Am J Dance Ther (2017) 39:126–141
DOI 10.1007/s10465-017-9242-8

Effects of Dance Classes on Cognition, Depression, and Self-Efficacy in Parkinson's Disease

Chantal M. Prewitt[1] · Jasmine C. Charpentier[1] · Joseph A. Brosky[1] · Nancy L. Urbscheit[1]

Published online: 7 March 2017

Abstract Executive function is an area of cognition commonly impaired in people with Parkinson's disease (PD). Deficits often result in poor planning, slow reactions, and reduced initiative. Reduced physical function is also associated with PD but studies indicated that it can significantly improve through dance (Earhart, 2009; Hackney et al., 2007a, b). Dance may provide some positive effect on executive function but there's little research investigating the effects of dance on cognitive symptoms of PD. The objective of this study was to determine whether executive function improves in individuals with PD following a dance program. Three different executive function measures (semantic fluency, dice, and fist-edge-palm) were assessed before and after an 8-week dance class that met twice a week. All measures were from the scales for outcomes in Parkinson's disease-cognition (SCOPA-COG). The fist-edge-palm measure was also assessed before and after one single class. Six individuals with PD and between 62 and 87 years of age participated in the study. Results showed no significant changes in any of the three executive function tests administered before and after the 8-week dance program. However, the fist-edge-palm measure given before and after a single class significantly improved ($p = 0.02$). This suggests that therapeutic dance may specifically improve the executive function domain of cognition, particularly when connected to physical movement. This finding also suggests that participating in dance class on a daily short-term basis can improve executive function. If this effect is consistent, dance programs could improve short-term executive function in individuals with PD.

Keywords Parkinson's disease · Dance · Cognition · Physical therapy

✉ Chantal M. Prewitt
cprewitt@bellarmine.edu

[1] Physical Therapy Program, Lansing School of Nursing and Health Sciences, Bellarmine University, 2001 Newburg Road, Louisville, KY 40205, USA

Introduction

Parkinson's disease (PD) is a neurodegenerative disease that significantly decreases the basal ganglia's production of dopamine, a neurotransmitter that allows for brain cells to communicate with each other for motor control (Petzinger, 2009). Although the disease is primarily characterized by motor dysfunction, people with PD also experience several non-motor symptoms that in many ways are just as debilitating. Some of the most significant non-motor symptoms experienced with PD are cognitive impairment and depression (University of Maryland Medical Center, 2011).

Cognitive Impairment

Mild cognitive impairment occurs in about 80% of all individuals diagnosed with PD (Sobreira et al., 2008). In addition, some studies have shown that in individuals diagnosed with early stage PD, and with no dementia, about 19–31% had cognitive deficits (Aarsland et al., 2009; Elgh et al., 2009; Kandiah et al., 2009). The cognitive deficiencies that accompany PD relate to executive function, attention, word finding, learning, memory, and visuospatial processes (Troster, 2011). The level of cognitive impairment varies between individuals and usually will not affect all six domains, especially in the early stages of PD (Troster, 2011). The domain of cognition most frequently impaired in people with PD (30%) is executive function (Sobreira et al., 2008). Executive function includes the skills of planning, problem-solving, interacting with a changing environment, focusing attention, and initiating tasks (Sobreira et al., 2008; Troster, 2011). These skills are necessary for anyone in order to manage an independent life.

Individuals with PD are primarily over 50 years of age (Van Den Eeden et al., 2003). The normal aging process would thus also be expected to influence cognition in people with PD. Aging particularly reduces the speed of processing, attentiveness, executive functions, and free recall (Vallet, 2015). However, there are cognitive deficits that occur with PD that are not associated with normal aging, such as deficits in language (e.g., taking everything literally), common memory (e.g., loss of names of colors), and automatic aspects of attention (e.g., not being able to carry on a conversation with one's passenger while driving home) (Vallet, 2015). While it has been shown that a decline in executive function is directly related to aging, when researchers control statistically for subject age, the loss of executive function in people with PD is directly related to the stage of the disease (Dirnberger & Jahanshahi, 2013).

Depression

Another major non-motor symptom of PD is depression, affecting 25–40% of those with the diagnosis (Okun & Watts, 2002). While depression could easily be associated with the hardships of aging and coping with a neurodegenerative disorder, the depression associated with PD is viewed as a biological change related

to the loss of dopamine available to the limbic system (which controls mood and emotions) (Okun & Watts, 2002). In the general elderly population, only 1.8% suffers a major depressive disorder and only 13.5% suffers from clinically significant depressive symptoms, which is significantly lower than the population with PD (Beekman, Copeland, & Prince, 1999; Okun & Watts, 2002).

Self-Efficacy

Self-efficacy is a measure of one's confidence in the ability to control/handle oneself and one's environment (Schwarzer & Jerusalem, 1995). High self-efficacy increases propensity to learn and meet goals (Bandura, 1993). Though there is little research on the impact of aging on self-efficacy, elderly people with high self-efficacy have been able to reduce health risk behaviors in terms of exercise, weight, consumption of dietary fat and alcohol, and smoking (Grembowski et al., 1993). The presence of depression correlates with low self-efficacy in normal people (Davis-Berman, 1988), which suggests that low self-efficacy may be an issue for those with PD. A survey done in Japan with people having PD, revealed that 66.5% of the subjects had low self-efficacy as measured by the general self-efficacy scale (Fujii et al., 1997).

Effects of Exercise on Cognition, Depression, and Self-Efficacy

Many studies demonstrate that with healthy aging subjects, exercise can have positive effects on cognition, depression, and self-efficacy (Ahlskog, Geda, Graff-Radford, & Petersen, 2011; Archer, 2011, McNeil, LeBlanc, & Joyner, 1991). The changes can be acute, as revealed by improved cognitive test scores after a short bout of exercise (Hillman, Snook, & Jerome, 2003). Likewise, regular exercise reduces the risk of developing mild cognitive impairment or dementia (Ahlskog et al., 2011). In the general population the risk of depression is reduced by regular exercise, and if depressive symptoms are present they are less severe if the patient is engaged in some form of regular exercise (Physical Activity Guidelines for Americans, 2008). In addition, a longitudinal study with people suffering from severe depression, reported that self-efficacy scores improved after 8 weeks of exercise (White, Kendrick, & Yardley, 2009).

Physical activity has been found to improve cognition, reduce depression, and raise self-efficacy in people with PD. Acute passive cycling exercise has been shown to improve executive function in individuals with PD (Ridgel, Kim, Fickes, Muller, & Alberts, 2011). Furthermore, therapeutic exercise has been reported to improve mood as well as scores on the unified disease Parkinson's rating scale (UPDRS) (Reuter, Engelhardt, Stecker, & Bass, 1999). Other studies also reported that areas of cognition particularly affected by PD, such as executive function, attention, and memory, improved with exercise (Colcombe & Kramer, 2003; Gordon et al., 2008).

Dance/Movement Therapy for Parkinson's Disease

Westbrook and McKibben (1989) demonstrated that patients with PD who participated in a dance/movement therapy (DMT) program, facilitated by credentialed dance/movement therapists showed improvement in initiation of movement when compared to those with PD who followed a more traditional exercise program. Recently, dance classes have become a significant part of therapeutic interventions for PD and several studies have revealed that dance has a greater positive impact on motor symptoms than traditional therapy (Earhart, 2009; Hackney, Kantorovich, & Earhart, 2007a; Hackney, Kantorovich, Levin, & Earhart, 2007b). Improvements in motor symptoms should be a major reason for any therapy for people with PD, but an equally important goal of therapy should be enhancement of cognition, alleviation of depression, and improved self-efficacy. Dance/movement therapy may provide these latter benefits as well. Several studies have found that participation in such partner dances as tango resulted in greater improvement in mood, program compliance, and quality of life than other forms of exercise, even when physical gains were similar (Hackney et al., 2007a, b; Hashimoto, Takabatake, Miyagugchi, Nakanishi, & Naitou, 2015; Rios-Romenets, Anang, Fereshtehnejad, Pelletier, & Postuma, 2015). Participating in a dance class program is a very pleasant and social activity that avoids some of the negative associations attached to many other forms of exercise. Hackney and Earhart (2010) recommended ways to provide PD partnered tango dance programs to help improve physical, emotional, and cognition characteristics impaired by PD. However, more research is needed to define the quantifiable effects of structured dance classes on the non-motor symptoms of PD.

Purpose of this Study

This study seeks to investigate the effects of therapeutic dance classes, facilitated by physical therapy instructors conducted over a period of 8 weeks on participants' cognition, depression, and self-efficacy, as well as the effects of a single 1-h dance class. The objective of this study is to further add to the growing collection of research by providing further evidence of long-term effects of dance on non-motor PD symptoms.

Methodology

Participants

Six individuals—three males and three females between the ages of 62 and 87—participated in an 8-week study. All had been diagnosed with PD by a physician and had scored between the early to moderate stages of I and III on the 5-stage Hoehn and Yahr scale for the progression of PD. The most recent diagnosis had been made less than a year before the start of the study, while the oldest diagnosis had been made 11 years prior. None of the participants were diagnosed with dementia.

Subjects regularly attended a university-based PD dance clinic established in 2010. This small dance clinic had on average between five and ten individuals with PD attending class. Most participants had learned about the class through a local community PD support group and had started attending with the hope of slowing down PD's progression, while improving mobility and balance, and enjoying the social interaction and exercise the classes might provide. Dancers included in this study had participated in the dance clinic for various lengths of time (3 months to 5 years) before they were asked to volunteer for the 8-week study. They remained in the regular dance clinic and participated during the data collection as they had before with other participants not included in this research project. The dancers who volunteered for this study continued to attend the dance clinic regularly after the study was completed. Prior to the study, the participants reported on their weekly exercise habits in a survey questionnaire. One participant's only regular exercise was the twice per week dance class. The rest of the participants routinely engaged in other modest activities (e.g. yoga, walking, tai chi, stationary bike) in addition to the dance class. They were told to continue their regular exercise routine throughout the duration of the study. The participants also reported in the questionnaire on chronic health issues they had beyond PD. One subject had no other chronic health issues while the others disclosed arthritis, chronic sinusitis, high blood pressure, breast cancer, or depression. However, none of the participants had dementia. Differing in age, length of diagnosis of PD, stage of PD, and additional health issues, the participants represented a non-uniform group of people with PD and served, as a collective, as the study's own control subjects. The purpose of the study was to test whether dance classes would improve their own individual non-motor symptoms over an 8-week-period. They were not compared with a group of sedentary PD individuals or with a cohort of the general aging population not diagnosed with PD. The Institutional Review Board at the university approved this 8-week long study, and all participants willingly gave their written consent to participate after receiving a thorough explanation of the study, its purpose, and testing procedures.

Dance Class

This investigation specifically examined the university's PD dance class called "Let's Dance!" Available to the public free of charge, the class was part of the doctor in physical therapy (DPT) service-learning curriculum, and met consistently twice a week for 1 h in a university laboratory skills classroom. Two faculty members of the university's physical therapy program and five or six DPT students led the class. The faculty instructors were recreational (not professional) dancers, and were both involved in the design and implementation of this research study. Some of the students who participated in the dance clinic had only minimal dance experience. That did not limit the program's effectiveness, however, since the students typically learned quickly, and the PD dance partners of those students new to dancing benefited from the experience of functioning as their "instructor" and helping someone learn. Although the research study period lasted only eight weeks, the class itself remains continuous and is offered throughout the year.

The format of the class followed a consistent structure, although the types of dances performed varied. The class would start with a warm-up, led by one of the instructors (a doctoral trained physical therapist), which included stretching combined with large, full-body movements and balance exercises that focused on rotation, and extension of the trunk and limbs. This was followed by two or three structured dances, a 5-min break with light refreshments, and another two or three more structured dances. For each class, dances were selected from a large repertoire of partner, group, and line dances: the bachata, ballroom waltz, Texas two-step, polka, shim-sham, swing, Cajun waltz, foxtrot, samba, tango, square dance, electric slide, meringue, samba, and barangara. When performing partner dances, the class participants were paired with either an instructor or a student. Near the end of class, the instructor led participants through a seated "cool-down" with relaxing, meditative, and controlled breathing exercises.

Research Design

Participants were administered a preliminary survey and consent form at the beginning of the study, along with a final survey at the end of the 8 weeks, which included tests measuring mood and self-efficacy. The tests used in this study were chosen for their specificity, reliability, validity, and clinical utility, or for ease of administration. All of the tests were administered by one of the dance instructors (who also conducted the study), and three or four DPT students partaking in the dance class. Participants were tested for cognition over an 8-week session with the SCOPA-COG. The tests were administered at the end of the first and last day of the 8-week class period.

In addition, changes in cognition were measured with short tests administered once a week right before and right after the dance class. These short tests were taken from parts of the SCOPA-COG and the montreal cognitive assessment (MoCA) and were given on alternating Tuesdays and Thursdays of the 8-week study.

Outcome Measures

Scales for Outcomes in Parkinson's Disease-Cognition (SCOPA-COG)

The SCOPA-COG was used for assessing changes in cognition over the course of the 8 weeks, not only because it was designed specifically to assess the type of cognitive decline experienced with PD, but also because it is a relatively short test that is easy to administer (Marinus et al., 2003). The 15-min test includes five categories of ten sections: memory and learning (verbal recall, digit span backwards, indicate cubes), attention (counting backwards, months backwards), executive function (fist-edge-palm, semantic fluency, dice), visuospatial (assembling patterns), and memory (delayed recall). These categories cover domains of cognition that are specifically affected by PD. The test has been validated by several studies to be a reliable means of scoring and assessing cognition, and displays valid psychometric properties (Forjaz, Frades-Payo, Rodriguez-Blazquez, Ayala, & Martinez-Martin, 2010).

Short Cognitive Tests

These tests, given before and after a 1-h dance class, were designed to evaluate areas of cognitive decline commonly experienced with PD, and are further described in Table 1. These tests were extracted from the SCOPA-COG and from the MoCA, a short 10-min test designed to screen for mild cognitive decline in a general population. While the MoCA was not designed specifically for PD, it is an internationally-recognized and well-validated test that is widely used to evaluate mild cognitive impairment in people with PD (Julayanont, Phillips, Chertkow, & Nasreddine, 2013).

Survey Questionnaires

Along with questions about medical history, exercise habits, and past participation in the dance class, both the preliminary and final surveys included three tests designed to evaluate the participants' psychological state: The general self-efficacy scale (GSE), the geriatric depression scale (GDS), and the Schwab and England activities of daily living scale (S&E ADL). Table 1 offers a more detailed description of these tests. Several published studies have demonstrated these tests to be valid and reliable (Greenberg 2012; McRae, Diem, Vo, O'Brien, & Seeberger 2002; Schwarzer & Jerusalem, 1995).

Statistical Analysis

The data collected from the questionnaires and cognitive tests were statistically analyzed in two formats: a "before and after" analysis, and a correlation analysis. For all statistical analyses performed in this study, a value of $p < 0.05$ was used to determine significance. The SCOPA-COG and the three tests on the questionnaires administered before and after 8 weeks were analyzed with the Wilcoxon Signed Rank test, which is used to analyze the differences between dependent matched pairs of nonparametric data, seen in "before and after" conditions. Since the scores on the weekly short cognitive tests were raw scores (0–10) rather than the scaled scores (0–3) originally developed for the various tests in the SCOPA-COG (Marinus et al., 2003), a nonparametric statistical test was not needed. Instead, the paired *t* test, the parametric form of the Wilcoxon Signed Rank Test, was used as it accommodated a smaller sample size. Like the Wilcoxon test, it analyzes the differences between pairs of related subjects or conditions. Due to periodic absences by some of our participants in the course of the 8-week study, the attendance, and therefore sample size, for these short once-a-week cognitive tests included four or five participants rather than all 6. The results from these tests and the survey questions were also analyzed with the Pearson's correlation coefficient test in order to determine correlation.

Table 1 Outcome measures

	Purpose of test	Scale
Questionnaire material		
General self-efficacy scale (GSE)	Rates the strength of one's belief in their own ability to overcome obstacles, & respond to difficult changes	10–40 40 representing highest perceived self- efficacy
Geriatric depression inventory (GDS)	Measures depression in the general older population	0–13 >4.0 suggestive of depression >8.5 almost always indicative of depression
Schwab and England activities of daily living	Rates one's ability to perform daily activities in terms of speed and independence. Developed specifically for PD	0–100% 10% increments 100% = completely independent 0% = vegetative
SCOPA-COG		
	Assesses levels of cognition in people with PD by testing domains of cognition particularly affected by PD	0–43 43 = highest level of cognitive function
Short cognitive tests		
Week 2	Visuospatial function	Copy drawing of a cube Draw clock at given time
Week 3	Fluency	Name as many words as possible in 80 s that begin with a chosen letter
Week 4	Verbal recall	The verbal recall section of the SCOPA-COG
Week 5	Executive function	Fist, Edge, Palm section of SCOPA-COG
Week 6	Attention	Tap when hear letter A in list of random letters
Week 7	Quantitative reasoning/attention	Serial 7 subtraction starting at 100

Results

The short cognitive test administered on week 5 (executive function) repeated the fist-edge-palm section of the SCOPA-COG in which participants were asked to perform a series of three consecutive hand movements a total of 10 times. The number of correct times the sequence of the three hand movements was performed out of the 10 served as their raw score (e.g. 7/10). The test was done right before (mean = 5.8 ± 3.7) and right after (mean = 7.4 ± 3.7) the single hour of dance class, and results showed a significant improvement ($p = 0.02$) according to the parametric paired t-test (Table 2).

Table 2 Short cognitive weekly tests analysis (paired *t* test)

	P value
Week 2—visuospatial	0.42
Week 3—fluency	0.16
Week 4—verbal recall	0.55
Week 5—executive functioning	0.02*
Week 6—attention	0.22
Week 7—quantitative reasoning	0.39

* Significant value ($P < 0.05$)

The results from the S&E ADL scale were also statistically significant ($p = 0.03$), as shown in Table 3. Higher percentages on the scale demonstrate higher levels of independence to perform daily tasks. The participants' class averages, 76% before and 82% after the 8 weeks, were comparable to the estimated average for the general population of those with early-onset PD at 78% (McRae et al., 2002). In comparison, the GSE and GDS analysis before and after 8 weeks of dance class did not show significance (Table 3). The average in GSE from our participants (28.8% before; 39% after) was consistent with studies estimating the national average for the normal adult population to be 29.5% (Schwarzer & Jerusalem, 1995). The participants' average for GDS (2.5 before; 2.5 after) is slightly lower than the estimated national average of 3.5 (Marc, Raue, & Brucem, 2008).

Additionally, there were several significant correlations with regard to the S&E ADL scale (Table 4). There was a strong positive relationship between the mean S&E ADL scores and the mean GSE scores, r value of 0.87 ($p = 0.02$). There was also a strong negative relationship between the mean S&E ADL scores and the mean GDS score, r value of -0.84 ($p = 0.04$). Lastly, there was a strong positive relationship between the mean GDS score and the change in the S&E ADL score over the course of the 8 weeks, r value of 0.93 ($p = 0.01$).

While some individual improvements were noted on the non-parametric tests administered before and after 8 weeks, there were no other significant findings. None of the 10 sections of the SCOPA-COG were found to have a significant change over the course of the 8 weeks when analyzed separately from the full test.

Table 3 Analysis of data before and after 8 weeks of dance class (Wilcoxon signed-rank test)

	US adult pop. avg.	Class avg. (before/after)	P value
General self-efficacy scale	29.5	28.8/30.0	0.75
Geriatric depression inventory	3.5	2.5/2.5	0.35
Schwab and England ADL	78% (w/PD)	76/82%	0.03*
SCOPA-COG	Not available	28.8/26.6	0.68

* Significant value ($P < 0.05$)

Table 4 Correlation analysis (Pearson's correlation coefficient test)

	R	Correlation	P value
Mean GSE and mean Schwab and England ADL	0.87	Strong, positive	0.02*
GDS and mean S&E ADL	−0.84	Strong, negative	0.04*
GDS and change in S&E ADL	0.93	Strong, positive	0.01*

* Significant value ($P < 0.05$)

The average scores (28.8 before; 26.6 after) and analysis ($p = 0.68$) are shown in Table 3.

Attendance by the participants varied during the 8-week long study. With a total of 16 dance classes during the study the average attendance was 11.4 ± 3.9 (data not shown). The written feedback provided by the participants on their final survey revealed great positive responses, offering qualitative support. Overall, the subjects were in agreement that the dance class helped them mentally, psychologically, and socially. One reported that the dance class "taught me to cope with my depression." Another stated she "enjoy[ed] the class because it [got] me out of the house and help[ed] me meet people." Others also noted improvements in their flexibility, coordination, and energy level. One participant even shared that although he failed to notice any physical changes over the course of the 8 weeks, he believed, nonetheless, that "the dance class was keeping the disease from progressing."

Discussion

Significant Findings

While improvements were noted in individual test results, most of the changes were small. However, there were several significant findings. Scores from the fist-edge-palm section of the SCOPA-COG before and after a single class period during week 5 significantly improved ($p = 0.02$). The fist-edge-palm exercise tested participant ability to demonstrate such aspects of executive functioning as problem-solving, initiating tasks, manifesting discipline, sustaining attention, and planning through a series of physical actions. This outcome suggests that dance may specifically improve the executive function domain of cognition. The overall scores on this section of the SCOPA-COG between the beginning of week 1 and the end of week 8 did show improvement, although without reaching statistical significance ($p = 0.12$). This suggests that the beneficial effect on executive function observed in the current study may be of only short duration, such that additional studies would be needed to determine any potential long-term effect. Even if the changes are only short-term, however, repeated short-term changes may be just as valuable as a permanent change.

Scores on the S&E ADL scale were significantly higher after 8 weeks ($p = 0.03$) suggesting an increase in the participants' perception of their own ability and locus of control. Mean S&E ADL scale scores were also correlated to mean scores on the

GSE scale and the GDS. The significant ($p = 0.02$) strong positive correlation between the S&E ADL scale and the GSE scale demonstrates an enhanced capacity to independently go about daily tasks. This relates closely to the concept of self-efficacy as a measure of confidence in one's abilities. Likewise, depression is one of the major symptoms associated with loss of independence and our results showed that there was a significant ($p = 0.04$) strong negative correlation between the S&E ADL and the GDS, demonstrating improved mood. This corresponds with studies that indicate that, relative to other exercise forms, dance resulted in greater improvement in mood and quality of life (Hackney et al., 2007a, b; Hashimoto et al., 2015; Rios-Romenets et al., 2015).

The benefits of a dance-based program for persons with PD extend to other areas, as well. Drugs are used in PD treatment largely to address physical changes and improve motor symptoms (Aminoff, 2007). Unfortunately, such treatments are often accompanied by side effects (Jain, Benko, & Safranek, 2012). Depression is also a debilitating comorbidity, frequently treated with medication, whereas therapeutic dance is a fun and cheap way to alleviate those symptoms without the risk of such side-effects. Moreover, while the dance instructors in this program were not trained dance/movement therapists, the class still focused on providing participants with variety of recreational physical activities, which has been linked to improved mood, cognition, reduced depression, and raised self-efficacy in people with PD (Colcombe & Kramer, 2003; Gordon et al., 2008; Reuter et al., 1999). Thus, it is reasonable that better GSE and GDS scores were linked to better mean S&E ADL scores, and it is likely that this would remain the case with a larger sample size as well.

The relationship between the GDS score and change in S&E ADL score is less clear. A significant strong positive relationship between the two suggests that those entering with higher levels of depression experienced a greater improvement in their ability to independently perform daily tasks over the course of the 8 weeks. While it is probable that those with higher levels of depression could have improved more on the scale because they started off at a lower baseline, these results may have been influenced by an outlier included in the data calculations and statistical analyses. Subject 3 was an outlier in both parameters and it is possible that he could have been responsible statistically for the significance of this correlation. This would need to be confirmed by replicating the study with a larger sample size.

Participants had positive written feedback regarding the dance class and their overall experience. They expressed enjoyment of the social interaction the class provided. They also indicated liking the occasion to meet new people who also had PD, as well as interacting and dancing with the students who participated in the dance clinic. This qualitative feedback reinforced quantitative analysis regarding the valuable benefits to be obtained by participating in a fun, inexpensive, and entertaining activity that has no side effects.

Decreased cognition, increased development of depression, and decreased self-efficacy are as debilitating to a person with PD as are the motor symptoms of the disease. Treatment protocols for PD currently focus on relieving motor symptoms, but treatment for non-motor symptoms has been largely neglected. Engaging in dance classes may be a partial solution for changing or alleviating the non-motor

disabilities of PD. Therapeutic dance is fun, inexpensive, without side effects, and a wide range of professionals are available to provide it (e.g. dance/movement therapists, occupational therapists, physical therapists, dance instructors).

Limitations

There were limitations regarding our participants that need to be addressed. Our study had a small sample size. Participants were diagnosed with PD at different times (1–11 years) and they had been attending the dance class for different lengths of time (3 months to 5 years). All of these factors could well have affected individual as well as group results. The results cannot be generalized, as participants were part of a non-uniform group of people with PD and functioned in retrospect as the study's own control subjects. Another limitation that potentially influenced the results was attendance. Some participants often had to miss class due, for example, to vacations, schedule conflicts, new health issues, and inclement weather. One participant had perfect attendance (16/16) whereas another was able to attend the class only once a week (7/16). Having a larger sample size of participants would help overcome these limitations. However, none of the correlation tests dealing with the relationship between attendance and other variables proved statistically significant. Additionally, multiple testers, including the instructors who conducted the study, may have introduced variability and thereby affected test reliability. This is true despite the fact that the tests used in the study were valid and reliable, and that administration of all testing was conducted in a standardized manner.

In addition, a systematic error might have positively influenced the results of the fist-edge-palm test at week 5. It is possible that the subjects improved on the test after one class period simply from having performed, and therefore practiced, the test before class (i.e., benefiting from a learning effect). Consequently, it is arguable that having more practice taking the test rather than gaining from the physical challenge facilitated by the dance class contributed to the changes identified. However, since other studies have also shown improvements in executive function directly following a short stint of exercise, the improvement observed in this study is not beyond what might be expected (Hillman et al., 2003). Moreover, scores should have also improved on other weekly repeated tests if this were the case. It would be possible to eliminate a recurrence of this error in a follow-up study by randomizing the timing of the test's administration over the duration of the study.

Recommendations for Further Research

Additional research with a larger number of participants would help support the outcomes of this preliminary study. In addition to repeating this study with a larger sample size, more stringent controls for potential sources of error and external factors are recommended (i.e., only using one person to administer the tests; and requiring subjects to have at minimum 90% attendance, for example, in order for their scores to be included as data).

This research could be extended through cross-sectional analysis. The same surveys and tests used in this study could be administered and compared to groups

of individuals with PD in different local exercise classes as well as to those not participating in any exercise regimen. Furthermore, the effects of different types of dance could be assessed using these same tests as well.

This study revealed a statistically significant improvement in executive function, in connection to movement. Consequently, additional research could also be designed to specifically assess the effects that dance may have on the domain of cognition. Further studies could assess different types of dances and their effects on individuals with PD at each stage of the Hoehn and Yahr Scale. Future studies might also demonstrate whether regular participation in dance class activities may provide long-term improvement in executive function.

Conclusion

Benefits of dance identified in this study include improved cognition, improved self-efficacy, and decreased depression in individuals with PD. This finding may support increasing the prevalence of dance as therapy to improve cognitive debility in the PD population. In addition, individuals with PD involved in community-based dance program activities are more likely to continue attending such classes regularly (Hackney & Earhart, 2010; Hackney et al., 2007a, b; Hashimoto et al., 2015; Rios-Romenets et al., 2015). Overall, these findings are promising and endorse the provision of dance for therapeutic programming as a potential solution to certain non-motor disabilities of PD. Structured dance programs associated with the PD community can offer community-based physical activities that are fun, engaging, and safe. Future studies could establish whether long-term dance classes can also alleviate or improve non-motor deficits associated with PD.

Acknowledgements The authors would like to thank the physical therapy students who assisted with this study along with Dr. Nancy Urbscheit, the founder and instructor of the "Let's Dance" PD dance class at Bellarmine University, for her excellent direction of the program and for allowing this research to be conducted. They would also like to recognize Bellarmine University for allowing and supporting this research study with special acknowledgement for the Honors program and Doctor of Physical Therapy program. Lastly, they thank the participants in this study for happily dedicating their time and effort to these tests and for their positive and delightful personalities that made this project a very enjoyable experience.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

Aarsland, D., Brønnick, K., Alves, G., Tysnes, O., Pedersen, K., Her, U., et al. (2009). Prevalence and characteristics of dementia in patients with early untreated Parkinson's disease. *Journal of Neurology, Neurosurgery and Psychiatry, 80,* 928–930.

Ahlskog, J. E., Geda, Y. E., Graff-Radford, N. R., & Petersen, R. C. (2011). Physical exercise as a preventive or disease-modifying treatment of dementia and brain aging. *Mayo Clinic Proceedings, 86*(9), 876–884.

Aminoff, M. J. (2007). Pharmacologic management of parkinsonism and other movement disorders. In B. G. Katzung (Ed.), *Basic and Clinical Pharmacology* (pp. 442–451). New York: McGraw-Hill Lange Medical

Archer, T. (2011). Physical exercise alleviates debilities of normal aging and Alzheimer's disease. *Acta Neurologica Scandinavia, 123*(4), 221–238.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist, 28*(2), 117.

Beekman, A. T., Copeland, J. R., & Prince, M. J. (1999). Review of community prevalence of depression in later life. *The British Journal of Psychiatry, 174*(4), 307–311.

Colcombe, S., & Kramer, A. F. (2003). Fitness effects on the cognitive function of older adults: A meta-analytic study. *Psychological Science, 14*(2), 125–130.

Davis-Berman, J. (1988). Self-efficacy and depressive symptomatology in older adults: An exploratory study. *International Journal of Aging and Human Development, 27,* 35–43.

Dirnberger, G., & Jahanshahi, M. (2013). Executive dysfunction in Parkinson's disease: A review. *Journal of Neuropsychology, 7*(2), 193–224.

Earhart, G. M. (2009). Dance as therapy for individuals with Parkinson disease. *European Journal of Physical and Rehabilitation Medicine, 45*(2), 231–238.

Elgh, E., Domellof, M., Linder, J., Edstrom, M., Stenlund, H., & Forsgren, L. (2009). Cognitive function in early Parkinson's disease: A population-based study. *European Journal of Neurology, 16,* 1278–1284.

Forjaz, M. J., Frades-Payo, B., Rodriguez-Blazquez, C., Ayala, A., & Martinez-Martin, P. (2010). Should the SCOPA-COG be modified? A Rasch analysis perspective. *European Journal of Neurology, 17*(2), 202–207.

Fujii, C., Aoshima, T., Sato, S., Mori, N., Ohkoshi, N., & Oda, S. (1997). Self-efficacy and related factors related in Parkinson's disease patients. *Nihon Kōshū Eisei Zasshi (Japanese Journal of Public Health), 44*(11), 817–826.

Gordon, B. A., Rykhlevskaia, E. I., Brumback, C. R., Lee, Y., Elavsky, S., Konopack, J. F., et al. (2008). Neuroanatomical correlates of aging, cardiopulmonary fitness level, and education. *Psychophysiology, 45*(5), 825–838.

Greenberg, S. A. (2012). The geriatric depression scale (GDS). *The Hartford Institute for Geriatric Nursing, New York University College of Nursing*, *4*. Retrieved from https://consultgeri.org/try-this/general-assessment/issue-4.pdf

Grembowski, D., Patrick, D., Diehr, P., Durham, M., Beresford, S., Kay, E., et al. (1993). Self-efficacy and health behavior among older adults. *Journal of Health and Social Behavior, 34*(2), 89–104.

Hackney, M. E., & Earhart, G. M. (2010). Recommendations for implementing tango classes for persons with Parkinson's disease. *American Journal of Dance Therapy, 32*(1), 41–52.

Hackney, M. E., Kantorovich, S., & Earhart, G. M. (2007a). A study on the effects of Argentine tango as a form of partnered dance for those with Parkinson disease and healthy elderly. *American Journal of Dance Therapy, 29*(2), 109–127.

Hackney, M. E., Kantorovich, S., Levin, R., & Earhart, G. M. (2007b). Effects of tango on functional mobility in Parkinson disease: A preliminary study. *Journal of Neurologic Physical Therapy, 31*(4), 173–179.

Hashimoto, H., Takabatake, S., Miyaguchi, H., Nakanishi, H., & Naitou, Y. (2015). Effects of dance on motor functions, cognitive functions, and mental symptoms of Parkinson's disease: A quasi-randomized pilot trial. *Complementary Therapies in Medicine, 23*(2), 210–219.

Hillman, C. H., Snook, E. M., & Jerome, G. J. (2003). Acute cardiovascular exercise and executive control function. *International Journal of Psychophysiology, 48*(3), 307–314.

Jain, L., Benko, R., & Safranek, S. (2012). Q/which drugs work best for early Parkinson's disease? *Journal of Family Practice, 61*(2), 106–108.

Julayanont, P., Phillips, N., Chertkow, H., & Nasreddine, Z. S. (2013). The Montreal cognitive assessment (MoCA): Concept and clinical review. In A. J. Larner (Ed.), *Cognitive screening instruments: A practical approach* (pp. 111–151). London: Springer.

Kandiah, N., Narasimhalu, K., Lau, P., Seah, S., Au, W., et al. (2009). Cognitive decline in early Parkinson's disease. *Movement Disorders, 24,* 605–616.

Marc, L. G., Raue, P. J., & Bruce, M. L. (2008). Screening performance of the geriatric depression scale (GDS-15) in a diverse elderly home care population. *The American Journal of Geriatric Psychiatry, 16*(11), 914–921.

Marinus, J., Visser, M., Verwey, N., Verhey, F., Middelkoop, H., Stiggelbout, A., & van Hilten, J. (2003). Assessment of cognition in Parkinson's disease. *Neurology, 61,* 1222–1228.

McNeil, J. K., LeBlanc, E. M., & Joyner, M. (1991). The effect of exercise on depressive symptoms in the moderately depressed elderly. *Psychology of Aging, 6,* 487–488.

McRae, C., Diem, G., Vo, A., O'Brien, C., & Seeberger, L. (2002). Reliability of measurements of patient health status: A comparison of physician, patient, and caregiver ratings. *Parkinsonism & Related Disorders, 8*(3), 187–192.

Okun, M., & Watts, R. (2002). Depression associated with Parkinson's disease. *Neurology, 58*(1), 63–70.

Petzinger, G. M. (2009). Does exercise impact Parkinson's? *Parkinson's Disease Foundation*. Retrieved from http://www.pdf.org/en/parkinson_exercise_impact

Physical Activity Guidelines for Americans. (2008). *U.S. Department of Health and Human Services*. Retrieved from https://health.gov/paguidelines/pdf/paguide.pdf

Reuter, I., Engelhardt, M., Stecker, K., & Baas, H. (1999). Therapeutic value of exercise training in Parkinson's disease. *Medicine and Science in Sports and Exercise, 31,* 1544–1549.

Ridgel, A., Kim, C., Fickes, E., Muller, M., & Alberts, J. (2011). Changes in executive function after acute bouts of passive cycling in Parkinson's disease. *Journal of Aging and Physical Activity, 19,* 87–98.

Rios-Romenets, S., Anang, J., Fereshtehnejad, S. M., Pelletier, A., & Postuma, R. (2015). Tango for treatment of motor and non-motor manifestations in Parkinson's disease: A randomized control study. *Complementary Therapies in Medicine, 23*(2), 175–184.

Schwarzer, R., & Jerusalem, M. (1995). Generalized self-efficacy scale. In J. Weinman, S. Wright, & M. Johnston (Ed.), *Measures in health psychology: A user's portfolio. Causal and control beliefs* (pp. 35–37). Windsor, UK: NFER-NELSON.

Sobreira, E., Pena, M., Filho, J., Souza, C., Oliveira, G., Tumas, V., & de Assis Carvalho do Vale, F. (2008). Executive cognitive tests for the evaluation of patients with Parkinson's disease. *Dementia & Neuropsychologia, 2*(3), 206–210.

Troster, A. (2011). Cognition and Parkinson's. *Parkinson's Disease Foundation*. Retrieved from http://www.pdf.org/en/cognitive_impairment_pd

University of Maryland Medical Center. (2011). Low intensity treadmill exercise is best to improve walking in Parkinson's, study suggests. *ScienceDaily*. Retrieved from https://www.sciencedaily.com/releases/2011/04/110412162404.htm

Vallet, G. T. (2015). Embodied cognition of aging. *Frontiers in Psychology, 6,* 463. doi: 10.3389/fpsyg.2015.00463.

Van Den Eeden, S. K., Tanner, C. M., Bernstein, A. L., Fross, R. D., Leimpeter, A., Bloch, D. A., & Nelson, L. M. (2003). Incidence of Parkinson's disease: Variation by age, gender, and race/ethnicity. *American Journal of Epidemiology, 157*(11), 1015–1022.

Westbrook, B. K., & McKibben, H. (1989). Dance/movement therapy with groups of outpatients with Parkinson's disease. *American Journal of Dance Therapy, 11*(1), 27–38.

White, K., Kendrick, T., & Yardley, L. (2009). Change in self-esteem, self-efficacy and the mood dimensions of depression as potential mediators of the physical activity and depression relationship: Exploring the temporal relation of change. *Mental Health and Physical Activity, 2*(1), 44–52.

Chantal M. Prewitt, Ph.D.
is currently an Assistant Professor in the Doctor of Physical Therapy Program at Bellarmine University in Louisville, Kentucky. She received her Ph.D. in Anatomy and Neurobiology from the University of Kentucky in Lexington, Kentucky.

Jasmine C. Charpentier
is currently a second year physical therapy student in the Doctor of Physical Therapy Program at Bellarmine University in Louisville, Kentucky. She received her Bachelor in Exercise Science from Bellarmine University in Louisville, Kentucky.

Joseph A. Brosky, PT, DHS, SCS
is a Professor, Chair, and Program Director in the Doctor of Physical Therapy Program at Bellarmine University in Louisville, Kentucky. He received his Bachelor in Physical Therapy from the University of Kentucky in Lexington, Kentucky, and his Doctor of Health Science from the Krannert School of Physical Therapy at the University of Indianapolis in Indianapolis, Indiana. Dr. Brosky is board certified in Sports Physical Therapy from the American Board of Physical Therapy Specialties.

Nancy L. Urbscheit, Ph.D., PT
is a Professor Emeritus in the Doctor of Physical Therapy Program at Bellarmine University in Louisville, Kentucky. She received her Bachelor in Physical Therapy and her Ph.D. from the State University of New York at Buffalo, in Buffalo, New York.