BMJ Neurology Open

Group therapeutic singing improves clinical motor scores in persons with Parkinson's disease

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To cite: Stegemoller E, Forsyth E, Patel B, *et al*. Group therapeutic singing improves clinical motor scores in persons with Parkinson's disease. *BMJ Neurology Open* 2022;**4**:e000286. doi:10.1136/bmjno-2022-000286

► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/bmjno-2022-000286).

Accepted 12 July 2022

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ABSTRACT

Background Previous reports suggest that group therapeutic singing (GTS) may have a positive effect on motor symptoms in persons with Parkinson's disease (PD).

Objective To determine the effect of a single session of GTS on clinical motor symptoms.

Methods Clinical motor symptom assessment was completed immediately before and after 1 hour of GTS in 18 participants.

Results A significant decrease in average scores for gait and posture and tremor, but not speech and facial expression or bradykinesia was revealed.

Conclusion These results support the notion that GTS is a beneficial adjuvant therapy for persons with PD that warrants further research.

INTRODUCTION

Incorporating music into current treatment strategies for Parkinson's disease (PD) is beneficial, yet the underlying mechanism remains a challenge to understand. Various forms of dance and drumming improve functional mobility, postural instability and walking rate, while singing improves voice, respiratory control and swallow.[1–6] These results are domain specific demonstrating improvements in outcome measures that are associated with the exercise/therapy or target area. Given that increased physical activity has many positive benefits in persons with PD,[7] detangling the effects of music from the effects of increased physical activity/exercise is difficult.[8] Examining the effects of music on non-domain specific outcome measures may provide further direction in understanding underlying mechanisms.

Group therapeutic singing (GTS) involves sitting and singing within a group for an hour, with no overt physical activity. In previous studies, Stegemöller *et al* found improvements in voice, respiratory control, swallow, quality of life after 8 weeks of GTS.[1 2] Participants in these studies also reported that the groups were fun and relieved stress, they felt better and were able to move better after GTS.[3] These results would suggest that GTS may have an effect on multiple symptoms, including motor symptoms of PD. Examining the effects of GTS on clinical motor symptoms may differentiate the effects of singing from physical activity, providing further insight into how music alone benefits person with PD. The purpose of this pilot study was to determine the effect of aa single session of GTS on the clinical evaluation of speech and facial expression, bradykinesia, gait and posture, and tremor using the Movement Disorders Society Unified Parkinson's Disease Rating Scale (MDS-UPDRS).[9] Given the previous results of GTS, we hypothesised that only speech and facial expression will improve after 1 hour of GTS.

METHODS

Participants

Eighteen participants (11 female, 7 male; age=74.9±7.2 years, 100% right handed, 100% white) diagnosed with PD by their treating neurologist were enrolled into the study. No participant demonstrated signs of severe cognitive impairment (Mini-Mental State Examination=28.4±1.8) or depression (Beck Depression Inventory=10.9±3.7) (supplementary table 1).

Participants were on the same PD medication as prescribed by their treating physician for 30 days prior to data collection (supplementary table 3). The average disease duration was 7.5±4.7 years and 53% reported that the right side was their most affected side. The average total score on the MDS-UPDRS (parts I–IV) was 73.4±13.6. All participants took their normal medication and their normal times, while the GTS session remained fixed at the same day and time. Thus, all participants were tested on medication, on average 206.2±92.4 min since taking their last dose (supplementary table 2). No participant took additional medication throughout the duration of the data collections or GTS session. Participants had been participating in GTS

for an average of 2.4±1.4 years prior to the date of data collection.

Singing session

The GTS session lasted 1 hour. The singing session consisted of a greeting song (5 min), a series of vocal exercises (15 min), therapist chosen group singing (15 min), participant chosen group singing (20 min) and a closing song (5 min). The session was led by a board-certified music therapist who used piano as the primary accompanying instrument. No lyrics or music were provided to promote proper posture while singing. The vocal exercises and therapist chosen songs have been used in previous GTS studies and a more detailed description can be found in these studies.[1–3]

Movement Disorders Society Unified Parkinson's Disease Rating Scale

Motor examination (part III) of the MDS-UPDRS was videorecorded immediately before and after the GTS session. Videos were coded to mask pre or post intervention order and were scored by two movement disorders neurologists that were masked to the study intervention. Since the MDS-UPDRS-III was recorded, scores for rigidity were not completed. Independent t-tests revealed no differences between the raters' scores (presession scores: p=0.48; postsession scores: p=0.55). Thus, the average of the scores was used for the remaining analyses. The speech and facial expression score was calculated as the sum of items 3.1 and 3.2. The bradykinesia score was calculated as the sum of items 3.4 through 3.8 plus 3.14. The gait and posture score was calculated as the sum of items 3.9 through 3.13, and the tremor score was calculated as the sum of items 3.15 through 3.18.

Statistical analysis

The Shapiro-Wilk test revealed that all distributions were normal. Paired t-tests probed for differences between pre and post MDS-UPDRS-III scores for the total motor score, and each domain (speech and facial expression, bradykinesia, gait and posture, and tremor). Effect sizes using Cohen's d were calculated. Significance was set a $p<0.05$. Change scores were calculated as the post score minus the pre score for descriptive results. Because participants were on medication, Pearson correlations were completed for time since medication and the change score for each MDS-UPDRS-III domain score and the total motor score. In addition, because participants had been singing for different lengths of time, Spearman correlations (years singing was not normally distributed) were completed for previous years singing and the change score for each MDS-UPDRS-III domain score and the total motor score.

RESULTS

The mean, SE and statistical results for all comparisons are shown in table 1. Individual participant change scores for the total motor score and each domain are shown in figure 1 and supplementary table 2. For the total motor score, 67% of the participants demonstrated an improvement (ie, decrease in score=−1.75) in motor symptoms. Results indicated a trend (p=0.09, d=0.19) towards significance. However, it is important to note that the largest individual participant improvement in total motor score was −11.5 points, and the largest worsening was +3.5 points. Results were variable across participants for domain scores, as changes across each domain were different for each participant. Nonetheless, results revealed a significant improvement in average scores for gait and posture (−0.62, p=0.03, d=0.25) and tremor (−1.28, p=0.05, *d*=0.27). For gait and posture, 56% of the participants demonstrated an improvement in score, and for tremor, 50% of the participants demonstrated an improvement in score. Average scores worsened slightly for bradykinesia (0.11) and speech and facial expression (0.03). For bradykinesia, 50% of the participants demonstrated an improvement in score, while only 33% of the participants demonstrated an improvement in score for speech and facial expression.

No significant correlations were revealed between time since medication and the change score for total MDS-UPDRS-III score (R=−0.09, p=0.73) nor each domain score (R≤0.23, p>0.36). There was no significant correlation between years singing and the change score for the total MDS-UPDRS-III score (R=−0.19, p=0.4) However, for years singing, a significant negative correlation was revealed for bradykinesia (R=−0.47, p=0.049) and a significant positive correlation was revealed for gait and posture (*R*=0.56, p=0.016). Those who had been singing longer showed a greater improvement in bradykinesia, while those with less experience singing showed a greater improvement in gait

Table 1 Mean, SE, range and paired t-test results for MDS-UPDRS-III scores

	Total motor	Speech and facial expression	Bradykinesia	Gait and posture	Tremor
Pre	40.22±2.14	3.61±0.20	24.31±1.33	6.31±0.59	6.00±1.16
Post	38.47±2.15	3.64±0.21	24.42±1.47	5.69±0.59	4.72±1.10
Range pre	23–57	2–5.5	12.5–34.5	1–10.5	0–15
Range post	26–57.5	2.5–5.5	17.5–33.5	1.5–9	0–14.5
t (17)	1.81	0.25	−0.19	2.37	2.10
P value	0.09	0.81	0.85	0.03	0.05
d	0.19	0.03	0.02	0.25	0.27

MDS-UPDRS, Movement Disorders Society Unified Parkinson's Disease Rating Scale.

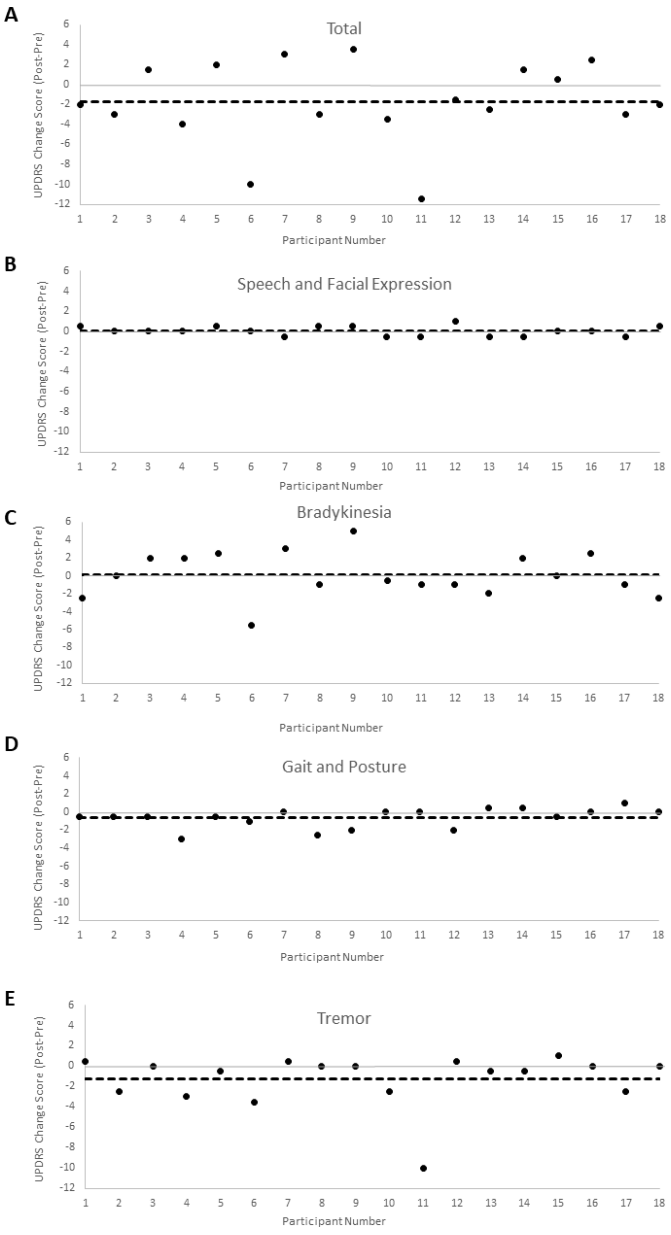

Figure 1 The change in individual participant MDS-UPDRS-III scores from pre-GTS to post-GTS for the (A) total motor score, (B) speech and facial expression score, (C) bradykinesia score, (D) gait and posture score, and (E) tremor score. GTS, group therapeutic singing; MDS-UPDRS, Movement Disorders Society Unified Parkinson's Disease Rating Scale.

and posture. There were no other significant correlations between years singing and tremor (R=–0.14, p=0.6) nor speech and facial expression (*R*=–0.17, p=0.5).

DISCUSSION

The purpose of this study was to determine the effect of a single session of GTS on the clinical evaluation of motor symptoms in persons with PD. Given that research has shown that GTS improves the voice in person with PD and GTS does not involve overt physical activity, we hypothesised that only speech and facial expression would improve after 1 hour of GTS, but not bradykinesia, gait and posture, and tremor. However, results were in contrary to our hypothesis. Scores for speech and facial expression, as well as bradykinesia, did not significantly change. Scores for gait and posture and tremor did significantly decrease and there was a significant association between years singing and gait and posture. Those with less experience singing showed the greatest improvement in gait and posture. The total motor score decreased, as well, and was close to significance. These results suggest that GTS may immediately engage and/or enhance other neural networks that are involved with gait, posture and tremor. Improvements in intervention specific symptoms (ie, speech, facial expression, voice, swallow, respiratory control) may take a longer period of time over several sessions before observing significant changes, as demonstrated in previous studies, or may be the result of fatigue after an hour of singing.[1–3] Moreover, results do support that improvements in bradykinesia may emerge over time given the significant association between years singing and the change in bradykinesia score. Those who had been singing long showed greater improvements in bradykinesia. Taken together, this supports the need for future long term research on the effects of GTS on motor symptoms.

An interesting finding of this study was that improvements in clinical motor symptoms were observed while participants were on their optimal PD medication dosage. There were no significant associations between time since medication and change scores, suggesting that GTS may account for the improvement in motor symptoms. However, since the timing of medication was not controlled and the dosage was not collected, it is likely that not all participants were in their peak state which may explain the variable response. Nonetheless, some participants demonstrated improvements in the total motor score up to 11.5 points while on medication. This promising result supports the need for further research aimed at optimising GTS for persons with PD. Understanding the underlying neurophysiology may be the first step.

Research has shown that engaging in music increases activity within the mesolimbic system, specifically the ventral tegmental area (VTA) and nucleus accumbens (NAcc).[10 11] These nuclei have connections with the basal ganglia as part of the limbic loop,[12–14] which may explain why singing improved gait, posture and tremor. Efferent projections from the NAcc target the output nuclei of the basal ganglia and the VTA has reciprocal connections with the striatum.[12 13] Research has traditionally suggested the functional loops with in the basal ganglia are segregated circuits.[13] However, there is increasing evidence that these circuits are not segregated and play an important role in modulating motor control based on mood, memory and cognition.[12] Indeed, research has shown that a unidirectional influence of the limbic loop over the motor loop in animal models.[15] Thus, a possible explanation of why a single session of GTS improved gait and posture and tremor in persons with PD may be that increased activity of the VTA and NAcc modulated activity within the limbic loop

of the basal ganglia in turn influencing or compensating for impaired activity within the motor loop. This proposed underlying mechanism of how GTS improves motor symptoms in PD are truly speculative based on limited research, andthere remains a need for continued research.

Limitations

While this was a preliminary study, there are limitations to consider. The criteria for diagnosis of PD is unknown due to the nature of the study site. There is the possibility that other neurodegenerative diseases may have been present in the participant sample. In addition, we did not control specifically for the timing or dose of medication, but rather maintained the same day and time for the GTS intervention. For both of these limitations, the study design reflects the typical delivery of the intervention in which GTS is offered at a particular time regardless of each individual's medication and the participants may have other diagnoses other than PD that are unknown at the time of the intervention. Finally, given the nature of the intervention and study design, there is the potential of a placebo effect and study bias. Further long-term research including an appropriate control is needed.

CONCLUSION

The results of this study provide the preliminary behavioural evidence suggesting that GTS improves motor symptoms beyond the typical pharmacological effect for some persons with PD. Any improvement in symptoms is worthy of continued research to further the understanding and implementation of music and singing in the treatment of persons with PD.

Contributors ES: study design and execution, data collection and analysis, writing of first draft. EF: data collection and analysis, review of manuscript. BP: data analyses, review of manuscript. AE: data analysis, review of manuscript.

Funding This study was supported in part by a grant from the GRAMMY Museum.

Competing interests None declared.

Patient consent for publication Consent obtained directly from patient(s)

Ethics approval This study involves human participants and was approved by Iowa State University Institutional Review Board. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as online supplemental information.

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REFERENCES

1 Stegemöller EL, Radig H, Hibbing P. Effects of singing on voice, respiratory control, and quality of life in persons with Parkinson's disease. *Disabil Rehabil* 2016;17:1–7.
2 Stegemöller EL, Hibbing P, Radig H, *et al*. Therapeutic singing as an early intervention for swallowing in persons with Parkinson's disease. *Complement Ther Med* 2017a;31:127–33.
3 Stegemöller EL, Hurt TR, O'Connor MC, *et al*. Experiences of Persons With Parkinson's Disease Engaged in Group Therapeutic Singing. *J Music Ther* 2017b;54:405–31.
4 Pantelyat A, Syres C, Reichwein S, *et al*. DRUM-PD: the use of a drum circle to improve the symptoms and signs of Parkinson's disease (PD). *Mov Disord Clin Pract* 2016;3:243–9.
5 Hackney ME, Earhart GM. Effects of dance on gait and balance in Parkinson's disease: a comparison of partnered and nonpartnered dance movement. *Neurorehabil Neural Repair* 2010;24:384–92.
6 Houston S, McGill A. A mixed-methods study into ballet for people living with Parkinson's. *Arts Health* 2013;5:103–19.
7 Lamotte G, Rafferty MR, Prodoehl J, *et al*. Effects of endurance exercise training on the motor and non-motor features of Parkinson's disease: a review. *J Parkinsons Dis* 2015;5:21–41.
8 Rawson KS, McNeely ME, Duncan RP, *et al*. Exercise and Parkinson disease: comparing tango, treadmill, and stretching. *J Neurol Phys Ther* 2019;43:26–32.
9 Martinez-Martin P, Rodriguez-Blazquez C, Alvarez-Sanchez M, *et al*. Expanded and independent validation of the movement disorder Society-Unified Parkinson's disease rating scale (MDS-UPDRS). *J Neurol* 2013;260:228–36.
10 Salimpoor VN, Benovoy M, Larcher K, *et al*. Anatomically distinct dopamine release during anticipation and experience of peak emotion to music. *Nat Neurosci* 2011;14:257–62.
11 Chanda ML, Levitin DJ. The neurochemistry of music. *Trends Cogn Sci* 2013;17:179–93.
12 Bourdy R, Sánchez-Catalán M-J, Kaufling J, *et al*. Control of the nigrostriatal dopamine neuron activity and motor function by the tail of the ventral tegmental area. *Neuropsychopharmacology* 2014;39:2788–98.
13 Alexander GE, DeLong MR, Strick PL. Parallel organization of functionally segregated circuits linking basal ganglia and cortex. *Annu Rev Neurosci* 1986;9:357–81.
14 Buot A, Yelnik J. Functional anatomy of the basal ganglia: limbic aspects. *Rev Neurol* 2012;168:569–75.
15 Aoki S, Smith JB, Li H, *et al*. An open cortico-basal ganglia loop allows limbic control over motor output via the nigrothalamic pathway. *Elife* 2019;8:e49995.

Supplemental Table 1: Demographic Data

Participant	Years Singing	Gender	Age	Years of Education	Handedness	Ethnicity	Disease Duration	Most Affected Side
1	3	F	85	17	R	White	No Data	No Data
2	2	F	78	16	R	White	5	R
3	3	F	80	16	R	White	5	R
4	0.25	F	74	16	R	White	6	L
5	0.5	F	84	16	R	White	8	R
6	2	M	70	16	R	White	2	L
7	0.17	M	79	20	R	White	7	R
8	0.75	M	85	16	R	White	1	R
9	2	F	64	16	R	White	2	L
10	3	M	73	23	R	White	12	L
11	4	F	73	17	R	White	13	L
12	3	M	83	19	R	White	7	R
13	4	F	69	16	R	White	16	L
14	2	M	67	16	R	White	4	R
15	1	F	77	16	R	White	17	L
16	4	F	69	13.5	R	White	6	R
17	4	F	77	12	R	White	6	R
18	4	F	61	16	R	White	11	L

Supplementary Table 2. MDS-UPDRS Raw Data and Time Since Medication Raw Data

Participant	Total Score		Bradykinesia		Gait and Posture		Tremor		Speech and Facial Expression		Time Since Medication (minutes)
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	
1	45	43	30.5	28	8	7.5	2	2.5	4.5	5	No data
2	29	26	18	18	4.5	4	3.5	1	3	3	150
3	47	48.5	30	32	9.5	9	3.5	3.5	4	4	150
4	41	37	20.5	22.5	7	4	10.5	7.5	3	3	300
5	35.5	37.5	24	26.5	5	4.5	3.5	3	3	3.5	120
6	42	32	23	17.5	4.5	3.5	11	7.5	3.5	3.5	180
7	48	51	30	33	3.5	3.5	9.5	10	5	4.5	150
8	33	30	22	21	6.5	4	1	1	3.5	4	180
9	29	32.5	17	23	4.5	2.5	2.5	2.5	4	4.5	330
10	48	44.5	21	20.5	8	8	15	12.5	4	3.5	430
11	52.5	41	30	29	8.5	8.5	10	0	4	3.5	210
12	49	47.5	34.5	33.5	10.5	8.5	0.5	1	3.5	4.5	210
13	36	33.5	20.5	18.5	1	1.5	11.5	11	3	2.5	180
14	36	37.5	25.5	27.5	6.5	7	0.5	0	3.5	3	210
15	57	57.5	30	30	8	7.5	13.5	14.5	5.5	5.5	300
16	34.5	37	26.5	26	8.5	8.5	0	0	2.5	2.5	120
17	38.5	35.5	24	23	6.5	7.5	4.5	2	3.5	3	240
18	23	21	12.5	10	3	3	5.5	5.5	2	2.5	45

Supplementary Table 3. Medication List

Participant	Medications
1	Carbidopa/Levodopa, Paxil, Losartan
2	Carbidopa/Levodopa
3	Carbidopa/Levodopa
4	Carbidopa/Levodopa, Synthroid, Propranolol, Aciphiex, Paxil
5	Carbidopa/Levodopa, Ropinirole, Simvastatin
6	Carbidopa/Levodopa, Citalopram
7	Carbidopa/Levodopa
8	Carbidopa/Levodopa, Gabapentin, Lipitor
9	Carbidopa/Levodopa, Metformin, Ranitidine, Fexofenodine, Toviaz, Lisinopril, Atorvastatin
10	Carbidopa/Levodopa, Azilect, Cozaar, Dyazide, Toprol, Cymbalta
11	Carbidopa/Levodopa, Ropinirole
12	Carbidopa/Levodopa, Warfarin, Diltiazem, Donepezil, Tamsulosin, Finasteride
13	Carbidopa/Levodopa, Azilect, Trihexyphenidyl, Amantadine, Baclofen
14	Carbidopa/Levodopa, Meloxicam, Melatonin, Sildenafil
15	Carbidopa/Levodopa, Rasagiline, Modafinil, Jantoven, Furosemide, Alendronate, Levothyroxin
16	Carbidopa/Levodopa, Amantadine, Amitriptyline, Amlodipine, Diclofenac, Furosenride, Losartan
17	Carbidopa/Levodopa, Atenolol, Losartan, Sertraline, Amlodipine Besylate, Baclofen
18	Carbidopa/Levodopa, Azilect, Amantadine, Baclofen, Clonazepam, Viibryd, Alprazolam