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The Effect of Group Music Therapy on Mood, Speech, and Singing in Individuals with Parkinson's Disease — A Feasibility Study

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Background: *Parkinson's disease (PD) is a progressive neurodegenerative disorder where patients exhibit impairments in speech production. Few studies have investigated the influence of music interventions on vocal abilities of individuals with PD.*
Objectives: *To evaluate the influence of a group voice and singing intervention on speech, singing, and depressive symptoms in individuals with PD.*
Methods: *Ten patients diagnosed with PD participated in this one-group, repeated measures design study. Participants received the sixty-minute intervention, in a small group setting once a week for 20*

consecutive weeks. Speech and singing quality were acoustically analyzed using a KayPentax Multi-Dimensional Voice Program™, voice ability using the Voice Handicap Index (VHI), and depressive symptoms using the Montgomery and Åsberg Depression rating scale (MADRS). Measures were taken at baseline (Time 1), after 10 weeks of weekly sessions (Time 2), and after 20 weeks of weekly sessions (Time 3).

Results: *Significant changes were observed for five of the six singing quality outcomes at Time 2 and 3, as well as voice range and the VHI physical subscale at Time 3. No significant changes were found for speaking quality or depressive symptom outcomes; however, there was an absence of decline on speaking quality outcomes over the intervention period.*

Conclusions: *Significant improvements in singing quality and voice range, coupled with the absence of decline in speaking quality support group singing as a promising intervention for persons with PD. A two-group randomized control study is needed to determine whether the intervention contributes to maintenance of speaking quality in persons with PD.*

Keywords: *Parkinson's disease; music therapy; group therapy; vocal ability; singing; depression*

Parkinson's disease (PD) is a progressive neurodegenerative disorder (Svircev, Hellmann, & Juncos, 2005). It affects between 12–20 people per 100,000 (Twelves, Perkins, & Counsell, 2003). The disease affects the dopaminergic neurons of the substantia nigra leading to symptoms of bradykinesia, hypokinesia, tremor, rigidity, and postural and gait abnormalities. However, non-motor features are also common including sleep disorders and mood changes, anxiety, depression, and feelings of isolation (Jankovic, 2008). The disease may progress quickly or gradually over years and many people diagnosed with PD become profoundly disabled.

Vocal Abilities in People with Parkinson's Disease

Voice impairment is one of the earliest and most frequent symptoms of Parkinson's Disease (Adams, 1997; Murdoch, Manning, Theodoros, & Thompson, 1997; Stewart et al., 1995) and might consequently, cause the patient to feel embarrassed and therefore choose to avoid any social interaction that requires speaking (Perez-Delgado, 2007). Those impairments in speech production, namely dysarthria, are due to reduced physiological support for speech (i.e., breath support) as well as diminished control of the musculature of the larynx and oral cavity (Kegl, Cohen, & Poizner, 1999). Specifically, there is progressive deterioration in speech amplitude (loudness) and mean fundamental frequency (Fo) (mean pitch), as well as abnormal rates of articulation (Harel, Cannizzaro, Cohen, Reilly, & Snyder, 2004). When combined, these impairments lead to speech characteristics of a soft, monotone, breathy or hoarse voice quality, and imprecise articulation. These characteristics combined with reduced facial expressions (masked faces) (Adams, 1997; Harel et al., 2004), lead to a reduced likelihood to participate in conversations or have "confidence in communication" as compared to healthy aging adults (Fox & Ramig, 1997).

People with PD present with disorders of laryngeal, respiratory, and articulatory functioning (Baker, Ramig, Luschei, & Smith, 1998; Yorkston, 1996). Logemann, Fisher, Boshes, and Blonsky (1978) found that 89% of persons with PD present laryngeal disorders, specifically breathiness, hoarseness, roughness, and tremulousness. Vocal intensity is also affected by the disease with Fox and Ramig (1997) discovering that those with PD displayed 2–4 decibels (measured at a distance of 30 cm) lower voice volume across a number of speech tasks in people compared with matched controls. Such level of change equates to a 40% perceptual reduction in loudness (Fox & Ramig, 1997).

Fundamental frequency variability, a measure of the melodic dynamics in the speaking voice, is reported to be lower in people with PD compared to healthy aging people (Logemann, Boshes, & Fisher, 1973; Ludlow & Bassich, 1984). Persons with PD tend to have higher speaking fundamental frequencies, particularly for males and display a reduced maximum frequency range (Holmes, Oates, Phyland, & Hughes, 2000). Vocal fold bowing (lack of medial vocal fold closure), asymmetrical vibratory patterns, and laryngeal tremor are present in at least 50% of people with PD (Perez, Ramig, Smith, & Dromey, 1996; Wang, Verhagen Metman, Bakay, Arzbaecher, & Bernard, 2003).

Respiratory Challenges in People with Parkinson's Disease

Respiratory disorders might cause morbidity and mortality in people with PD, because of pulmonary functional impairments. In a study by Polatli, Akyol, Cildag, and Bayülkem (2001), 21 patients with PD were tested for maximal flow rate at 25% of remaining forced vital capacity (FVC)[1] (MEF25%) and the volume of air expired during the first second of the FVC (FEV1). The maximal voluntary ventilation[2] (MVV) was found to be significantly lower in PD in comparison to healthy controls. When respiratory abnormalities were examined in this group of patients it was found that 62% were showing upper airway obstruction, 31% were showing central or peripheral obstructive pattern, 27.6% were showing restrictive dysfunction, 27.6% were presenting air trapping, and 12.1% suffer from lung insufflation (Sabaté, González, Ruperez, & Rodríguez, 1996).

The cause for the respiratory difficulties is disputed. Some postulate that the deficiencies reflect involvement of the upper airway musculature, probably due to in-coordinated expiratory effort or abnormally low chest wall compliance (Izquierdo-Alonso, Jiménez-Jiménez, Cabrera-Valdivia, & Mansilla-Lesmes, 1994). Others believe that the deficiencies are due to less coordinated and less explosive muscle force in this population (Polatli et al., 2001). A third suggestion is that these pulmonary dysfunctions are induced by the simultaneous action of a group of factors including the degree of bradykinesia or rigidity and the musculoskeletal limitations of vertebral column probably induced by the anomalous Parkinsonian posture (Sabaté et al., 1996).

The Effect of Music Therapy for People with Parkinson's Disease

There is still a paucity of research in the music therapy discipline that focuses specifically on the maintenance and rehabilitation of communicative, emotional, and physical functioning of people with PD. The value of music therapy in the rehabilitation of vocal expression and communication of people with neurological damage is emerging in the literature, with a notable increase in interest about its effects over the past 10 years (Baker, 2005; Baker, Wigram, & Gold, 2005; Baker & Wigram, 2004; Elefant, 2001, 2002, 2005; Elefant & Wigram, 2006; Haneishi, 2001,

[1]Vital capacity is the maximum amount of air a person can expel from the lungs after a maximum inspiration.

[2]Maximal Voluntary Ventilation — The maximum volume of air that a person can inhale and exhale by voluntary effort per minute by breathing as quickly and deeply as possible.

2006; Kennelly, Hamilton, & Cross, 2001; Pacchetti et al., 2000; Pilon, McIntosh, & Thaut, 1998; Tomaino, 2000).

In Haneishi's study (2001), 10 participants with PD received 8 sessions of individual therapy sessions of a Music Therapy Voice Protocol (MTVP) to address impairments in speech intelligibility, voice quality, vocal intensity range, and intonation. The effects of the intervention were compared with a control group ($n = 10$). The MTVP included vocal and singing exercises. The statistical calculation revealed that speech intelligibility, resonant voice quality, vocal intensity range, intonation, and positive affect significantly increased in the music therapy group over time, but not in the control group.

Similar findings are presented in a recent study by Di Benedetto and associates (2009) where 20 patients with PD received 20 individual music therapy sessions and 26 hr of choral singing. The authors reported significant improvement in maximum duration of sustained vowel phonation (MDPh) and prosody during reading. The same study also reported a significant improvement in functional residual capacity (FRC%), maximum inspiratory pressure (MIP), and maximum expiratory pressure (MEP) after participating in a 46 hr combined intervention program (Di Benedetto et al., 2009). In another study, an increase in intensity, fundamental frequency and improved voice stability through the Lombard's effect (consistently increase in voice intensity due to masking noise) was found in 17 individuals with PD (Quedas, Duprat, & Gasparini, 2007).

Theoretical Framework

Our intervention has been informed by research findings drawn from physiological and neuromusical studies. Respiration together with the laryngeal system generates subglottal pressure necessary for vocal fold vibration (Stark, 2003). People with PD have difficulty sustaining expiratory pressures which help maintain subglottal pressure and therefore present with insufficient vocal intensity necessary for their speech to be heard by others (Binazzi et al., 2006). Singing requires greater subglottal pressure than speaking (e.g., Leanderson, Sundberg, & Von Euler, 1987) so engaging participants with PD in singing where they are required to exert conscious control over their expiratory pressures would enable them to build abdominal muscle strength and coordination (Engen, 2005).

Singing is a useful medium to address intonation of people with PD (Mean fundamental frequency (Mean Fo) and fundamental frequency variability (Fo variability) because the cortical regions and networks responsible for music and speech overlap (Patel, 2008). Therefore, engaging people with PD in singing may function to maintain the neural connections necessary to express emotion in the voice and subsequently improve (or at the very least maintain) the aforementioned intonation components. Further, intonation is affected by the emotional state of the individual (Davis, 1998). For example, intonation patterns can be used to diagnose affect disorders (e.g., Alpert, Poughet, & Silva, 2001), schizophrenia (Fricchione, Sedler, & Shukla, 1986) and depression in Parkinson's disease patients (Benke, Bosch, & Andree, 1998). It is possible that involvement in music therapy may affect the emotional state of the individual and directly influence the intonation style used. Singing may facilitate a relaxation response which directly increases vocal fold flexibility, enabling the speaker to express more emotional dynamics in his voice (Bunch, 1997; Kitch & Oates, 1994). This increase in vocal flexibility would also be reflected in an increased vocal range.

An accumulating yet limited body of research exists which suggests that Music Therapy may be effective in treating speech, singing, and respiration in individuals with PD. We formulated the following hypotheses to increase the body of music therapy research for individuals with PD, with specific attention to the delivery of interventions in a group setting.

Hypotheses

H1: There will be a significant change in fluency of speaking, mean fundamental frequency (Fo), mean Fo variability, intensity, consistency of intensity, and voiceless sound and voiced sound during speaking from baseline Time 1 (T1) to 10 weeks after weekly sessions Time 2 (T2) and from T1 to 20 weeks after weekly sessions Time 3 (T3).

H2: There will be a significant change in fluency of singing, singing accuracy, mean intensity, consistency of intensity, and amount of voiceless sound and voiced sound during singing from T1 to T2, and T1 to T3.

H3: There will be a significant change in the maximum vocal range from T1 to T2, and T1 to T3.

H4: There will be a significant change in participants' perception of their voice handicap across three domains (physical, functional, emotional) from T1 to T2, and T1 to T3.

H5: There will be a significant change in depressive symptoms from T1 to T2, and T1 to T3.

Method

Ethics

The research proposal was approved by the Regional Ethics committee for Medical Research Ethics, Haukeland University Hospital in Bergen, Norway. Prior to participation in the study, patients were informed of the study's purpose and tasks. Informed consent was obtained from all participants.

Participants

Ten patients diagnosed with PD agreed to participate in the study (3 females and 7 males, age range 55–84 [*SD* ± 8.9; 64 mean age], diagnosed 2–7 years prior to the study). All participants were stable responders to levodopa and assessed as at Stage 2–3 of PD's according to Hoehn and Yahr's scale (Hoehn & Yahr, 1967; Goetz et al., 2004). Participants were recruited from the ParkVest study, a cohort of patients—involved in the largest longitudinal demographic study of PD patients at the Department of Neurology, Haukeland University Hospital in Bergen, Norway. Description of participants is summarized in Table 1.

Design and Data Collection

Participants were randomly divided into two equal intervention groups in order to keep the group size small. A single group repeated measures design was adopted to test study hypotheses. Data collection took place three times: at baseline (T1), after 10 weeks of weekly music therapy (T2), and after 20 weeks of weekly music therapy (T3). Data collection consisted of a combination of acoustic and self-report data.

Group Voice and Singing Intervention

The music therapy intervention groups met once a week for 20 weeks, each session lasted 60 min. The groups met in a large room at the hospital's rehabilitation center, a location already familiar to the participants.

Table 1
Demographic Data of Participants

Participant	Gender	Age	Diagnosis in yrs	Employment	Leisure activity
1	M	64	5	Yes	Walking
2	M	64	4	Reduced	Walking
3	F	61	4	No	——
4	M	77	4	No	Fishing
5	M	61	4	No	Walking
6	F	55	5	Yes	——
7	M	61	2	No	Mountain hikes
8	F	74	7	No	Sings in choir
9	M	63	2	No	Mountain hikes
10	M	84	5	No	——
Mean (± *SD*)		64 (±8.9)	4.2 (±1.4)		

Note. —— No leisure activity was reported by participants.

The intervention protocol was implemented as follows:

1. Introductory conversation including greetings and sharing experiences related to the preceding week (5–10 min).
2. Breathing exercises: The participants were instructed to inhale and exhale with abdominal muscle movements. Participants were initially encouraged to activate deep abdominal inhaling and exhaling and later to focus more on controlled breathing while the therapist counted (in seconds) and snapped his fingers the time the air was exhaled (5–10 min).
3. Vocal exercises: participants were asked to produce a glissando from the highest to the lowest comfortable pitch. This exercise was repeated on subsequent pitches, which ascended and descended by half or whole steps from the starting pitch (5–10 min).
4. Singing exercises: The participants sang 3–5 songs selected from a list of participant-chosen music selections (Beatles and Norwegian folk songs), with the music therapist accompanying the participants' singing with his own voice and chordal strumming on the guitar (20–30 min).
5. Closing conversation: During the closing conversation, participants articulated their experiences of the session (5–10 min).

Measures

A combination of acoustic and self-report measures was administered to detect change in the dependent variables.

Acoustic measures. Testing at Time 1, 2, and 3 took place between 10:00 and 16:00 hr in a quiet therapy room at the rehabilitation center with an ambient noise level < 30 dB. All tests were performed individually, on days when the group voice and singing intervention were not held. Acoustic measures were analyzed using data generated from three separate tasks and all were recorded digitally. Vocal data was captured in three different situations.

1. *Spoken passage*. Participants were asked to read out a short story containing non-emotionally laden material. Participants were directed to read out the given passage twice at a pace comfortable for them. The passage was in Norwegian standard bokmål and 232 syllables long.
2. *Voice range*. Participants were asked to sing the lowest and highest pitches they were able to produce. They were asked to make 3 attempts at this task and their "best" effort was used in the analysis.
3. *Singing of a song*. Participants were asked to sing the Christmas carol "Silent Night" (in Norwegian standard bokmål). No starting note was given or tempo. Participants were merely asked to sing at a pitch and tempo comfortable for them and to sing the carol twice. The carol was 45 syllables long.

Vocal samples were recorded in the Samson Wireless, Concert 77 Fitness System, high-performance UHF wireless solution, using a SE10, a low profile, omni-directional head worn microphone at a distance of 10 cm from the lips of the participants. From there the signal went through a balanced XLR microphone cable to Mbox 2 audio interface (Digidesign). The level IN (input level on interface) was gained to the same level for every recording. The interface was connected with a USB 2 cable to a Macbook Pro laptop (Apple). The Software used for recordings were Logic Pro 9.1.1 (6), a digital audio recording and editing software program (Apple). Audio data were imported to KayPentax Multi-Dimensional Voice Program™ (MDVP) model 5105; Multi-Speech Model 3700 version 3.2 with the Real-time Pitch 5121, and trimmed to ensure only the target data were being analyzed. Procedures were as follows for each of the three items.

1. *Spoken passage*. Each of the two readings of the passage were trimmed to remove all silence pre and post readings and saved as individual files for analysis.
2. *Voice range*. The audio data were visually inspected in MultiSpeech and the highest and lowest frequencies identified. One second of sustained vocalization was obtained for each high and low frequency and saved as individual files for analysis.
3. *Singing of a song*. Each of the two singing attempts in each trial were trimmed to remove all silence pre and post singing section, and saved as individual files for analysis.

MDVP was used to analyze the audio data for Fo (mean pitch) and Fo variability (the variability of the pitch—the higher the variability, the less monotonal the speech/singing is), intensity, consistency of intensity, the percentage of voiceless and voiced sound, the singing accuracy, and the maximum vocal range. Reliability has been established (Kent, Vorperian, & Duffy, 1999) when the same sample of an utterance was repeatedly analyzed (within system reliability, $r = 0.86$) and when a sustained vowel sound was analyzed ($r = 0.99$).

Pitch data were analyzed after calibrating the software to ensure the signal analyzed did not contain artifact noise. Pitch ranges for males were set at a maximum of 350 Hz and 500 Hz for females. Vocal intensity measures were not calibrated for a minimum as low volumes were anticipated and the authors wanted to increase the chances of some data being adequately picked up by the software. The software is unable to process dB readings lower than 30 dB (see Table 2).

From these data, several further calculations were made to generate the raw data used for statistical analyses.

1. Fluency: the sample fluency was calculated by dividing the number of syllables by the sample length (spoken passage, singing of a song).
2. Mean Fo, Fo SD (spoken passage), and lowest and highest Fo's (vocal range): due to frequency being a logarithmic measure (log 12), all data were transformed using a logarithmic transformation (spoken passage).
3. Singing Accuracy: to determine the degree to which participants' singing was changing in accuracy, a measure of deviation from a target pitch was calculated by taking the

TABLE 2
Procedures Performed with the Audio Files Prepared for Analysis

	Spoken passage	Singing of song	Vocal range
Length of sample (s)	X	X	—
Mean Fo (Hz)	X	—	—
Mean Fo *SD* (Hz)	X	—	—
Mean intensity (dB)	X	X	—
Mean *SD* of intensity (dB)	X	X	—
Voiced Sound (s)	X	X	—
Voiceless Sound (s)	X	X	—
Highest Fo	X	X	X
Lowest Fo	—	—	X
Starting Fo	—	—	—

Note. — Data not relevant or nonexistent.

participants' first note as the baseline and then predicting what the highest frequency should be within their performance. From here, using a logarithmic transformation first, the deviation of their actual pitch from that of the predicted was calculated.

4. Mean dB and dB SD: due to decibel being a logarithmic measure (log 10), all data were transformed using a logarithmic transformation (spoken passage, singing).

Voiced and Voiceless data were collected as a total number of seconds. To determine the proportion of voiced and voiceless sound, the number of seconds of data were divided by the total sample length of each audio file and then converted to percentages (spoken passage, singing).

Self-report measures. The Voice Handicap Index (VHI) is a self-assessment questionnaire for use with people who experience voice disorders in their daily life (Jacobson et al., 1997) and was administered at Time 1, 2, and 3 to evaluate participants' perception of aspects of their voice. It has been applied in several studies to assess people's perception of their voice function and impairments (e.g., Weigelt et al., 2004) and the effect of voice treatment (e.g., Holmberg, Ihre, & Sodersten, 2007). The VHI has been successfully translated into German, Dutch, French and Swedish (Hakkesteegt, Wieringa, Gerritsma, & Feenstra, 2006; Nawka, Wiesmann, & Gonnermann, 2003; Ohlsson & Dotevall, 2009; Woisard, Bodin, & Puech, 2004).

The VHI questionnaire is comprised of 30 items representing three different aspects related to voice disorders: physical, functional, and emotional (Jacobson et al., 1997) each of which is represented by 10 items scored on a 5-point Likert scale. The total score ranges from 0 to 120 and the lower the score, the lower the impact of the voice disorder is perceived to have on the person's life. The VHI has high internal consistency reliability ($r = 0.86$), and high test-retest reliability ($r = 0.95$). Translation from English to Norwegian was performed using a formal method of forward-backward translation in accordance to accepted protocol (Bullinger et al., 1998). A native Norwegian who is professional English translator translated the questionnaire into Norwegian, and then a native Norwegian who works in Health sector translated the measure back from Norwegian to English.

The Montgomery and Åsberg Depression rating scale (MADRS; Montgomery & Åsberg, 1979) is a 10-item questionnaire used to measure the severity of depressive episodes in patients with mood disorders such as in PD. The MADRS was administered by a nurse with prior experience administering the measure at T1, T2, and T3. The MADRS has been widely accepted as a useful measure in drug-treatment trials, mainly because of its particular sensitivity to treatment effects. Since there is a comparative lack of emphasis on somatic symptoms, the scale is useful for the assessment of depression in people with physical illness, such as the participants in the present investigation. Reliability between raters using the MADRS through a structured interview guide (SIGMA) was $r = 0.93$, $p < 0.0001$, with all 10 items of the scale showing good to excellent interrater reliability (Williams & Kobak, 2008). Good validity of the scale was in several languages and studies (Suzan, Aylin, Senar, & Elif, 2001; Satthapisit, Posayaanuwat, Sasaluksananont, Kaewpornsawan, & Singhakun, 2007).

Data Analysis

Wilcoxon Signed Rank Tests (2-tailed) were used to determine the significance of the change between Times 1, 2, and 3 since the distribution of the data were asymmetric. Alpha levels were set at a p value < 0.05. Because this was a pilot study and relatively few tests were conducted, no adjustments were made for multiple comparisons.

Results

Spoken Passage

There were no statistically significant changes to the variables related to the spoken passage between T1 and T3 (see Table 3); however, there were some trends evident, for instance some notable changes in intensity at T2, and voicelessness at T3.

There were notable decreases in the percentage of voiceless sound and increases in the intensity of speech between T1 and T2 but these were not significant. Fluency increased slightly from T1 and T2 and was sustained at T3. The mean fundamental frequency and variability increased and intensity and consistency of intensity also increased. The mean degree of voiced sound decreased slightly at T3 however participants were more consistent in the percentage of voiced sound. It is interesting to note that there were also no decreases in spoken voice quality over the 20 week intervention period as would have been expected in PD (Di Benedetto et al., 2009).

Singing

Significant outcomes at a level of $p < 0.01$ were found for 5 out 6 variables at both T2 and T3. There was no difference in the rate of syllables sung at T2 and T3 when compared with T1. Participants were significantly ($p < 0.01$) closer to singing the target note at the end of the program compared with the T1 data and a smaller *SD* indicated, that as a group, they were also more consistent in achieving this. Decibel levels were significantly ($p < 0.01$) stronger at T2 and T3 when compared with T1. Further, participants were significantly ($p < 0.01$) more consistent in producing decibel levels, that is, they were singing at a more consistent volume. These results show that the degree of voiceless sound (breathiness etc.,) decreased and more voice increased over the course of the program and this result was significant ($p < 0.01$).

Voice Range

The voice range of the participants did not change significantly at T2; however, it increased significantly from T1 to T3 ($p < 0.05$; see Table 3).

Voice Handicap Index

Statistical analyses of participants' perceptions of their handicap are presented in Table 4. Only the physical subscale of the Voice Handicap Index showed significant change ($p < 0.05$) at T3 (after 20 weeks of weekly sessions). The other two subscales, functional and emotional, and the scale as a whole presented no significant results at T2 or T3 (after 10 or 20 weeks of weekly sessions). However noticeable trends were:

1. High standard deviation in scores across all components
2. Participants did not perceive substantial impairment in their voices at the outset (T1).
3. Total scores showed a slight decrease in scores indicating a small improvement in participants' perceptions of their voices.
4. Participants noticed an improvement in their functional use of and their own experience of their voices.

Montgomery and Åsberg Depression Rating Scale

There were no significant changes in mean scores for the MADRS at both T2 and T3 (see Table 5). It is notable that two participants (3 & 6) showed means score changes of (−9) and (+8) respectively. These changes were in opposite directions thereby contributing to the overall stability of scores.

Discussion

This study examined the influence of a group voice and singing intervention in 10 individuals with PD and found significant improvements occurring for five out of six vocal parameters related to singing and the physical subscale of the Voice Handicap Index.

Spoken Passage

Although no significant changes were observed for outcome variables related to the spoken passage, there were some positive trends in speech presented by participants at T2 and T3 evaluations. Two elements, intensity of speech at T2 and degree of voiceless sound at T3 showed mean score changes that were noteworthy. These findings contradict our initial hypothesis as well as the findings presented by Di Benedetto and associates (Di Benedetto et al., 2009) who found significant change in the

TABLE 3
Characteristics of the Acoustic Data

Variable	Time 1 Mean	*SD*	Time 1 Median	Time 2 Mean	*SD*	Time 2 Median	Time 3 Mean	*SD*	Time 3 Median	Time 1–2 *z* value	*p* value	Time 1–3 *z* value	*p* value
Speaking													
Fluency (syllables per min)	228.1	41.2	241.1	235.14	39.0	237.7	235.04	42.4	248.6	1.27	.20	1.27	.2
Fo (Hz)	139.6	17.2	141.2	138.61	21.8	142.6	142.45	18.93	145.8	—		—	
Fo (log12)	1.98	.051	2.0	1.98	.07	2	1.99	.05	2.0	.87	.39	.87	.39
Fo var. (Hz)	18.54	.78	17.4	18.88	.69	20.0	19.34	.62	18.3	—		—	
Fo var.(log12)	1.16	.1	1.1	1.16	.15	1.2	1.17	.19	1.2	−.15	.88	.87	.39
Intensity: dB	46.36	3.13	47.2	46.15	2.34	47.2	47.07	2.2	48	—		—	
Intensity: dB (log10)	1.67	.03	1.7	1.66	.02	1.7	1.67	.02	1.7	−1.78	.07	.05	.96
Consistency of dB (log10)	.61	.08	0.6	.63	.08	0.7	.64	.07	0.6	−.97	.33	−.97	.33
Voiceless	17.81	6.16	16.6	28.37	4.7	26.9	15.81	2.6	15.8	.8	.39	−1.82	.09
Voiced	27.82	4.87	27.9	32.3	7.61	34.7	26.02	2.9	25.7	.153	.88	−.76	.45
Singing													
Fluency (syllables per min)	101.1	17.4	106.8	97.40	22.2	105.1	101.56	20.94	108.9	−.97	.33	.26	.80
Singing accuracy (log12)	.84	.08	1	−.05	.06	0.0	−.04	.03	0.0	−2.80	< .01*	−2.80	< .01*
Intensity: dB	49.36	4.98	49.63	52.35	3.46	48.4	49.63	.43	49.5	—		—	

TABLE 3
Continued

Variable	Time 1 Mean	*SD*	Time 1 Median	Time 2 Mean	*SD*	Time 2 Median	Time 3 Mean	*SD*	Time 3 Median	Time 1–2 *z* value	*p* value	Time 1–3 *z* value	*p* value
Speaking													
Intensity: dB (log10)	1.11	.05	1.7	1.69	.03	1.7	1.69	.03	1.7	2.80	< .01*	2.80	< .01*
Consistency of dB (log10)	1.15	.04	1.76	.53	.09	0.5	.55	.07	0.6	−2.80	< .01*	−2.80	< .01*
Voiceless	39.75	3.53	39.0	16.08	6.65	15.6	15.32	3.54	15.7	−2.80	< .01*	−2.8	< .01*
Voiced	39.88	5.81	41.8	62.54	11.0	66.9	62.29	6.44	61.2	2.80	< .01*	2.80	< .01*
Voice Range													
Voice range (semitones)	15.10	4.04	16.83	17.1	4.38	16.9	17.90	2.6	18.6	1.52	.13	1.96	< .05*

Index Statistical significance — * *Note.* —— Data not relevant or non existent.

prosody in speech passage. These differences could be the result of Di Benedetto and colleagues more intense intervention protocol (two weekly sessions in comparison to one weekly session in the present study), or the fact that the intervention was implemented during individual therapy (Haneishi, 2006; Perez-Delagado, 2007) rather than in groups. Further, differences could be attributed to the lack of concurrent speech training which was part of Di Benedetto et al.'s study. Of particular importance was our finding that participants' speech did not deteriorate over the course of the 20 weeks which one would expect as the disease progresses (Haneishi, 2006). This finding suggests that the intervention may have helped maintaining speech function. Future studies using a two-group randomized control trial study design will be needed to directly examine this important question.

Singing

Results of the vocal analysis for singing found significant improvements at T2 and T3 in most singing components including: increases in vocal intensity and consistency of intensity, increases in singing pitch accuracy, increases in voiced sound (with a corresponding decrease in voiceless sound), and increases in voice range. These results support our initial hypothesis. We assume that the significant positive change observed for consistency of voicing (i.e., less voiceless sound during singing, more voiced sound during singing), increase in vocal intensity, consistency of vocal intensity, and increased singing accuracy, are all indicators of a higher level of control over vocal expression in singing and endurance of voice production.

The mean degree of voiced sound decreased slightly at T3; however participants were more consistent in the percentage of voiced sound. Despite the fact that significant increases in singing pitch accuracy and in voice range were noted, these skills and improvements did not transfer to a change in prosody during speech. The relatively short intervention period and the fact that the intervention was performed in a group rather than an individual format may have limited opportunities for extensive vocal practice and therefore larger carry over effects to be realized. Again, perhaps the improvements in singing skills prevented deterioration in speech function. A randomized control trial would allow for a more direct examination of this

TABLE 4
Results of the Voice Handicap Index Variable

Variable	Time 1 Mean	*SD*	Time 2 Mean	*SD*	Time 3 Mean	*SD*	Time 1–2 *z* value	*p* value	Time 1–3 *z* value	*p* value
VHI — Physical	8.1	6.59	8.4	4.52	10.67	8.46	−.24	.81	−1.97	< .05
VHI — Functional	9.6	6.35	7.9	4.93	9.11	6.92	1.27	.203	.48	.64
VHI — Psychological	4.70	6.09	4.7	5.60	4.56	7.84	−.70	.483	.60	.55
VHI — TOTAL	22.4	—	21.0	—	24.34	—	.36	.72	.05	.96

TABLE 5
Montgomery and Åsberg Depression Rating Scale

Delta	Time 3	Time 1	Participant #
2	4	2	1
−4	2	6	2
−9	1	11	3
1	0	1	4
0	7	7	5
8	8	0	6
0	0	0	7
3	5	2	8
0	0	0	9
2	2	0	10
—	2.9	2.9	mean
—	2.81	3.62	*SD*

Note. — Information not relevant.

theory. In addition, increasing the frequency of sessions may lead to cumulative effects of treatment as found in Baker et al.'s (2005) study of people with traumatic brain injury. The fact that a decline in speech production did not occur during the treatment period suggests that singing may play a role in preventing speech deterioration. Therefore, engaging in community leisure activities involving singing, such as community choirs, is recommended (Stige, Ansdel, Elefant, & Pavlicevic, 2010).

This was the second study to evaluate the effect of a voice and singing intervention on individuals diagnosed with PD. Findings reported here align closely with those of Haneishi (2006), in that we also found increases in vocal intensity range, and improved intonation in singing, as a consequence of participating in the intervention. However the main difference lies with the fact that this study involved a protocol within a group context which may be more financially viable for the public health system to support than the individual sessions of Haneishi's study.

Voice Handicap Index

When examining the subscales of the Voice Handicap Index, a significant difference was observed for the physical subscale. Slight decreases in scores were reported for the other subscales and the scale as a whole. The small number of participants and the high variability among participants even at T1 may have contributed to non-significant findings for the functional and emotional subscales. Moreover, the high disposition of participants in the initial examined elements (T1), limited the potential for obtaining a significant change due to a ceiling effect.

Our data revealed that participants perceived deterioration in the physiological use of their voice despite the objective data reported in the physical subscale. In contrast, they recognized an overall improvement in their vocal functioning and their psychological perception of their voices. The combination of these two contrasting findings (which underpin the lack of significant change in the scale as a whole), suggest that participants developed an increased awareness of their vocal physical difficulties, but at the same time became more accepting towards them and better able to use their voices in social settings. It would seem that a deeper understanding of one's vocal limitations might lead to more effective use in social settings and would benefit from further research to identify the correlations and substantiate this idea. Barnes and Ward (2000) suggest that motivation for participation is of critical importance to achieving a change within an intervention; therefore an individual's intervention specifically tailored to each participant's level of functioning and musical preferences (rather than a group intervention used within the present project) might have yielded more significant results.

Changes in Symptoms of Depression

There were no significant changes in MADRS scores at T2 or at T3. This may be explained by the floor effect as T1 MADRS scores were low (0–11, $M = 2.9/60$) indicating that depressive symptoms were not high in this specific group of participants from the outset. Nonsignificant changes in symptoms of depression were also noted by Haneishi (2006) in her study. These results may reflect the fact that both programs were focusing on achieving improvement in speech and singing characteristics; being more technical by nature, rather than focusing on improving symptoms of depression. Therefore different protocols may be more suitable when decreasing depressive symptoms is the primary focus of the intervention. Alternatively, the MADRS might not have been sensitive enough to detect slight changes in depressive symptoms, a point also relevant for Haneishi's study which administered the Positive and Negative Affect Schedule (PANAS) scales (Watson, Clark, & Tellegen, 1988).

Limitations of the Study

There were several limitations of the study. First, the small number of participants ($N = 10$) limited possibilities to generate statistically significant results. Furthermore, the small sample size limits possibilities for generalization. Additionally, the lack of a control group weakens the design and the researchers cannot conclude that significant gains were exclusively the product of the intervention itself and not some other unknown variable. However, taking into account the regression typical of most individuals with PD, improvements in the client condition are seldom, strengthens arguments that gains found for participants in this study may be attributed in part to the intervention. Finally, the study was designed as a pilot study and the intervention was presented to a small number of people receiving group music therapy for one hour a week. For future studies, we suggest increasing the frequency and duration of the intervention protocol (i.e., sessions twice a week; longer intervention period), increasing the sample size, and adding a control group.

Conclusion

This research project examined the effect of a group voice and singing intervention on speech and song production characteristics in individuals with PD. The results suggest that this type of intervention may lead to improvements in singing abilities, with slight improvements in speech also noted. The intervention may have also prevented deterioration of speech production, but a larger, randomized control trial study is needed to directly examine this hypothesis.

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