individual performance; (3) camaraderie among group members with frequent spontaneous positive reinforcement among group members.

2.7.3. Preliminary outcome measures

Table 3. Speech-language pathologist and graduate student clinician feedback about the group.

Weaknesses and negatives	Strengths and positives
• Lead clinician cannot pay attention to all subjects on all responses; having one more person present was needed	• Sustained vowels, mid-to-high and mid-to-low pitch vowels easily done as group activity
• Harder to judge individual 'effort' that was being put into the production some of the time	• Able to do up to full sentence responding (~12–15 syllables) as a group when projecting on screen
• Worried that at times someone was just mouthing the response during choral activity	• Most of the time felt they could accurately judge effort and loudness level in choral responding
• Difficult to work at conversational level as a group; response rate dropped significantly in these tasks	• Participants were competitive with one another and pushed each other to be loud
• Unable to monitor all conversations done in dyads at the same time so could have missed some off-target responses	• Dyads forced relatively natural feedback from a peer about how loud a person was being
• Not always sure that members were completing the homework (or at least not completing it accurately)	• Distractions and conversation noise in the room forced individuals to concentrate and to increase loudness
• Some parings of subjects seemed to work better than others (referencing amount of responses by individuals in conversational tasks)	• Several chances in each session for spontaneous productions/interactions among group members; gave a chance to look for carryover outside of specific therapy tasks
• Subjects can look away from the clinician – cannot tell if they are participating fully	• Psychosocial benefits expressed by some group members; camaraderie among participants

Table 4. Vocal intensity means (dB) and standard deviations (SD) by time and speech task.

		Pre	Post	Combined
Reading	Mean	65.22	70.91	68.07
	SD	3.64	3.70	3.66
Monologue	Mean	62.01	68.28	65.15
	SD	2.16	3.64	3.01
Combined	Mean	63.62	69.60	66.61
	SD	3.48	4.35	3.81

Table 5. Time × Task ANOVA results for vocal intensity (dB), fundamental frequency (F0) mean and standard deviation (SD).

		F	*p*	Partial eta-squared
dB	Time	27.281	**0.000**	0.245
	Task	2.522	0.024	0.071
	Time × Task	0.267	0.581	0.006
F0 mean	Time	2.247	0.036	0.048
	Task	1.094	0.655	0.019
	Time × Task	0.754	0.701	0.008
F0 SD	Time	1.516	0.286	0.029
	Task	0.941	0.339	0.010
	Time × Task	0.841	0.768	0.005

Bold values indicate statistically significant using an alpha level of 0.01.

Table 6. Acoustic analysis result for fundamental frequency (F0) maximum, minimum, range, and maximum phonation time (MPT).

	Pre	Post	*t*	*p*
F0 Maximum	238	281	3.118	**0.007**
F0 Minimum	129	148	2.071	0.092
F0 Range	108	133	2.84	**0.006**
MPT	10.8	15.3	5.022	**0.003**

Bold values indicate statistically significant using an alpha level of 0.01.

2.7.3.1. Vocal Intensity. Means and standard deviations for vocal intensity (dB) during reading and monologue are presented in Table 4. The Time × Task ANOVA resulted in a statistically significant main effect of Time (see Table 5 for ANOVA results). Inspection of the mean dB values for tasks combined indicated that intensity was significantly higher post-treatment (70.91 dB) compared to pre-treatment (65.22 dB). The 5.69 dB change represented an 8% increase from the pre-treatment dB level. The main effect of Task also was statistically significant. The reading condition had a dB value that was 2.9 dB higher than the monologue. The interaction effect of task and time was not statistically significant. The partial eta^2 values were used as a measure of effect size; as shown in Table 5 all of the partial eta^2 values were relatively small (Time main effect accounted for ~25% of the variance, and task ~7% of the variance), despite the statistical significance of the two main effects.

2.7.3.2. Additional acoustic measures. The Time × Task ANOVAs for F0 mean in the reading and the monologues resulted in non-significant main and interaction effects (Table 5). The F0 *SD* ANOVA also resulted in statistically non-significant main and interaction effects (Table 5).

Means, *t* values and probabilities for the remaining acoustic measures are presented in Table 6. F0 maximum on sustained/a/did increase significantly ($p = 0.007$) from 238 Hz pre- to 281 Hz post-group intervention (~18% increase from the pre-intervention value). F0 minimum did not change significantly post-intervention. The F0 range that was calculated from a person's maximum and minimum values did increase post intervention from 108 Hz to 133 Hz. This 23% increase from pre-intervention was statistically significant ($p = 0.006$). Finally, MPT increased from a mean of 10.8 s to 15.3 s. This 4.5 s increase (42% over the pre-intervention value) was statistically significant ($p < 0.003$).

2.7.3.3. VHI Total score. VHI Total score pre-treatment was 50.40 (*SD*: 22.49). Post-treatment the score dropped to 35.80 (*SD*: 20.79). This 29% reduction in the *VHI* Total score indicated an improvement in the extent of the impact of voice for the participants (i.e., less negative impact from the voice). The paired *t*-test resulted in a value of 6.71 with $p = 0.004$ ($df = 14$). Looking at the individual participants, 13 of 15 (87%) had a reduction in voice handicap that ranged from 8 to 47 points (mean = 17).

2.7.3.4. Listener perception of vocal loudness. For the reading passages, listeners identified the post-treatment reading as louder than the pre-treatment for 12 of 15 participants (80%). The calculated χ^2 value of 6.22 ($df = 1$) had a probability of occurrence of 0.007 allowing rejection of the null hypothesis that the post-treatment samples would be judged as

louder than the pre-treatment samples 50% of the time.

For the monologue samples, listeners identified the post-treatment productions as louder for 13 of 15 participants (87%). The calculated χ^2 value of 7.96 (*df* = 1) had a probability of occurrence of 0.009 allowing rejection of the null hypothesis that the post-treatment samples would be judged as louder than the pre-treatment samples 50% of the time.

2.7.4. Secondary analysis: correlation of home practice minutes to dB and VHI changes

Although not part of the original focus of this study, feedback from some participants during the 8-week intervention suggested that the total home practice time varied across subjects. The homework minutes are an important part of the LSVT® program. They also were considered an essential part of the 8-week intervention, perhaps even more so than in the individual therapy given that the 8-week intervention includes fewer therapy minutes which are accumulated in a less intense therapy schedule.

Homework logs were available allowing tracking of practice minutes at home. These were summed for each subject and then correlated with the magnitude of the dB change and the magnitude of the VHI score change, respectively. The average home practice minutes was 2038 for the 8 weeks (*SD*: 262 min) which translated into 255 min per week (4 h, 15 min) or 36 min a day on average. Across subjects, home practice minutes ranged from 1475 to 2314 (or 26 min/day up to 41 min/ day). *Pearson correlation coefficients* relating total minutes of home practice to changes in dB and VHI score were, 0.622 ($p > 0.000$) and 0.735 ($p > 0.000$), respectively.

3. Discussion

3.1. Delivery of services in a group format

The primary purpose of this study was to demonstrate the feasibility of delivering loud-focused group voice therapy to individuals with PD. The intent in developing the group treatment was to have it mirror LSVT® to the extent possible. Overall, the feedback from the clinicians about the design of the group and ability to execute the loud-voice tasks was positive. Clinicians indicated that the warm-up activities were the part of LSVT® that was most amenable to the group format. These were structured responses, done in drill like fashion, and one clinician could lead the group through this activity. The warmups took 30–40 min which is comparable to LSVT®, representing ~40% of the total session time (proportionally the warmups took slightly less than what would occur in LSVT® where these warm-ups take about half of the session). It was also possible to devise activities for choral responding at the word, phrase, and sentence level. Projection of stimuli to a large screen served as a useful way to provide the stimuli to the group; this was preferred over paper copies of stimuli to read from because it kept the participants looking in a common direction with their head up. This made it relatively easy for the lead clinician to scan the room to help determine who was or was not participating and to get a sense of the effort that individuals were putting into the task. Obtaining conversational responses at a high response rate was less easily accomplished compared to doing LSVT®. In general, activities that required spontaneous answering (e.g., describe a favorite hobby) cannot be done chorally, so individual responding was elicited. However, in the group format, this reduces the response rate for any one individual within the session. This difficulty was anticipated, and was one of the reasons for using a longer session time (90 min) in an attempt to increase the absolute number of responses from a given individual knowing that there would be more non-talk time in the session during some activities.

Clinicians reported that they generally were able to track participation level in group activities and they were fairly confident in judging the loudness and effort level from individuals, even when much of the responding was done in unison. However, on more than one occasion they did note uncertainty about whether specific subjects were participating with a voice at the target loudness level. Additionally, it is not known from this study how accurate the clinician's perceptions of effort and loudness level for an individual truly were in the group setting. This will be of importance to determine given that one of the tenets of LSVT® is that participants practice using the high effort, louder voice at a high response rate (Ramig, Countryman, O'Brien, Hoehn, & Thompson, 1996).

The clinicians indicated that they liked using requests for individual responding or sub-group responding as a means for more carefully assessing loudness and effort level by individuals. Other positives about the group approach reported by the clinicians included: (1) a sense of competitiveness among participants regarding loudness level that appeared to encourage high effort and loud voice responding, (2) natural feedback from peers about an individual's loudness in the latter weeks when working at the spontaneous/conversational level (e.g., ''what did she say?'' ''I couldn't hear you down here!''), (3) a rather noisy and distracting room environment with many people in it that may have mimicked more natural environments and prompted louder responding during group tasks, and (4) many opportunities for the clinicians to observe spontaneous communication of participants with each other before, during and after the sessions. This last item provided the chance not just to observe but to give feedback and instruction to participants during or after natural communication exchanges with peers which might lend support to generalization of behaviors. Maintaining a singular focus on increased effort and loudness in the group setting was not identified by the clinicians as difficult.

Although psychosocial support was not the focus of this group, several participants offered anecdotal comments suggesting they derived such support from the group. Some indicated that friendships had emerged; many commented about the 'energy-level' during sessions that carried over into their day; still others noted that it was good to be around people dealing with similar issues. Psychosocial benefits are often reported for group interventions even if the group itself

is not specifically designed to address psychosocial issues (Elman & Bernstein-Ellis, 1999; Williams & Dugan, 2002).

There were some challenges in delivering loud-focused therapy in a group in addition to those alluded to above. One difficulty noted briefly above was the possibility that a group participant might not use the targeted effort and loudness level during warm-ups or other choral responding. The clinicians expressed confidence in making this judgment most of the time. Presumably they based their decision on how the participant looked during the task and possibly based on instances when the person was called upon to respond individually. However, during group responding, it is possible that some merely looked like they were responding at the target level without actually generating the loud voice. Repeated practice using the high effort, loud voice is a primary focus of LSVT® (Ramig, Countryman, O'Brien, Hoehn, & Thompson, 1996; Spielman et al., 2007). In an individual setting the SLP could know this fairly quickly and easily based either on perceptions of loudness or sound level meter readings. The investigators are currently testing a vocal monitor device that uses a throat microphone to measure an individual's vocal intensity that is unaffected by ambient noise. Using such a device, it will be possible to track a participant's vocal performance along with a clinician's assessment of that performance to gauge accuracy of the clinical judgment.

A second difficulty was devising group tasks that elicited a high response rate from the participants. For the warm-ups, as well as the lower hierarchy tasks in which group reading could be utilized (phrases, sentences), this was not difficult. However, when moving toward responses that were more spontaneous and conversational, group responding was not possible. There may not be an acceptable answer for this problem other than to move to individual responding. Breaking the larger group into dyads or triads for conversational practice was one strategy used here, but even that may not allow for a high enough response rate. More careful tracking of the actual number of responses from each participant during therapy activities also will be of interest in future investigations of the group work to see how this compares to response rates in individual LSVT®.

There were two primary differences regarding homework completed for the group participants compared to what occurs in LSVT®. The first difference was that the previous week's homework was not reviewed individually with participants at the start of each session. A few minutes were spent at the start of each group session to gather homework and to inquire about any difficulties/issues that arose in completing the work. The reason for not reviewing the homework in more detail was simply to conserve the face-to-face time in the group for actual voice production work. A potential pitfall to skipping the more detailed homework review each week is that some individuals could be completing the work inaccurately or not hitting the therapeutic loudness target. This might prove critical in determining the extent to which voice changes actually happen as a function of whatever intervention is attempted (individual or group, 4 weeks or 8 weeks, etc.).

A second homework-related difference was that the minimum number of daily homework minutes, and the total minutes of homework over the course of treatment, were substantially greater for the group intervention compared to LSVT®. In LSVT®, patients are asked to complete homework for 20–30 min a day on non-treatment days (divided between two sittings) and 5–10 min once on treatment days (Ramig, Countryman, O'Brien, Hoehn, & Thompson, 1996, 2001; Trail et al., 2005). This results in a minimum of 320 min and a maximum of 520 min of homework over the course of 4 weeks (or 5–8.6 h). In contrast, during the group intervention, subjects completed homework for 30–45 min on non-treatment days and 20–30 min on treatment days. This resulted in a minimum of 1600 min and a maximum of 2400 min of practice over 8 weeks (26.6–40 h). The group intervention was twice as long as individual LSVT®, substantially increasing the clinician's time required to prepare homework materials. However, all subjects completed the same exercise materials, i.e., these lessons were not individualized for each participant. If the intervention ultimately proves effective without individualized homework, then clinician preparation for homework is essentially a one-time activity and would not need to be redone with each group that is convened. At least as designed in this investigation, homework review time was negligible in that only a few minutes were spent with the group in general review of the completed homework.

There was a substantial time commitment required of participants to complete homework. Based on the homework logs, this was a dedicated group, who by self-report met or exceeded the minimum daily homework minutes requested of them. The participants knew that they were participating in a research program. They also were a group of individuals with PD who were fairly early in the disease process, at least as far as speech and voice were concerned. These factors likely promoted a high level of dedication and ability to complete a rather heavy home-practice regimen. The treating clinicians also placed heavy emphasis to the group on doing daily practice at the prescribed number of minutes. It may be unreasonable to expect such a high level of commitment from other groups of individuals with PD. However, in light of the less intense face-to-face treatment schedule and a reduction in total treatment hours, a greater amount of practice outside of therapy was built into the program and heavily emphasized by the lead clinician when addressing the group each week.

3.2. Pre- to post-treatment changes in voice

A second purpose of this study was to report pre-to-post treatment changes as measured immediately after completing the 8-week intervention. Vocal intensity was increased at the post-treatment recording suggesting that the training may have had the desired intent, although generalization and retention of the dB gain have yet to be demonstrated as has been done with individual LSVT® (Ramig, Countryman, O'Brien, Hoehn, & Thompson, 1996; Ramig et al., 2001). Vocal intensity was increased by ~6 dB which is consistent with three other studies of group voice therapy for individuals with PD (de Angelis et al., 1997; Robertson & Thomson, 1984; Sullivan et al., 1996). Somewhat greater increases in intensity (8–14 dB) have been reported for those who complete LSVT® (Ramig et al., 2001; Ramig & Dromey, 1996). The

LSVT® treatment program follows a more intense schedule of therapy and has a greater total number of treatment sessions and minutes than what was completed in the current study. It may be that the reduction in treatment frequency and treatment minutes are important factors that influence the dB change that occurs.

One of the principal reasons cited by the LSVT® developers for its success is the intensity of the treatment schedule. Spielman et al. (2007) modified the LSVT® therapy schedule and reported an 8 dB increase at the end of the 6-week treatment. The authors interpreted these findings as support for the notion that the LSVT® treatment dose could potentially be altered and still result in a dB increase. The group therapy regimen described in the current study could be considered an even greater reduction in the intensity of traditional LSVT®. Future studies that specifically assess group treatment dosage will be needed to establish the relationship between group treatment frequency/intensity and outcome measures such as dB. Accounting for home practice minutes might also be an important consideration in these future studies as they are considered integral to LSVT® and were found to be strongly correlated with magnitude of dB change in the current group intervention approach.

The dB increases in this study were noted in a standard reading passage and a prompted monologue. There was no attempt to document the participant's dB in more spontaneous situations, either in the clinic or at the participant's home. As such, it cannot be definitively stated that the dB increase was used or maintained outside of the clinic or the recording situation. However, based on both written and verbal feedback from participants and their significant others, there were subjective reports of louder voice use in functional situations from participants. On the post-treatment questionnaire, 87% reported they felt their voice was improved and 67% reported that others had commented on voice improvement. The majority of specific comments regarding improvement focused on louder voice. Additionally, family members verbally recounted situations or stories to the SLP suggesting that at least some participants had incorporated a louder voice into their daily life. For example, the daughter of one participant described several situations in the home setting where the individual with PD used a loud enough voice that it could be heard throughout the house. Another reported that a nursing home employee commented on her voice and how ''understandable'' her speech was.

Listener ratings of increased loudness following the group therapy were consistent with the dB data. Eighty-seven percent of participants were judged to be louder post-treatment. This, along with the dB change, suggests that participants had been trained to increase vocal effort and loudness within the group intervention. The correlation of the homework minutes with the magnitude of the dB gain also is suggestive of a therapeutic effect, but more stringent evaluation of outcomes in studies paralleling what has been done for LSVT (i.e., randomization, alternative or no-treatment comparisons, etc.) is needed. Again, generalization outside of therapy and retention over time will also need to be assessed.

Although increasing voice loudness was the focus of the intervention, prior studies have documented changes to other aspects of voice and speech for individuals completing LSVT®. The same occurred for the set of other acoustic measures included in the present study with significant increases in maximum F0 and F0 range on sustained vowel production as well as an increase in MPT. These changes are not surprising considering that the warm-up exercises and daily homework consisted in large measure of sustained vowel productions, all at increased effort and loudness, and some also at higher and lower pitches. It would seem that this repeated and prolonged practice at the task resulted in a measureable change. However, the mean F0 and standard deviation of F0 did not change for the reading passage or monologue. This is in contrast to earlier studies of LSVT® that did report such changes (Ramig, Countryman, O'Brien, Hoehn, & Thompson, 1996; Ramig et al., 2001). The lack of a statistical difference in the present study for mean F0 may be a function of the small *N* (and therefore limited power); if the less conservative alpha level of 0.05 were specified, the main effect of time for mean F0 would have been considered statistically significant. However, it might also be that the 8-week group program may simply not have provoked as large a change in F0 mean and *SD* as occurs in LSVT®. Many hours of homework time were spent on louder voice and completing the warm-up exercises, but much of that time focused on sustained vowel productions rather than paragraph reading or monologue. Additionally, during the weekly meetings, the most challenging activity to devise and execute within the group setting were those at the conversational speech level. A redesign of activities at this level of the treatment hierarchy may be necessary. Or perhaps other program designs should be considered (e.g., group work up to the time when conversational speech is reached in the treatment hierarchy, shifting to individual work at that point).

The extent to which participants perceived a voice handicap did improve following the group intervention as indicated by a statistically significant reduction in the total *VHI* score. The 29% reduction in the score is comparable to findings from Spielman et al. (2007) who reported a 25% decrease for a group of individuals with PD who completed an extended version of LSVT®. The *VHI* does not reflect specifically on the targeted voice behavior, namely increased vocal effort and loudness, but rather on a more global perception of the individual regarding the extent to which the voice impacts them internally or in their daily functioning. As such, the change in scores post group intervention suggests that the 8-week program may have had a broader impact on the participants.

Based on the participant feedback, they were able to readily discern that the focus of the group was on increasing vocal loudness. Their responses on the post-study questionnaire appear to be generally positive both toward the program itself and as a reflection of perceived benefit. The majority indicated that they had to repeat less often and they were talking more than before the intervention. A significant portion also had received comments from others about perceived improvement in voice. This participant feedback is congruent with the VHI scores suggesting less negative impact on the person's life related to voice issues.

3.3. Conclusions and limitations

Participant and clinician feedback regarding the group intervention suggested that it may be feasible to execute loud-focused therapy tasks with individuals with PD, although not all of the activities used in LSVT® translate well into the group situation. In trying to imitate LSVT® activities as closely as possible, the warm-up exercises as well as some tasks involving single words, short phrases, and sentences may be doable as a group activity although even here there are still challenges to address including: can clinicians accurately determine if an individual is performing at their target loudness level during choral responding? Is the participant response rate during choral activities comparable to what occurs in LSVT®? With what frequency and duration does the group need to meet to achieve the loudness goal?, etc. Additionally, there are some aspects of LSVT® that do not appear amenable to group activities. This was noted as therapy attempted to incorporate more conversational, less rote, speech activities.

There are several limitations to this study relative to the pre- to post-group measures. This study was principally intended as a proof-of-concept study, not a treatment efficacy study. Because of the study design limitations, the pre-to-post changes that are reported must be regarded cautiously. Some of these limitations include the following:

1. No attempt to establish stability of the voice measures at the pre- and the post-intervention stages. It is possible that the differences reported here from pre- to post- could have been a function of natural day-to-day variability in performance in the individuals with PD. Future studies should incorporate multiple recordings in the week before starting the group and multiple recordings at each time period of interest after intervention is complete to first determine whether the measures are stable at each time epoch.
2. No alternative intervention or no-intervention arm of the study was included here, and therefore no randomization of subjects into different groups.
3. Limited number of subjects which disallows the possibility of looking at subject factors that might be influential on participation in the group as well as outcomes (e.g., PD disease severity; participants depression status, speech characteristics, etc.).
4. No attempt yet to determine whether any voice changes following the group work are maintained beyond the immediate post-treatment period of 3 days. Future work to track retention of these immediate gains is needed. Such studies will need to follow a stringent treatment-outcome design that addresses the limitations noted in this feasibility study.
5. Limited understanding of clinician-related behaviors and variables that might impact running of the group and/or outcomes. For example, it will be important to assess the extent to which the treating clinician is able to track and give feedback on-line regarding an individual participant's loudness during group activities, particularly those that involve choral responding. Such ability would seem essential for maximizing the impact of the loud-focused group treatment; without appropriate encouragement, re-instruction and feedback during the high effort/increased loudness activities, it would seem unreasonable to expect behaviors to change toward the target in a timely manner, if at all.
6. The issue of home practice and its influence on the outcomes of the group treatment are deserving of further attention. There was a strong correlation noted in the present study between minutes of home practice and changes in dB and VHI scores. Identifying the most efficient way to structure the home practice and track its completion may be an important avenue for making the group approach a viable alternative to individual LSVT®.

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Appendix A. Continuing education

1. Extending the Lee Silverman Voice Treatment (LSVT®) beyond the usual 4 weeks with a less frequent therapy visits (as done by Spielman et al., 2007) has been attempted in the past with the following outcome(s):
   a. Significant increases in voice sound pressure level immediately after treatment and 6 months later.
   b. No significant change in voice sound pressure level but significant improvements in voice handicap scores.
   c. No significant change in voice sound pressure level, voice handicap score or listener ratings of voice.
   d. Significant increases in voice sound pressure level immediately after treatment, but a return to pre-therapy levels at 6 months post treatment.
2. Group voice therapy for individuals with Parkinson's disease has been attempted in three prior studies with the following general outcomes:
   a. Overall improvements in voice (including loudness) that were maintained for 24 months or more.
   b. No improvements in voice at any time period after therapy ended.
   c. The majority of participants demonstrated improvements in voice (including loudness and/or intensity) at least immediately after the therapy ended.
   d. Improvements in other aspects of voice such as pitch range and quality, but no change in loudness.
3. In the current study, the voice intensity results indicated the following:

a. No significant change immediately following the completion of the voice group program.
b. Greater than a 5 dB increase that was statistically significant.
c. A dB increase that was comparable to what has been reported for (LSVT®).
d. A statistically significant dB increase for the monologue task but not the reading task.

4. In the current study, the voice handicap ratings from the participants indicated the following:
a. No significant reduction in the extent of the perceived voice handicap following the group therapy.
b. A significant reduction in the perceived voice handicap that was twice that reported in studies of LSVT®.
c. A slight worsening of the perceived voice handicap following the group therapy.
d. A significant reduction in the perceived voice handicap that was approximately what has been reported in studies of LSVT®.
5. The amount of homework time reported by the participants was:
a. Not significantly correlated with the magnitude of the change in voice dB or change in VHI score.
b. Significantly positively correlated with the magnitude of the change in voice dB or change in VHI score.
c. Significantly negatively correlated with the magnitude of the change in voice dB or change in VHI score.
d. Significantly positively correlated with the magnitude of the change in voice dB, but not significantly correlated with the change in VHI score.

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