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The Effects of the "SPEAK OUT! ®" and "LOUD Crowd®" Voice Programs for Parkinson Disease

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Abstract

Individuals with Parkinson's disease (PD) experience difficulties in various motor functions due to decreased amplitude and sensory guidance. Speech production is a motoric behavior, and difficulties with oral communication are often seen in these patients. The communication problems are primarily due to decreased airflow from the lungs, incomplete vocal fold vibration, and an insufficient range of motion and coordination of the speech articulators. Current behavioral management methods for communication difficulties with PD typically address the reduced vocal intensity in "one-on-one" voice therapy sessions. The present study investigated the effects of a set of voice remediation programs for PD that includes individual and group therapy components, namely, the SPEAK OUT!® and LOUD Crowd® programs. Objective measurements of vocal intensity and perceptual measurements of the patients' ratings of the voice were recorded during the pre- and post-voice treatment phases. Statistically significant improvements were identified in both objective and perceptual measurements.

Keywords: Parkinson disease, PD, voice therapy, group therapy, quality of life

1. Background

Parkinson disease is a chronic progressive neurodegenerative disorder caused by significant loss of dopaminergic neurons insubstantia nigra of the midbrain. It affects over 1 million patients in the United States (Olanow, Stem, & Sethi, 2009). The disease typically begins in the 5th or 6th decade of life and is associated with increased frequency with aging, although young onset PD before the age of 40 years is also well reported. The cardinal features that help with diagnosis include bradykinesia, rigidity, resting tremor and postural instability; the latter more so with advancing disease. The presentation of PD is not just limited to motor symptoms. Non-motor symptoms of PD are often poorly recognized and contribute to reduced quality of life and early nursing home placement (Chaudhuri, Healy, & Schapira, 2006). These include loss of smell, autonomic dysfunction (constipation, urinary problems, orthostatic hypotension), sleep disturbances and mood and cognitive disorders. (Seppi, Weintraub, Coelho, Perez-Lloret, Fox, Katzenschlager, Hametner, Poewe, Rascol, Goetz, &Sampaio, 2011; WHO, 2014). Disruption of speech in PD affects almost 90% of patients over the course of the illness and can be a very disabling symptom. (Duffy 2013). Commonly known as hypokinetic dysarthria, this is characterized by reduced pitch and loudness. (Spielman, Mahler, Halpern, Gilley, Klepitskaya, & Ramig, 2011). PD also affects the movements and coordination required for oral communication. Early studies by Logemann and colleagues with 200 individuals with PD found that 87% of the participants presented with laryngeal dysfunction (Logemann, Fisher, Boshes, &Blonsky, 1978).

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The dysfunction is generally characterized by substantially reduced loudness, a breathy voice, a monotone pitch, reduced articulator movements, and intermittent and/or rapid speech (Boone, McFarlane, Von Berg, &Zraick, 2013). Treatments for PD typically target motor symptoms with pharmacological and surgical therapies (deep brain stimulation or DBS) along with non-pharmacological ancillary therapies. Oral communication issues with PD are mainly addressed with behavioral management. To improve motor functions to carry on oral communication, one needs to have adequate respiratory support to produce the air pressure necessary for the vocal folds to vibrate. The vocal folds need to adduct to vibrate properly to produce voice. Then, the speech articulators make the movements necessary for different speech sounds with timing coordinated to produce clear and intelligible utterances. To date, a variety of attempts have been made to improve one or more parts of speech/voice production. Amongst these methods, the successful outcome of the Lee Silverman Voice Treatment (LSVT®) has been extensively studied. The LSVT® emphasizes vocal loudness. It is designed to provide four intensive "one-on-one" therapy sessions per week for four weeks. The SPEAK OUT!® program addresses vocal intensity of the individuals with PD in a different way (Parkinson Voice Project, 2015). Developed by Elandary and colleagues in 2010, the SPEAK OUT!® program emphasizes speaking "with intent" in an attempt to activate a direct pathway of the brain called the pyramidal system (Duffy, 2013), which is generally intact in individuals with PD. In its standard format, the program is designed to provide 12 intensive one-on-one therapy sessions over four weeks. An American Speech-Language-Hearing Association (ASHA)-certified speech-language pathologist (CCC-SLP) guides each session in accordance with the uniquely designed workbook. After completing the SPEAK OUT!® program, each participant becomes a member of the LOUD Crowd®. The LOUD Crowd® is a group therapy program that provides weekly voice therapy sessions to continue utilizing the members' improved voices in both structured and unstructured settings without a specified ending point.

Traunmuller (1994) explained that speech signals have four characteristics including phonetic, transmittal, affective, and personal. Human communication is not limited to the functional message exchanges, but it also contributes to the quality of personal life with affective and personal concerns. The synergistic combination of the individual and group therapy may contribute to the patient's quality of life perception, and it may correlate to the physiological improvements of the vocal intensity. The prevalence of PD is noticeably higher with advanced age (Pringsheim, Jette, Frolkis, &Steeves, 2014). With the limited physical mobility and retirement from active lives, elderly individuals with PD tend to have limited conversational opportunities. Many LOUD Crowd® participants and their families have attested to the value of continuous group therapy in both functional and social concerns. To date, only one research report has been published about the SPEAK OUT!® (Levitt, 2014); it involved six participants. The present research study was intended to further investigate the effects of the SPEAK OUT!® and LOUD Crowd® programs to examine whether they are viable options for addressing the oral communication issues with PD. The long-term goal underlying the present study is to search for additional options of the evidence-based voice therapy programs for individuals with PD that also contribute to the improvement of quality of life.

2. Method

2.1 Participants

The present study called for participants between 60 and 80 years of age to control other disabilities that potentially arise with aging beyond 80 years of age, as described by Jacobsen, Kent, Lee & Mather (2011). Twelve native speakers of General American English (GAE) with PD participated in the study (Mage = 72.2, SD=5.92, age range: 65-80 years), including four females and eight males. The onset of PD occurred within five years from the initial meeting with each participant (see Table 1). The participants were recruited through the office of the Parkinson Voice Project clinic (PVP) in Richardson, Texas. All participants were free of the medications that address symptoms with PD for at least 12 hours prior to the recording of the voice samples in order to rule out the potential effects of medications described by Sidtis, Rogers, Godier, Tagliati, and Sidtis (2010).

Table 1: Participants

	Age	Onset of PD
M1	78	2007
M2	65	2009
M3	70	2010
M4	78	2009
M5	65	2011
M6	78	2012
M7	74	2010
M8	80	2013
F1	77	2013
F2	67	2008
F3	65	2011
F4	69	2010
Mean	72	2010
SD	5.92	

2.2 Data Collection and Instrumentations

Participants' data were collected at four intervals during the 12-week study period, including (Time 1) pre-treatment baseline, (Time 2) at the completion of the 12 one-on-one SPEAK OUT!® voice therapy sessions over four weeks, (Time 3) after attending four of the LOUD Crowd® group voice therapy sessions, and (Time 4) after attending eight of the LOUD Crowd® group voice therapy sessions (see Figure 1). Although the participants could not strictly follow the schedule due to various health conditions, effort was made to keep the data collection dates as close as possible to the schedule defined on the research protocol. Data collection took place at a quiet room in the Parkinson Voice Project clinic in Richardson, Texas. Following Sapir and colleagues, participants were encouraged to participate in the data collection at approximately same time of the day for all four sessions (Sapir, Spielman, Ramig & Fox, 2007). For the voice recordings, a digital audio recorder (Marantz PMD660) was used with a condenser microphone placed 30 cm from each participant's mouth. The microphone was calibrated using a 70 dB SPL white noise as a calibration signal with 30 cm distance from the signal generator. The PRAAT (v.5.0.11) acoustic analysis software program was used to organize and to analyze voice data. Audacity (v.2.0.5) was used for data recording.

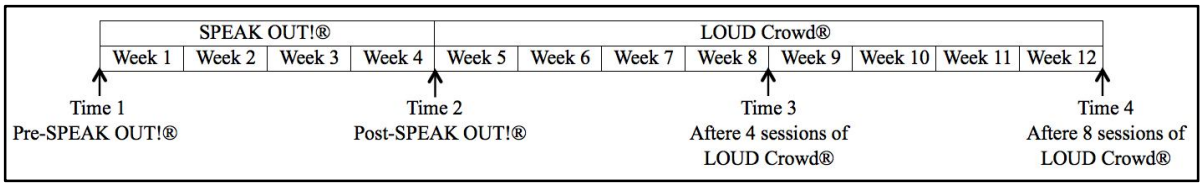

Figure 1: Data Collection Schedule. Four Sessions for Each Participant during a 12-Week Research Period

The present study quantified the effects of the voice therapy by objective measurements of the vocal intensity of the participants' voices, and by perceptual measurements of the participants' ratings of their voices and their effects on their lives. The vocal intensity was measured in units of dB SPL during the voice production of seven different materials as described on Table 2. To measure the changes in participants' perception of their voice productions, Voice-Related Quality of Life (V-RQOL) was used (Hogikyan & Sethuraman, 1999). To avoid systematic bias due to the order effect, the order of the data collection was randomized for each participant in accordance with Jadad, Moore, Carroll, Jenkinson, Reynolds, Gavaghan, &McQuay (1996).

2.3 Materials

2.3.1 Voice Recordings

The tasks for the voice recordings were (1) /a/ gliding phonation from the lowest to the highest pitch level, (2) sustained corner vowels phonation (for six seconds) of /a/, /i/, and /u/, and (3) production of three sentences used in the acoustic analysis of individuals with PD by Sapir et al., (2007).

Each of the three sentences includes one of the corner vowels (see Table 2). Each participant recorded six repetitions of these tasks. The test subjects were prompted to say the vowel or sentences at comfortable pitch and loudness levels for the above-mentioned items (2) and (3), and with comfortable loudness for item (1). One of the investigators counted six seconds and used a hand gesture to cue when to start and stop the sustained vowel phonation. Participants were frequently prompted to take a sip of water during the voice recordings to prevent dehydration.

Table 2: Voice Recording Materials

Type of production	Materials
Frequency range	/a/ Gliding phonation (lowest to the highest pitch level)
Sustained vowel phonation	/a/ /i/ /u/
Sentences	"Buy Bobby a puppy." Extracted /a/ from "Bobby" "Blue spot is on the key again." Extracted /i/ from "key" "Potato stew is in the pot." Extracted /u/ from "stew"

2.3.2 Voice-Related Quality of Life (V-RQOL)

Participants responded to the ten V-RQOL questions (see Table 3) orally. The five rating scales of the V-RQOL(Hogikyan & Sethuraman, 1999) were explained to the participants, and a sheet with the descriptions of the answering options described by Hogikyan and Sethuraman (1999) (see below) was presented to each participant.

1 = None, not a problem
2 = A small amount
3 = A moderate (medium) problem
4 = A lot
5 = Problem is "as bad as it can be"

Each participant provided his/her rating for the V-RQOL questions as one of the investigators read each question. After the participant finished answering the ten questions, the investigator read each question for the second time to verify the participant's responses.

Table 3: V-RQOL Questions

(Hogikyan & Sethuraman, 1999)

P1	I have trouble speaking loudly or being heard in noisy situations.
P2	I run out of air and need to take frequent breaths when talking.
P3	I sometimes do not know what will come out when I begin speaking.
S4	I am sometimes anxious or frustrated (because of my voice).
S5	I sometimes get depressed (because of my voice).
P6	I have trouble using the telephone (because of my voice).
P7	I have trouble doing my job or practicing my profession (because of my voice).
S8	I avoid going out socially (because of my voice).
P9	I have to repeat myself to be understood.
S1	I have become less outgoing (because of my voice).

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*Note: The item starts with "P" measures physiological domain, and those that begin with "S" measure social-emotional domain.

3. Results

The collected data over four sessions with each participant were organized for the data analyses of vocal intensity and for the computation of the V-RQOL physiological and social indices. The Wavesurfer (v.1.8.8p4) software program was used to segment the recorded voice data. To measure the vocal intensity, a linear predictive coding (LPC)-based algorithm encoded in the PRAAT (v.5.0.11) acoustic analysis software was used with the Burg method (Kay, 1988; Marple, 1987).

3.1 Vocal Intensity

Table 4 shows the changes in vocal intensity over time in seven types of productions of three corner vowels (/a/, /i/, and /u/). The vocal intensity increased with all three vowels with sustained phonation and in the produced sentences. The comparable vocal intensity increase was confirmed during the gliding /a/ phonation over Time 1 to Time 2.

Table 4: Vocal Intensity Changes Over Time (Unit: dB SPL)

Type of production		Time 1	Time 2	Time 3	Time 4
/a/ glide-up	*M*	65.40	83.37	84.90	84.25
	SD	4.84	7.09	5.99	7.03
Sustained /a/	*M*	62.15	81.21	83.24	82.51
	SD	4.19	8.07	6.10	8.93
Sustained /i/	*M*	62.40	76.94	78.44	78.28
	SD	4.77	5.89	5.80	7.37
Sustained /u/	*M*	64.55	79.05	80.72	79.38
	SD	4.37	4.84	6.73	7.11
/a/ from "Buy Bobby a puppy."	*M*	64.36	84.32	84.01	83.54
	SD	5.35	6.18	5.38	7.08
/i/ from "Blue spot is on the key again."	*M*	63.32	77.36	77.84	76.99
	SD	4.77	6.19	4.85	8.20
/u/ from "Potato stew is in the pot."	*M*	65.56	82.02	81.72	80.52
	SD	5.82	6.59	5.59	7.80

Statistical analyses were conducted using IBM SPSS Statistics 19 (v. 19.0.0.2). An analysis of Variance (ANOVA) with repeated measures with Greenhouse-Geisser corrections revealed that the change of the vocal intensity over time was significant [$F(3,33)=43.3$, $p<0.001$]. A set of tests of within-subject contrast analyses identified a statistically significant difference in vocal intensity between Time 1 versus Times 2, 3, and 4 ($p<0.001$), suggesting that the vocal intensity significantly increased from the pre-therapy baseline phase (Time 1) to the completion phase of the 12 one-on-one SPEAK OUT!® voice therapy sessions (Time 2), and the improvement was maintained over the LOUD Crowd® group voice therapy sessions for eight weeks (Times 3 and 4).

3.2 Voice Related Quality of Life (V-RQOL)

The V-RQOL includes six questions in the physiological functioning domain and four questions in the social-emotional domain. The scores from the participants' responses were totaled separately, and the indices in these two domains were computed in accordance with the procedures described by Hogikyan and Sethuraman (1999).The improvements in the V-RQOL scores were obtained in both physiological and social-emotional aspects (see Table 5). An ANOVA with repeated measures with a Greenhouse-Geisser correction revealed that the change of the scores over time was significant [$F(1.5, 16.9)=2128.5$, $p<0.01$]. A series of tests of within-subject contrast analysis revealed that a statistically significant difference between Time 1 versus Times 2, 3, and 4 (Time 1 vs. Time 2: $p<0.05$; Time 1 vs. Time 3 and Time 1 vs. Time 4: $p<0.01$).

Table 5: Vocal-Related Quality of Life (V-RQOL) Changes Over Time (Unit: V-RQOL index)

Type of production		Time 1	Time 2	Time 3	Time 4
Social-emotional scores	*M*	79.69	90.36	92.19	92.19
	SD	15.63	12.03	10.70	12.25
Physiological scores	*M*	72.05	85.42	86.61	88.37
	SD	14.98	15.62	10.12	11.29
Total scores	*M*	75.10	87.40	88.81	89.90
	SD	14.12	13.54	9.44	11.44

3.3 Additional Analyses

Several additional data analyses were conducted to validate the results. First, the effects of the sex differences were explored. When adding sex as a between-subjects factor to both voice and V-RQOL data, the results revealed no significant main effects or interactions with sex. The results suggest that sex differences did not affect the analyses for the vocal intensity or V-RQOL data. Second, nonparametric Friedman's tests were conducted to address potential effects of the small sample size. The results of the Friedman's tests identified the main effect of time for each of the vocal intensity measurements of the seven types of voice production and two types of the V-RQOL measures. These results suggest that for each of the nine measurement items, there was a significant change across time. Lastly, correlation coefficient analyses were conducted using nonparametric Spearman's *rho* for all seven vocal intensity variables with the two V-RQOL variables (physiological and social-emotional domains) at each time point. At Time 1, there were no significant relationships between V-RQOL and any of the seven types of voice production. At Time 2, significantly positive relationships were identified between the V-RQOL scores in the physiological domain and the vocal intensity measurements of all seven types. At Time 2, another significantly positive relationship was identified between the V-RQOL scores in the social-emotional domain and thesustained phonation of /a/. At Time 3, the V-RQOL scores in the physiological domain appeared to have a significantly positive relationship with the glide up /a/ phonation and sustained vowel phonations of /a/, and /u/. The V-RQOL scores in the social-emotional domain showed a significantly positive relationship with the three sustained vowel phonations of /a/, /i/, and /u/. At Time 4, the V-RQOL scores in the physiological domain demonstrated a significantly positive relationship with the glide up /a/ phonation and sustained vowel phonation of /a/, whereas the V-RQOL scores in the social-emotional domain were significantly positively related to the glide up /a/, sustained /a/ and /u/ productions.

4. Discussion

The data collected with 12 individuals with PD in the present study suggest that the SPEAK OUT!® and LOUD Crowd®voice therapy programs are effective in (1) increasing the vocal intensity in sustained phonation and in sentence reading, measured in units of dB SPL, (2) improving the patients' perception of their voices' functioning as measured by V-RQOL. The results of the correlations coefficient analyses of the four data points suggest that the improvements of the vocal intensity highly correlate to the participants' perception of their voice-related physiological and social-emotional functioning throughout their lives. Taken together, the results of the present study complied with the previous case study findings the effects of the SPEAK OUT!® program(Levitt, 2014) vocal intensity and the participant-rated perceptions of their voices. With respect to the vocal intensity, the improvements were observed in all seven types of voice production. The greater gain in vocal intensity was obtained with /a/ than /u/ and /i/. The production of /u/ showed a greater gain than that of /i/. The identical order of the effects was present in both sustained vowel phonation and in the vowels extracted from the sentence productions. Ladefoged and Johnson (2011) explained the sonority of speech sound, which is defined as different levels of inherent loudness of speech sounds relative to other sounds. Ladefoged and Johnson's figure shows the sonority of these three vowels in the order of /a/, /u/, and /i/ (Ladefoged& Jonson, 2011).The same order of the sonority was identified in the present study. The results of the present study need to be further examined in terms of the other quality aspects of the voice, such as the changes in the harmonic-to-noise ratio and formant 1 and 2 figures over time. It is also important to examine the double-blinded clinician's perceptual ratings about the changes in participants' voices. If the results of the further data analyses comply with the findings of the present study and future studies replicate the present results with greater numbers of participants and with control groups, they will provide important information about the synergistic effects of the individual and group voice treatment methods for individuals with PD.

5. Future Directions

For the future, a larger scale study with a greater number of participants would be ideal. The use of a control group, however, needs to be carefully evaluated with this particular population. Swallowing difficulties are rather common with PD. Because of the reduction of movements and coordination, food often drops into the airway rather than completely moving into the esophagus. Food in the airway commonly causes aspiration pneumonia, which can be life-threatening to individuals with PD. The most important function of the larynx is airway protection. Proper closure of the vocal folds protects the airway during swallowing, and it also enables necessary adduction of the two vocal folds for vibration during voicing. Speech and swallowing mechanisms share many of the intra-oral and pharyngeal structures that provide proper sensory information and motor control for their functions.

A pilot study of a voice treatment for PD, namely LSVT®, has reported potential benefit of voice therapy for swallowing safety (Sharkawi, Ramig, Logemann, Pauloski, Rademaker, Smith, Pawlas, Baum, & Werner, 2002). Knowing the potential benefit of voice therapy on swallowing safety, it seems unethical to blindly assign some individuals with PD to a control group without therapy. In contrast, the longer span of longitudinal study far beyond eight-week post one-on-one therapy is essential. With degenerative course of the disease, individuals with PD continue losing dopamine-producing neurons over time. It is important to investigate whether continuation of voice therapy could contribute for PD patients to maintain functional communication. It is also important to find out the optimal level of daily practice and/or weekly group therapy to maintain functional communication. Despite debilitating disease progression that restricts PD patients' mobility, they could stay connected with community if they can carry on functional communication, which may contribute to improve their quality of life.

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