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Effects of a Music Therapy Voice Protocol on Speech Intelligibility, Vocal Acoustic Measures, and Mood of Individuals with Parkinson's Disease

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*This study examined the effects of a Music Therapy Voice Protocol (MTVP) on speech intelligibility, vocal intensity, maximum vocal range, maximum duration of sustained vowel phonation, vocal fundamental frequency, vocal fundamental frequency variability, and mood of individuals with Parkinson's disease. Four female patients, who demonstrated voice and speech problems, served as their own controls and participated in baseline assessment (*study *pretest), a series of MTVP sessions involving vocal and singing exercises, and final evaluation (*study *posttest). In* study *pre and posttests, data for speech intelligibility and all acoustic variables were collected. Statistically significant increases were found in speech intelligibility, as rated by caregivers, and in vocal intensity from* study *pretest to posttest as the results of paired samples* t*-tests. In addition, before and after* each *MTVP* session (session *pre and posttests), self-rated mood scores and selected acoustic variables were collected. No significant differences were found in any of the variables from the* session *pretests to posttests, across the entire treatment period, or their interactions as the results of two-way ANOVAs with repeated measures. Although not significant, the mean of mood scores in* session *posttests (*M *= 8.69) was higher than that in* session *pretests (*M *= 7.93).*

Remediating speech and voice disorders is one of the essential, unsolved problems in the treatment of Parkinson's disease (PD). Although at least 70% of patients with PD manifest speech and voice disorders (Hanson, Gerratt, & Ward, 1984; Ramig & Gould, 1986), pharmacological interventions and traditional speech therapy have not proven consistently effective (Ramig, Bonitati, Lemke, & Horii, 1994). Subsequently, communication debilitation leads to frustration in patients and their family members; patients tend to withdraw from conversations and social activities (Ramig, 1995), which seriously impairs their quality of life.

In an effort to alleviate these communication difficulties, recent speech therapy studies have emphasized intensive treatment with maximum phonatory effort as a new treatment strategy for hypokinetic dysarthria, a speech disorder in PD patients. In 1987 Ramig and her colleague developed an intensive treatment program called the Lee Silverman Voice Treatment for Parkinson's Disease (LSVT) (see Ramig, 1995). Its primary goal was to increase vocal loudness and to decrease breathiness through improving vocal fold adduction. Following a 1-month LSVT treatment, the researchers found statistically significant improvement in maximum duration of sustained vowel phonation, maximum fundamental frequency range, mean fundamental frequency, and fundamental frequency variability, all of which are the acoustic variables associated with vocal production efficacy. Speech articulation also improved, though it was not a direct focus of treatment. Follow-up showed that these positive outcomes were maintained over 6 to 12 months after the termination of treatment (Ramig et al., 1994).

In further study, Smith, Ramig, Dromey, Perez, and Samandari (1995) found that laryngeal measurement supported the effectiveness of the LSVT when they examined posttreatment laryngostroboscopic observation on two voice therapy groups of patients. One group received treatment that focused on phonatory and respiratory effort (VR group) and a second group focused only on respiratory functioning (R group). The VR group showed improved vocal fold adduction, as assessed by videolaryngostroboscopic examination, and increased vocal intensity by 12.5 dB, whereas the R group showed no improvement in vocal fold adduction and decreased vocal intensity by 1.9 dB. These findings showed that physiological changes accompany increased vocal intensity when both phonatory and respiratory efforts are employed in treatment.

Ramig speculated that intensive phonatory efforts enabled PD patients to override bradykinesia and improve vocal and speech performance (Ramig et al., 1994). At the same time, she emphasized that maximum results can be attained only when the patients are continuously motivated or energized to maintain a high level of performance during as much of each therapy session as possible (Ramig, 1995). In this context, singing may be a suitable treatment application in terms of enhancement for intensive phonatory effort along with enjoyable experiences that may lead to continuous motivation.

Singing naturally intensifies various aspects of speech production. For example, singing elicits a louder voice than does speech based on active respiration. Learning how to distribute the breath to sing a musical phrase may help patients develop ways to use their respiratory capacities. Diaphragmatic-intercostal breathing will expand the lower back ribs and will provide sufficient space for the diaphragm to support the tone production (Decker & Kirk, 1995). Singing also can improve intonation because it incorporates pitch variability and range. Practicing songs at desirable tempos also might improve abnormal speech rates. Exaggerating consonants while articulating song lyrics may help improve speech intelligibility (Cohen, 1994).

The requirement for correct posture in singing also is beneficial for speech production of PD patients, who tend to have a stooped posture with bowed head and drooped shoulders. Good posture stabilizes the basic conditions of speech production, such as efficiency of respiration (Brookshire, 1992; Seikel, King, & Drumright, 1997). Further, singing involves facial muscle movements that are much larger than those in speech. People with PD often show mask-like faces because of hypokinesia (Duffy, 1995), and the resulting reduction of lip movements, and lack of facial expressions interfere with effective communication (Ramig and Gould, 1986). Singing may promote active facial movements which contribute to clear articulation as well as nonverbal communication.

In terms of motivation for treatment, singing also may play an important role. Rider, Mickey, Weldin, and Hawkinson (1991) examined the effects of toning, listening, and singing on psychological and physiological responses of 17 musically trained subjects. The results of the Profile of Mood States (POMS) showed that toning and singing groups indicated less depression than did control and listening groups, and all three experimental groups yielded less perception of fatigue than did the control group. When applying these outcomes to rehabilitation settings, it is assumed that singing may help patients feel less fatigue that comes from rehabilitation exercises and a disease per se, such as PD.

Singing has been recommended as a valuable therapeutic tool to improve speech production in music therapy for speech rehabilitation (Krauss & Galloway, 1982; Lathom, Edson, & Toombs, 1965; Marsh & Fitch, 1970; Michel & May, 1974; Seybold, 1971). Although the number of studies presenting acoustic data on speech is limited, several researchers indicated the potential for positive results from singing in speech rehabilitation. Darrow and Starmer (1986) examined the effects of vocal training on the fundamental frequency, vocal range, speech rate, and intonation of children with hearing impairments. Subjects participated in vocal training that included vocal exercises and song practice. While no significant differences in speech rate or intonation were found, a significant decrease in fundamental frequency and a significant increase in frequency range occurred. The results supported the premise that singing and vocal training offer valuable benefits to speech training for children with hearing impairments.

As for singing and speech problems of neurologically impaired persons, Cohen conducted a series of studies (Cohen, 1988, 1992, 1995; Cohen & Masse, 1993). In her 1988 study, Cohen examined the effects of superimposed rhythm to decrease the excessively fast speech rate of a person with right-hemispheric injuries and Kluv-Bucy Syndrome. Results demonstrated an 11% of decrease in speech rate during the melody and rhythm treatment, in which the subject sang along while tapping, and a 28% of decrease during the functional speech and rhythm treatment, in which the subject repeated sentences while tapping.

Cohen continued to investigate the effects of singing instruction in another study on the speech production of persons with dysfunctional speech production (i.e., apraxia, dysarthria, Broca's aphasia) resulting from either traumatic brain injury or cerebrovascular accident (1992). In addition to a measure of speech rate, measures of fundamental frequency, fundamental frequency variability, vocal intensity, and speech intelligibility were collected for analysis. Results showed that 4 out of 6 treatment subjects indicated improvement in fundamental frequency variability, speech rate, and intelligibility of speech. Cohen made future recommendations including investigation with a larger sample size in consideration of cerebral localization of brain injury, medications, age, premorbid musical experience, and time elapsed since onset of injury.

Using a larger sample size of subjects with various neurological diseases, Cohen and Masse (1993) further investigated the effects of singing and rhythmic instruction on the speech rate and intelligibility. The singing instruction group showed most progress in speech intelligibility when compared with a rhythm instruction group and a control group. Both singing and rhythm instruction groups showed improvement in speech rate, though it was not statistically significant. The researchers found, however, that the speech rate made less improvement in patients with progressive neurological conditions, such as PD, than those with nonprogressive conditions. They stated that the results of performance by the patients with degenerative diseases could not be interpreted in the same way as those of other nondegenerative disease patients.

Cohen and Masse (1993) also indicated that their method of measuring speech rate was not sufficiently sensitive to reflect the functional improvement in speech of patients with progressive disease. Though the treatment groups increased the speech rate upwards to 190 words per minute, which was defined as "improvement" in the Computerized Assessment of Intelligibility of Dysarthric Speech (CAIDS) testing, this rate of speech did not necessarily mean intelligible speech in patients with degenerative neurological conditions. Since short rushes of speech and inappropriately placed pauses due to respiratory dysfunction cause reduction of speech intelligibility in PD patients, slowing the speech rate with exaggerated articulation and placing pause for breaths at syntactically and semantically appropriate boundaries are often useful (Brookshire, 1992). The poor treatment outcomes and measurement problems, which Cohen and Masse found related to progressive disease, may strongly suggest the need for specific approaches and measurement methods for PD's speech problems.

The Music Therapy Voice Protocol (MTVP) for PD thus was developed by the researcher to respond to these issues. Since there has been no music therapy research that focuses on PD's speech impairments, a session format from Cohen's vocal instruction program for two patients with cerebrovascular accidents (1995) was reviewed as a beginning point for a new voice treatment program for PD. The MTVP focused on the vocal and singing exercises in consideration of speech symptoms of PD, which are closely related to phonation and respiration. Perceptual and acoustic speech parameters, such as speech intelligibility and vocal intensity, were selected to reflect possible MTVP treatment outcomes in those speech symptoms. The changes in the patients' mood also were measured to investigate whether the MTVP distracted patients from fatigue and promoted a positive mood, which might encourage adherence to treatment.

Therefore, the purpose of this study was to investigate the effects of MTVP on (a) speech intelligibility; (b) acoustic parameters of speech (i.e., vocal intensity, maximum vocal range, maximum duration of sustained vowel phonation, vocal fundamental frequency, and vocal fundamental frequency variability); and (c) mood of individuals with PD. The following two research questions were examined based on different sets of data. The first research question was examined by comparing the data collected in baseline assessment (*study* pretest) and final evaluation (*study* posttest). The second research question was examined by comparing the data collected in *session* pretests and *session* posttests.

1. Do measures of speech intelligibility, vocal intensity, maximum vocal range, maximum duration of sustained vowel phonation, vocal fundamental frequency, and vocal fundamental frequency variability significantly differ from baseline assessment (*study* pretest) to final evaluation (*study* posttest) when a series of MTVP sessions is applied?
2. Do measures of mood, vocal intensity, vocal fundamental frequency, and vocal fundamental frequency variability significantly differ from *session* pretests to *session* posttests?

Methodology

Subjects

Four Caucasian females, who ranged in age from 67 to 77 years, volunteered to participate as subjects. They had diagnoses of Parkinson's disease (PD) and were affiliated with Parkinson's disease support groups in a Midwest metropolitan area. Selection criteria included those who (a) demonstrated one or more of the symptoms including reduced loudness, changes in voice quality (i.e., breathy voice, hoarse voice), imprecise articulation, monotone voice, vocal tremor, changes in speech rate, or lowered pitch; (b) had problems with breathing (i.e., shallow and short breath, lack of breath support); (c) did not receive speech therapy that focused on voice and speech problems during their participation in this study; (d) were native speakers of English; (e) indicated sufficient hearing acuity to follow directions; (f) indicated sufficient visual acuity to read large print materials; (g) were not diagnosed with dementia; and (h) were able to maintain a sitting position for 60 minutes. No specific criteria for participation existed regarding (a) age; (b) gender: (c) musical experience and education; (d) stage of PD on the Hoehn and Yahr scale (Hoehn & Yahr, 1967); and (e) diagnosis of other diseases or conditions (e.g., depression).

Music Therapy Voice Protocol (MTVP)

The Music Therapy Voice Protocol (MTVP) was developed by the researcher:

1. Opening conversation (3 min), in which each subject conversed with the researcher. The topic for each opening conversation was not specified, but related to current events.
2. Warm-up (5 min) included (a) facial muscle self-massage, in which each subject massaged her own facial muscles with finger tips following the researcher's demonstration in order to relax the facials muscles and to increase facial expression; (b) inhalation and exhalation with abdominal muscle movements, in which each subject inhaled and exhaled quietly with her hands on her abdomen following the researcher's demonstration to feel the inward and outward movements of abdominal muscles for deep breathing.
3. Vocal exercises (20 min) consisted of the following tasks, each of which the researcher modeled for the subject: (a) to warm-up the laryngeal musculature and to practice deep breathing, each subject was asked to yawn so as to open her throat and to sing a glissando from her highest comfortable pitch to her lowest comfortable pitch on the syllables, "mah" or "pah;" (b) to increase resonance and breath support, each subject was asked to sing a series of vowels, "EE-AY-AH-OH-OO," without a break on a single note and using her comfortable starting pitch. The same series of vowels was repeated on subsequent pitches, which ascended and descended by half steps from the starting pitch; (c) to further increase breath support with lifted soft palate, each subject was asked to sing a phrase that included an ascending perfect 5th followed by a descending major scale, using her comfortable starting pitch. The same task was repeated on subsequent pitches, which ascended and descended by half steps from the

starting pitch; (d) to increase resonance and articulation, each subject was asked to sing a phrase by using a series of syllables, "Lah-Beh-Dah-Meh-Nee-Poh-Too-Lah-Beh," using her comfortable starting pitch. The same task was repeated on subsequent pitches, which ascended and descended by half steps from the starting pitch; (e) to develop articulation particularly through wide motion of the lips, the tongue, and the jaw during vocalization, musical excerpts from each patient's favorite tunes also were arranged for vocal exercises. The musical excerpts were transposed as needed, and simple syllables, instead of original words, were often used to make patients concentrate on voice production. Original accompaniment of the excerpts also was simplified to emphasize the basic beat to facilitate vocalization. As an example, Mozart's "Voi che sapete" from *Le nozze di Figaro* was used for Subject 1, who particularly enjoyed opera, by asking her to repeatedly sing the syllable, "pah" on each note for the first several measures of the song in her comfortable vocal range.

4. Singing exercises (15 min): Two or three songs, which had been selected according to each individual subject's preferences, were prepared for each session. These songs were different in terms of the phrase length, word complexity, and range. The subject breathed in at the beginning of each phrase and was encouraged to sing one phrase in one breath. Depending on the musical context, a change in dynamics also was required.
5. Maximum duration of sustained vowel phonation (5 min): Each subject sustained vowel sounds as long and as steadily as possible. The subject was encouraged to take deep breaths and to use abdominal muscles to sustain her projection. To provide immediate feedback, the duration time was measured by a stopwatch for the subject to observe.
6. Review and speech exercises (9 min): Each subject practiced speech exercises, consisting of words, phrases, and sentences. The last three sentences of the exercises were recorded for subjects to review their performance, as well as to make their acquired vocal skills generalize to speech. The same speech exercises were used throughout all treatment sessions.
7. Closing conversation (3 min): During the closing conversation, the researcher again reminded each subject of important points in improving speech. The subjects always were encouraged to take a deep breath before speaking and to produce a louder

voice. Keeping good posture also was emphasized throughout treatment session.

Procedure

After the four subjects signed a consent form, each subject participated in a baseline assessment (*study* pretest), a series of 12 to 14 MTVP sessions, and a final evaluation (*study* posttest). All MTVP sessions were conducted individually and were 60 minutes in duration. Generally the sessions were held three times each week with some adjustments to accommodate doctor's visits and therapy sessions. The total number of the sessions differed slightly from subject to subject due to the medical conditions of subjects or their family members. Two subjects completed 12 sessions and two subjects completed 14 sessions.

All subjects received the baseline assessment (*study* pretest) within 1 week before the first MTVP session and the final evaluation (*study* posttest) within 1 week after the last MTVP session. Since all subjects indicated problems with transportation, baseline assessment (*study* pretest), MTVP sessions, and final evaluation (*study* posttest) took place at their respective homes.

Data Collection for Dependent Variables

Two different sets of data were collected in this study: (a) data collected in baseline assessment (*study* pretest) and final evaluation (*study* posttest), and (b) data collected in *session* pretests and *session* posttests. A description of these two sets of data follows. The frame work for collecting these two data sets are summarized in Table 1 and Table 2 respectively.

Data collected in baseline assessment (study *pretest) and final evaluation* (study *posttest)* (see Table 1).

1. An assessment of speech intelligibility, by using the "Speech Intelligibility Inventory: Self-Assessment Form" (Kent, 1994), was completed both by the subjects themselves and their caregivers. Increasing speech intelligibility was the primary goal of the MTVP. This assessment form was selected as a perceptual measurement to assess speech intelligibility in functional communication. This assessment form was designed to serve two purposes: (a) a self-report by subjects, and (b) an objective report completed by spouses or caregivers. It consists of 21 items which determine the

TABLE 1
Data Collected in Baseline Assessment (Study *Pretest) and Final Evaluation* (Study *Posttest)*

Tasks	Dependent Variables
1. "Speech Intelligibility Inventory: Self Assessment Form" (Kent, 1994)	Speech intelligibility rated by subjects Speech intelligibility rated by caregivers
2. Reading of the "Rainbow Passage" (Fairbanks, 1960)	Vocal intensity (dB) Fundamental frequency (Hz) Fundamental frequency variability (semitone)
3. Singing from the lowest to the highest pitch	Maximum vocal range (semitone)
4. Producing an "Ah" vowel sound as long and steadily as possible	Maximum duration of sustained vowel phonation (second)

degree of intelligibility in various situations in daily life and one item regarding an overall rating for speech intelligibility. The data were converted into numerical scores as follows: "always" = 1, "often" = 2, "sometimes" = 3, "seldom" = 4, and "never" = 5. For each application, the scores for 22 items were summed, then mean scores were calculated. To determine test-retest reliability for speech intelligibility, each caregiver was asked to complete this assessment form a week before the scheduled sessions began. At the initiation of the first session, each caregiver again completed this assessment form. Reliability between the two administrations of the speech intelligibility assessment was determined by the calculation of a correlation coefficient between the two test scores. The result was $r = .90$, which indicated high reliability.

2. Acoustic data for the reading of the "Rainbow Passage" (Fairbanks, 1960) were collected for vocal intensity, vocal fundamental frequency, and vocal fundamental frequency variability. Vocal intensity is an essential variable that makes speech intelligible (Ramig, 1992). Vocal fundamental frequency has a tendency to increase with vocal intensity because fundamental frequency and vocal intensity are related to the same mechanism. (Seikel et al., 1997). Likewise, decreases in vocal fundamental frequency variability is related to the rigidity of the cricothyroid muscle as a result of PD. The outcome is a monotonous voice (Ramig & Gould, 1986).
3. Maximum vocal range was determined by asking subjects to sing from their lowest to highest pitches along with a keyboard ac-

TABLE 2
Data Collected in Session *Pretests and* Session *Posttests*

Tasks	Dependent Variables
1. "Rejeski Feeling Scale (FS)" (Rejeski, Best, Griffith, & Kenney, 1987) rated by subjects	Mood
2. Five consecutive words from the declarative sentences included in the initial and final conversations of each MTVP session	Vocal intensity (dB) Fundamental frequency (Hz) Fundamental frequency variability (semitone)

companiment. This was done because reductions in maximum vocal range were typical of PD patients (Canter, 1965).

4. Maximum duration of sustained vowel phonation was determined by asking subjects to produce an "Ah" vowel sound as long and as steadily as possible at a comfortable pitch and loudness level. This measure provides an indicator of phonatory and respiratory function (Seikel et al., 1997). Canter (1965) reported that maximum duration of sustained vowel phonation was reduced in the majority of PD patients.
5. Medical history and musical background were collected in the Parkinson's Disease Questionnaire and the Music Questionnaire, both of which were administered only in the baseline assessment session. The Parkinson's Disease Questionnaire was developed to gather descriptive information regarding onset, stage of PD, medical history, speech and voice characteristics, presence of other typical symptoms of PD, diagnosis other than PD (e.g., depression), and past experiences in speech therapy and music therapy. The Music Questionnaire was constructed to assess a subject's musical background including musical preference, experience, and education. All information was considered in choices of musical material and in designing vocal and singing exercises for each subject, but not used for data analysis.

Data collected in session *pretests and* session *posttest* (see Table 2).

1. Mood scores were collected by using the "Feeling Scale (FS)" constructed by Rejeski and his colleagues to measure dynamic changes in affect during physical exercises (Rejeski, Best, Griffith, & Kenney, 1987). This is an 11-point, bipolar scale which ranges from +5 to −5 with textual descriptions: +5 = Very Good, +3 =

Good, +1 = Slightly Good, 0 = Neutral, –1 = Slightly Bad, –3 = Bad, and –5 = Very Bad. Subjects were required to circle a number between –5 and +5, with and without corresponding descriptive text to indicate their mood at the beginning and at the end of each MTVP session. The researcher added a constant +5 to each original value of the scale to simplify the calculation. It was reported that the FS is sensitive to positive and negative feeling states that were defined by the Multiple Affect Adjective Check List, and the FS scores are directly associated with the positive value that the participants placed on physical activity (Rejeski and Gauvin, 1995). The measure also proved sensitive to physiological demands; increases in workload yielded more negative FS ratings (Hardy and Rejeski, 1989). In one music therapy research study, MacNay (1995) used the FS to assess the influence of preferred music on mood before and after cardiac rehabilitation exercise segments. It was not possible to check the reliability since moods fluctuated frequently in the subject sample. Because of its practical characteristics, FS was used at the beginning and at the end of each MTVP session to determine whether or not the subject's mood improved as a result of a 1-hour session.

2. Acoustic data for conversational speech, including vocal intensity, vocal fundamental frequency, and vocal fundamental frequency variability, were taken from five consecutive words included in declarative sentences in the opening and closing conversations of each session. Conversational speech, instead of reading the "Rainbow Passage," was used to collect the acoustic data for each session, because practicing the same reading material repeatedly in 12 sessions was considered to reflect familiarity to the material rather than effect of each session. Declarative sentences in the conversation were used to avoid intonation variability which may occur among different context of conversational speech. The researcher speculated that possible physical fatigue as a result of intensive 1-hour MTVP session may influence acoustic variables after each session.

Acoustic Analyses

All speech and voice samples were recorded through a stereo headset with a microphone (Pioneer, SE-DJ250), which was connected to a cassette tape recorder (Sony, TCM-5000EV). The stereo headset with a microphone worn by the subjects made it possible to maintain the same distance between the subjects' mouth and the microphone for each session so that the speech samples were recorded under the same conditions. The recording level of the cassette tape recorder remained set at the same level throughout the study to maintain consistency.

The recorded data were analyzed using MultiSpeech™, a computer software program specially designed for speech science. Vocal intensity and fundamental frequency were automatically calculated from the sound source by the computer program. The maximum duration of sustained vowel phonation was obtained by measuring the time length of waveform on the input screen. The researcher calculated vocal fundamental frequency variability based on the vocal fundamental frequency data and their standard deviations that were provided by the computer. The maximum vocal range was acquired through measuring the highest and lowest fundamental frequency respectively for 0.5 s. The difference in frequency (Hz) was then translated into semitones.

Results

To determine whether the data were significantly different from the baseline assessment (*study* pretest) to the final evaluation (*study* posttest), a series of paired samples *t*-tests was calculated on the following variables: (a) measures of speech intelligibility assessed by the "Speech Intelligibility Inventory: Self-Assessment Form;" (b) acoustic data for the reading of the "Rainbow Passage": vocal intensity, vocal fundamental frequency, and vocal fundamental frequency variability; (c) maximum vocal range; and (d) maximum duration of sustained vowel sounds. Table 3 shows that the results yielded significant differences from baseline assessment (*study* pretest) to final evaluation (*study* posttest) in speech intelligibility, as rated by caregivers, and vocal intensity. All other variables, especially speech intelligibility as rated by subjects themselves, and a measure of vocal fundamental frequency, also showed improvement, though not statistically significant.

To determine whether the data were significantly different from *session* pretests to *session* posttests, a two-way, repeated measures analysis of variance (2 × 3 ANOVA) was calculated for each of the following variables: (a) mood scores; and (b) acoustic measures for five consecutive words from the declarative sentences included in the opening and closing conversations for each session: vocal intensity, vocal fundamental frequency, and vocal fundamental fre-

TABLE 3

Results of t-*Tests Comparing Baseline Assessment* (Study *Pretest) on Final Evaluation* (Study *Posttest) on Speech Variables*

Variables	Assessment *M*	Assessment *SD*	Evaluation *M*	Evaluation *SD*	*t*-value	2-tail significance
Vocal intensity	74.15	4.04	84.06	7.99	3.81	.032*
Intelligibility-S	2.68	1.18	3.38	0.87	2.82	.067
Intelligibility-C	2.35	0.73	3.13	0.48	3.44	.041*
Maximum duration	16.08	5.69	18.94	6.97	1.22	.311
Vocal range	17.04	4.20	20.87	4.66	1.86	.160
Fo	151.18	16.59	176.56	28.27	3.00	.058
Fo variability	4.07	1.44	4.21	2.01	.44	.690

Note. Vocal intensity = vocal intensity in dB; Intelligibility-S = speech intelligibility scores rated by subjects; Intelligibility-C = speech intelligibility scores rated by caregivers; Maximum duration = maximum duration of vowel phonation in seconds; Fo = vocal fundamental frequency in Hz; Vocal range = maximum vocal range in semitone; Fo variability = vocal fundamental frequency variability in semitone.

$^*p < .05$.

quency variability. Since the MTVP treatment was continued over 1 month, the interaction between the effect of each MTVP session and the effect of having a series of sessions across 1 month also was considered. Therefore, a total of 12 MTVP sessions, which took over 1 month to complete, were divided into three time periods that corresponded to early (Sessions 1 to 4), middle (Sessions 5 to 8), and late sessions (Sessions 9 to 12). For subjects who received 14 sessions, the data for the last two sessions were not included in the statistical analyses. All results showed no significant differences in any main effects or interactions as follows. The results of the main effect comparing *session* pretests and *session* posttests yielded $F = 3.50$, $p = .158$ for mood, $F = .03$, $p = .867$ for vocal intensity, $F = .45$, $p = .552$ for vocal fundamental frequency, and $F = 1.16$, $p = .361$ for vocal fundamental frequency variability. The results of the main effect comparing the three time periods yielded $F = 1.45$, $p = .306$ for mood, $F = 1.90$, $p = .230$ for vocal intensity, $F = .89$, $p = .459$ for vocal fundamental frequency, and $F = .04$, $p = .958$ for vocal fundamental frequency variability. The results of interactions of these two main effects were $F = .93$, $p = .446$ for mood, $F = 1.45$, $p = .306$ for vocal intensity, $F = .50$, $p = .629$ for vocal fundamental frequency, and $F = .74$, $p = .515$ for fundamental frequency variability. Although no significant difference was found, mean mood scores improved from 7.94 to 8.69 on an 11-point rating scale from the *ses-*

TABLE 4

Means and Standard Deviations for Session *Pretests and* Session *Posttests*

Variables	Presession		Postsession	
	M	*SD*	*M*	*SD*
Mood	7.93	1.50	8.69	.73
Vocal intensity	76.13	3.45	76.40	1.23
Fo	156.81	27.03	164.44	12.17
Fo variability	3.50	1.47	3.86	1.94

Note. Vocal intensity = vocal intensity in dB; Fo = vocal fundamental frequency in Hz; Fo variability = vocal fundamental frequency variability in semitone.

sion pretests to *session* posttests. Table 4 presents the means and standard deviations of *session* pretest and *session* posttest measures.

Discussion

The purpose of this study was to examine the effects of the Music Therapy Voice Protocol for Parkinson's Disease (MTVP) on speech intelligibility, vocal intensity, maximum duration of sustained vowel phonation, maximum vocal range, vocal fundamental frequency, vocal fundamental frequency variability, and mood of individuals with Parkinson's disease (PD). The MTVP was successful in increasing vocal intensity through respiratory and phonatory efforts included in vocal and singing exercises. The MTVP also influenced improved the mood of the participants.

Increases in speech intelligibility rated by caregivers or spouses and vocal intensity (dB) from baseline assessment (*study* pretest) to final evaluation (*study* posttest) were sufficiently large to achieve statistical significance despite the small sample size. Speech intelligibility rated by the subjects themselves and a measure of vocal fundamental frequency may achieve statistical significance with a larger sample of subjects who would have a comparable speech disabilities, assuming they would obtain similar results. An increased sample size also would minimize the sampling variability in the mean performance and provide a better representation of the population. Since the MTVP focused on increasing vocal intensity to improve speech intelligibility, results of the *t*-tests indicate achievement of the main goal of the MTVP in the four patients with PD.

As for mood scores, small sample size and high variability in *session* pretest scores seemed to affect the statistical results despite the increase in mean. No subject's ratings were lower than 6 on an 11-

point rating scale with a range from 0 to 10. It is speculated that there was a ceiling effect due to limitation of the measurement. Increased mood in *session* posttests, however, implies positive psychological reactions to the MTVP regardless of possible physical fatigue, which might have yielded only small increases in acoustic variables from the *session* pretests to *session* posttests. Enjoyment of singing may distract the subjects from fatigue.

Positive mood following a treatment session may not be easily attained in rehabilitation settings in general, though motivation for adherence to treatment is one of the critical issues for rehabilitation. Regardless of widely acknowledged value of rehabilitation programs, individuals who need them are often resistant to participate (Clair, 1996). Intolerance of discomforts may be a factor for the lack of adherence. Depression, which is commonly seen in chronic or progressive disorders, may also greatly discourage positive feelings toward rehabilitation, and consequently affect participation. One speech therapy study with stroke patients indicated no effect on mood during or following treatment (Lincoln, Jones, & Mulley, 1985). In the course of the MTVP treatment, however, the patients reported higher scores in mood in *session* posttests when compared with the scores in *session* pretests. Speech therapists may find the MTVP helpful in not only improving vocal production but also in motivating patients so as to enhance the maximum results of treatment.

In addition to positive mood following the MTVP treatment, patients also reported the functional impact of the treatment both on their daily speech and their musical experiences outside the treatment. Subject 1 stated that she was very pleased to make herself understood in a telephone conversation with her grandson. She also started singing in church, though she had not sung for years before she experienced the MTVP. Subject 2 reported her successful experience in reading a story for the English literature class at a community college she attended. She also was successful in making her speech intelligible during conversations in noisy restaurants. After completion of the MTVP treatment, she planned to participate in church choir to maintain her improved speech. Successful experiences in singing might motivate the patients not only to participate in the treatment itself but also to use their new vocal skills in their functional speech outside the treatment. Singing also might encourage musical behaviors that may promote socialization. Since generalization from treatment setting to daily life is another critical issue of rehabilitation, the MTVP may have a great potential to facilitate this process.

Though the subject sample was small and the results cannot be the generalized to a broad population with PD, this study indicates that music therapy may influence vocal production in PD patients. Vocal and singing exercises with an emphasis on phonatory and respiratory efforts may have great potential to provide PD clients with stronger vocal projection, which enhances improvement in speech intelligibility. Vocal and singing exercises also may promote adherence to treatment and generalization from clinical settings to daily life. Further research must replicate use of the MTVP with a larger sample of PD patients with speech and voice problems to examine its treatment effects, and calibration, as well as time and cost efficacy as a rehabilitation program.

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