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Changes in Vocal Loudness Following Intensive Voice Treatment (LSVT®) in Individuals With Parkinson's Disease: A Comparison with Untreated Patients and Normal Age-Matched Controls

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Abstract: This study assessed the impact of the Lee Silverman Voice Treatment (LSVT®) on vocal loudness [sound pressure level (SPL)] in a group of dysarthric individuals with idiopathic Parkinson's disease (IPD). Pre- to post-treatment changes in SPL in the treated group were compared with changes in voice SPL during the same time in two control groups: individuals with IPD not treated with the LSVT® and in non-disordered individuals, age-matched to the patients. All subjects produced the same voice and speech tasks—sustaining vowel phonation, reading the "Rainbow Passage," producing a short monologue, and describing a picture. These tasks were recorded at three different occasions: just prior to treatment, just after treatment, and 6 months following treatment. The individuals treated with LSVT® increased voice SPL from baseline to post-treatment by an average of 8 dB and from baseline to 6 months follow-up by an average of 6 dB. These changes were statistically significant and perceptibly audible. No significant changes in SPL were observed in the control groups during the time corresponding to the treatment and follow-up. Differences in SPL between the treated and untreated patients at post-treatment and follow-up were statistically significant for all voice and speech tasks. These findings, along with others, provide additional support for the efficacy of the LSVT®.

Key words: LSVT®; Parkinson's disease; speech therapy; vocal loudness; dysarthria. Mov. Disord. 16:79–83, 2001.

Over one million Americans suffer from Parkinson's disease (PD). Many have voice and speech abnormalities as a result of their PD; some of these abnormalities are significant enough to impair communicative ability and quality of life[1–5] in these individuals. They have been named collectively *hypokinetic dysarthria* and have been characterized by reduced loudness (hypophonia), reduced pitch inflection (hypoprosodia), reduced range of articulatory motions (hypokinetic articulation), short rushes of speech, and stuttering.[1,6,7] Medication and traditional speech therapy methods have been ineffective in treating these voice and speech abnormalities.[6,8–12]

Ramig and her colleagues[13–16] have developed an intensive speech therapy program known as the Lee Silverman Voice Treatment, or LSVT®. This treatment is designed to overcome or compensate for some of these abnormalities. This program emphasizes high-effort loud phonation to improve respiratory, laryngeal, and articulatory functions during speech. Unlike previous attempts at speech treatment,[8–12] the LSVT® has been shown to have positive and long-term effects in individuals with PD.[15,17] Specifically, physiologic, acoustic, perceptual, and clinical studies have shown that individuals with idiopathic PD treated with LSVT® improve vocal fold adduction and vibratory motions, voice loudness, sound

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pressure level (SPL), voice quality, pitch inflection, and speech intelligibility.[14–16,18–21] Improvement in swallowing has also been reported following LSVT®.[22] The LSVT® has also shown promising results in the treatment of dysarthria associated with other neurologic disorders, such as cerebellar ataxia and multiple sclerosis.[23,24]

To assess the efficacy of the LSVT® it is important to establish that any measure of treatment outcome is treatment-specific and not secondary to extraneous factors such as placebo and Hawthorn effects or improvement associated with repeated testing (e.g., familiarity with test material, test procedures and the experimenter, test practice, etc.). One way to rule out these extraneous factors is to compare the LSVT® with an alternative treatment method. Such a method should be nearly identical to the LSVT® in its therapy schedule, structure and intensity, but different in the main focus of treatment. Recently, the LSVT® was compared to an alternative treatment method that emphasized high *respiratory* effort, in contrast to the LSVT®, which emphasizes high *respiratory-phonatory* effort. The main difference between the two treatment methods is the focus of the LSVT® on improving laryngeal function (specifically, vocal fold adduction and activation and coordination of laryngeal muscles). Research findings[15–17] clearly demonstrate the superiority of the LSVT® over the alternative treatment program, although the latter also yields improvement in voice and speech in some patients.[16] The significantly greater improvement with the LSVT® method argues against placebo or Hawthorn effects as the main causes for the treatment outcome. The fact that improvement nevertheless occurs with both treatment methods raises the possibility that some of the improvement may be secondary to normal fluctuations in the severity of the symptoms or repeated testing and familiarity with the testing procedures and environment.

The purpose of the present study was to test for these possibilities by comparing changes in SPL in patients treated with LSVT®, in untreated patients with Parkinson's disease, and in neurologically normal age-matched controls during the same period from pre-treatment to 6 months follow-up. We reasoned that if the effects seen with the LSVT® can be seen in the untreated patients, then these effects may be related, at least in part, to normal fluctuations in SPL associated with the disease or its medication regimen. If, on the other hand, the fluctuations or changes are seen only in the treated group, then these changes are more likely to be treatment-specific. Furthermore, these effects may be attributed, in part, to familiarity with the test procedures. If the fluctuations or changes in SPL are related to familiarity with test procedures, then all three groups should show a similar pattern of fluctuations or changes in SPL.

MATERIALS AND METHODS

Subjects

Three groups were included. Two groups consisted of individuals with IPD, one (seven males, seven females) receiving LSVT® (henceforth, PD-T), and the other (seven males, eight females) receiving no treatment for voice and speech (PD-NT). A third group (seven males, seven females) consisted of individuals who were neurologically normal (NN) and without voice and speech abnormalities. The mean age for the PD-T, PD-NT, and NN groups was respectively, 67.9 (SD = 9.0), 71.2 (12.71), and 69.8 (6.8), a non-significant difference ($F = 0.3803–1.466$, $P > 0.05$). For the PD-T and PD-NT groups mean time (in years) since diagnosis was, respectively, 8.6 (6.3) and 7.8 (5.2), a non-significant difference ($F = 0.3104$, $P > 0.05$). Severity of speech and voice disorder pretreatment was judged by the attending speech-language pathologist on a scale of 1-5 (1 = mild, 5 = severe). Neither pretreatment severity of speech and voice disorder nor pretreatment SPL levels were significantly different between the two patient groups. The vast majority of the individuals who particpated in both groups were in the moderate range (level 3), though both groups were represented by individuals with all levels (1–5) of speech and voice impairment. Analyses of the results by gender yielded no significant differences ($F = 0.978–2.312$, $P > 0.05$) for any of the SPL measures. Therefore, the data for the males and females in each group were pooled and will be reported without regard to gender.

All subjects with Parkinson's disease were optimally medicated at baseline and were stable on their medication throughout the course of the study as assessed by his/her attending neurologist. All subjects had adequate hearing for daily communication, as reported by the patients and informally observed by the experimenters and clinicians involved in the study. All subjects consented to participate in this study on a voluntary basis and were aware they would be randomly assigned to a treated or untreated group. Patients not assigned to the treatment group were offered treatment 6 months later at the completion of the study. However, all subjects were unaware of the purpose of the study. Treatment was offered to all patients free of charge.

Treatment

The LSVT® is intensive, with a duration of four one-hour sessions per week for four weeks. It emphasizes high effort level and encourages patients to perform at a

maximum effort level throughout every session. The LSVT® maximizes phonatory efficiency by improving vocal fold adduction and overall laryngeal muscle activation and control through the use of high-effort loud phonation.[13,15,16] Special care is taken to increase vocal fold adduction without causing vocal hyper-adduction and strain. Maximum prolongation of "ah" and maximum pitch range (both high and low pitches) tasks are taught. Patients are encouraged to maximize phonatory effort and are given frequent encouragement to "think loud" during sustained phonation tasks, reading, and conversational speaking tasks.[13,15,16] Attention is given to the respiratory system in the form of general reminders for subjects to take deep breaths "to be loud." The respiratory system is indirectly stimulated during all "think loud" speech tasks.

Voice Recording Procedures

The three subject groups were recorded seven times: three times within two weeks prior to the start of treatment for the PD-T group as baseline (henceforth "pre"), twice just after the PD-T group's completion of treatment (henceforth "post"), and twice at 6 months after treatment (henceforth FU6). The recordings *within* each of these major events (i.e., pre, post, and FU6) did not yield statistically different results for any of the groups. Therefore the data within each event were averaged for each individual, and this average was then used for group statistics.

The recordings were obtained in a sound-treated room while the subject was seated in a dental or straight-back chair and performed these tasks: (1) sustaining vowel "ah" phonation for as long as possible for six repetitions, (2) reading the "Rainbow passage,"[25] (3) speaking freely on a self-chosen topic ("monologue"), and (4) describing the "Cookie Theft Picture."[26]

Acoustic analysis.

Sound pressure level (SPL) was calculated for sustained phonation, reading, monologue, and picture description using the continuously hand-recorded peak SPL that was displayed at 1 second intervals from the digital output of the sound level meter. Mean vocal SPL measures derived from hand-recorded second-to-second peak vocal SPL have been reported not to be statistically different from the mean vocal SPL measures derived from a custom-built software program.[16,27]

RESULTS

The mean and standard deviation (in parentheses) of the SPL measures for the three groups and for the different voice and speech tasks are shown in Table 1, along with the results of an analysis of variance with repeated measures design. The results of a one-way analysis of variance comparing between-group differences are shown in Table 2.

As can be seen, the PD-T group showed a significant increase in SPL from baseline ("pre") to post-LSVT® and from baseline to FU6 for each of the voice and speech tasks. Differences between post and FU6 mean SPL were not statistically significant for any of the speech tasks.

TABLE 1. *Mean and standard deviation (in parentheses) of dB SPL (30 cm) during sustained phonation /a/, rainbow passage, monologue, and picture description at pre, post, and 6 months follow-up (FU6) across subject groups: treated (PD-T), untreated (PD-NT), age-matched neurologically normal controls (NN). Pretreatment vs. post-treatment, pretreatment vs. 6 month follow-up treatment and posttreatment vs. 6 months follow-up treatment for each task*

Group and Task	Pre dB spl	Post dB spl	FU6 dB spl	Pre vs. Post Significance		Pre vs. FU6 Significance		Post vs FU6 Significance	
				F =	*P* <	F =	*P* <	F =	*P* <
PD-T									
/a/	69.1 (5.1)	82.4 (3.9)	79.8 (3.7)	60.200	0.001	16.762	0.001	3.050	ns
Rainbow	71.3 (3.2)	77.9 (4.2)	76.1 (3.2)	21.990	0.001	14.435	0.001	1.480	ns
Monologue	69.0 (3.6)	74.5 (4.0)	72.7 (3.6)	14.572	0.001	6.673	0.025	1.498	ns
Picture	68.9 (4.6)	74.4 (4.3)	73.4 (3.7)	10.585	0.005	7.748	0.025	0.355	ns
PD-NT									
/a/	69.3 (4.1)	70.5 (4.4)	70.6 (4.1)	0.408	ns	0.524	ns	0.010	ns
Rainbow	71.6 (3.6)	71.9 (4.1)	71.9 (4.1)	0.053	ns	0.12	ns	0.006	ns
Monologue	69.3 (3.9)	69.4 (3.9)	69.5 (3.2)	0.002	ns	0.047	ns	0.030	ns
Picture	70.4 (4.4)	70.7 (4.1)	70.7 (4.1)	0.019	ns	0.254	ns	0.458	ns
NN									
/a/	73.0 (5.2)	73.5 (5.3)	72.3 (6.1)	0.050	ns	0.096	ns	0.253	ns
Rainbow	73.6 (2.5)	73.8 (2.1)	73.4 (2.5)	0.058	ns	0.036	ns	0.192	ns
Monologue	71.9 (3.5)	72.2 (3.4)	71.5 (3.2)	0.054	ns	0.093	ns	0.288	ns
Picture	72.1 (3.3)	72.4 (2.4)	72.0 (3.1)	0.068	ns	0.001	ns	0.085	ns

ns, not significant.

TABLE 2. *Results of a one-way analysis of variance comparing mean SPL across the three groups at pretreatment, post-treatment, and six month follow-up (FU6) for each of the voice and speech tasks*

Group	Voice and Speech Task							
	/a/ Significance		Rainbow Significance		Monologue Significance		Picture Significance	
	F =	*P* <	F =	*P* <	F =	*P* <	F =	*P* <
Pre								
PD-T vs PD-NT	0.001	ns	0.009	ns	0.022	ns	0.658	ns
PD-T vs NN	3.929	ns	4.391	0.05	4.533	0.05	4.296	0.05
PD-NT vs. NN	4.871	0.05	3.334	ns	3.704	ns	1.481	ns
Post								
PD-T vs PD-NT	59.484	0.001	16.045	0.001	12.547	0.005	6.174	0.025
PD-T vs NN	24.683	0.001	10.283	0.005	2.556	ns	2.304	ns
PD-NT vs. NN	3.257	ns	2.891	ns	4.523	0.05	2.159	ns
FU6								
PD-T vs PD-NT	35.414	0.001	12.146	0.005	5.586	0.05	7.409	0.02
PD-T vs NN	12.126	0.005	4.770	0.05	0.657	ns	0.936	ns
PD-NT vs. NN	0.935	ns	1.900	ns	2.248	ns	3.299	ns

ns, not significant.

The PD-NT and NN groups showed no significant changes in mean SPL from pre to post and from baseline to FU6 for any of the voice and speech tasks.

At *baseline* (pre), there was no significant difference in mean SPL between the PD-T and PD-NT groups for sustained /a/, Rainbow, monologue, and picture description. Mean SPL data across the three groups were compared pre, post, and at FU6 (Table 2). There was a significant difference between the PD-T and NN groups (higher SPL in the NN group) for Rainbow passage, monologue, and picture description, but not for sustained.

At *post-treatment*, there was a significant difference in mean SPL between the PD-T and PD-NT (higher in the PD-T group) for sustained /a/, Rainbow passage, monologue, and picture description. There was a significant difference in mean SPL between the PD-T and NN groups (higher SPL in the PD-T group) for sustained /a/ and Rainbow, but not for monologue and picture description.

At *FU6*, there was a significant difference in mean SPL between the PD-T and PD-NT groups (higher SPL in the PD-T group) for all tasks. There was a significant difference in mean SPL between the PD-T and NN groups (higher SPL in the PD-T group) for sustained /a/ and Rainbow, but not for monologue and picture description.

DISCUSSION

The main findings in this study may be summarized as follows: (1) In general, pre-treatment, individuals with PD had a weaker voice (lower SPL) than that of the normal subjects, especially during the speech tasks; (2) voice SPL in the untreated patients and in the normal subjects did not change significantly throughout the study; (3) patients treated with the LSVT® improved voice SPL significantly, and this improvement was maintained at 6 months follow-up; and (4) the patients' voices following treatment were significantly stronger (had higher SPL) than that of the untreated patients.

The significant increase in SPL following LSVT® and the relatively stable SPL in the untreated patients and in the age-matched controls suggests that the effects of the LSVT® are treatment-specific and not related to extraneous factors such as repeated testing and familiarity with the testing material, experimental setting, or the experimenter.

The improvement in SPL in individuals treated with the LSVT® has been shown to be perceptible, in as much as the speech of these individuals after treatment is judged to be louder and of better quality.[18] The magnitude of these changes is clinically significant in that the changes have previously been associated with improved speech intelligibility, communication, and overall quality of life for the patients and their families.[15,16,21]

The present findings add further evidence to the already large body of acoustic, perceptual, physiologic, and clinical data attesting to the efficacy of the LSVT® in the treatment of voice and speech abnormalities in individuals with PD.[13–21] Recent findings document that the LSVT® improves swallowing in dysarthric individuals with PD.[22] Why the LSVT® produces such positive results is beyond the scope of this study and is addressed elsewhere.[17] Given the positive and long-term effects of LSVT®, physicians and other clinicians should seriously consider referring dysarthric individuals with PD for speech therapy similar to that of the LSVT®.

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