Feasibility of an Intensive Trial of Modern Dance for Adults with Parkinson Disease

Glenna Batson

Complementary Health Practice Review 2010 15: 65
DOI: 10.1177/1533210110383903

Complementary Health
Practice Review
15(2) 65-83

DOI: 10.1177/1533210110383903
http://chpr.sagepub.com
SAGE

Feasibility of an Intensive Trial of Modern Dance for Adults with Parkinson Disease

Glenna Batson, PT, ScD, MA[1]

Abstract

Although preliminary evidence supports the psychophysical benefits of dance for adults with Parkinson disease, guidelines for community-based dance programs await further scrutiny for safety and efficacy. This pilot study was designed to assess the feasibility of an intensive trial of group-delivered modern dance for 11 adults with early-to-middle stage Parkinson's. The Timed "Up and Go" test and the Fullerton Advanced Balance scale were administered to assess balance safety and re-administered at closure along with a self-reported feedback questionnaire. Video recordings were analyzed for qualitative behavioral change. Pre/posttest comparisons from the Timed "Up and Go" test were not significant, while those from the Fullerton Advanced Balance Scale were significant at the .05 level for the group as a whole ($p = .01$) with an average score change of $+3.1$ points. Although qualitative results generally concurred with the social benefits associated with an enjoyable form of expressive exercise, important indicators surfaced bearing on future research and community program designs. These include need for more rigorous stratification of participants and adapting dance class structure to address specific group needs to promote motor learning for sustained functional gains.

Keywords

parkinson, dance, feasibility, balance

Each year, 114.7 adults per 100,000 between the ages of 50 and 99 are diagnosed with degenerative, idiopathic Parkinson disease (Bower, Maraganore, McDonnell, & Rocca, 1999). Clinical signs of Parkinson disease (PD) manifest as bradykinesia, rigidity, resting tremor, freezing episodes, and postural instability (Morris, Iansek, Summers, & Matyas, 1995). Weak and inflexible postural responses and stereotypical movement patterns such as shuffling steps and reduced foot clearance at swing in gait are associated with high risk of falls (Bloem et al., 2004; King & Horak, 2009; Kim, Horak, Carson-Kuhta, & Park, 2009). As the disease advances, moving spontaneously becomes progressively more difficult. Movements become slower and halted and are marked by episodes

[1] Department of Physical Therapy, Human Performance & Biodynamics Laboratory, Winston-Salem State University, Winston-Salem, NC, USA

Corresponding Author:
Glenna Batson, Winston-Salem State University, 601 Martin Luther King Jr Drive, Winston-Salem, NC 27110, USA
Email: batsong@wssu.edu

of freezing and other abnormal movements. Robbed of spontaneous expression of normal movement amplitude and timing, persons become habituated to progressively smaller spheres of activity and nonuse (Hirsch, 2009). These deficits lead to forced reliance on conscious attention and cognitive control strategies to sustain the flow of the simplest of automatic everyday actions, such as sitting-to-standing, walking, and turning (Smith & Batson, 2010).

Although both the etiology of PD (Olanow & Tatton, 1999) and its cure (Nieuwboer, De Weerdt, Dom, & Lesaffre, 1998) appear elusive, the more promising non-pharmacological (or nonsurgical) treatments for improving postural stability are those that challenge dynamic balance by demanding continual adjustment to changing environmental contexts (Hirsch, Toole, Maitland, & Rider, 2003). Such an overall goal for exercise—especially for people with neurological impairments—should be to provide an environment conducive to solving motor problems leading to acquisition, retention, and transfer of functional capabilities similar to the functional demands of everyday life (Goodwin et al., 2008; Hirsch, 2009). Evidence-based examples purporting to test such an approach include Tai Chi (Li et al., 2007) and treadmill aerobic exercise (Skidmore, Patterson, Shulman, Sorkin, & Macko, 2008).

Recently, dance has shown promise as a rhythmic, enjoyable, social, and cost-effective intervention that helps adults with PD improve mobility and balance, as well as enhance cognitive and psychological performance (Hackney & Earhart, 2010; Hackney, Kantorovich, & Earhart, 2007; Westheimer, 2008). Dance is ''human behavior composed of purposeful, intentionally rhythmical, and culturally influenced sequences of nonverbal body movements and stillness in time and space and with effort'' (Hanna, 2008, p. 492). Modern dance is a subset of 20th-century Western classical dance, which constitutes a form of nonverbal communication through bodily gesture. ''Dancers declare or make visible, thoughts, ideas, and images through patterns of movement and stillness of their body'' (Stevens & McKechnie, 2005, p. 249). Such nonverbal communication occurs through at least three intersecting ways: (a) action observation—direct perception and experience of physical motion of the whole moving body and facial expression through neural mirroring and kinesthetic resonance (Gallese, 2007); (b) recognition and recall of patterns and structures, which call upon both declarative and procedural learning (Stevens & McKechnie, 2005); and (c) rhythm as an aid to learning and guiding motor coordination.

Attending to the body as it moves through space enhances motor learning (Baker et al., 2007). Challenging perception of spatial relations and exploring movement range, allegedly strengthens neural connections in brain regions representing the body schema (Haggard & Wolpert, 2005). Many natural, complex sensorimotor activities (e.g., sports, leisure activities, and select physical occupations) also involve integration of spatial patterning, rhythmic synchronization, and coordination of the whole body (Brown, Martinez, & Parsons, 2006). Although modern dance contains movements that could also be called ''functional'' or task-specific (e.g., bending, walking, and reaching), it is distinguished from both functional and athletic activities in that the ''goal'' of movement is the deliberate and purposeful expression of the body itself through movement (Longstaff, 2000; Stevens & McKechnie, 2005).

The therapeutic value of dance has been established for elderly populations (Hui, Chui, & Woo, 2009). Older adults who dance have shown improvements in balance, functional mobility, and motivation to choose healthier, more active behaviors (Song, June, Kim, & Jeon, 2004; McKinley et al., 2008). At the same time, dance differs from other complementary therapies in its use of improvisation, musical accompaniment, partnering (intentional touch to lead and follow in movement), and progression of complexity of coordinative structures (Hackney & Earhart, 2010; Stevens & Mckechnie, 2005).

Although initial reports of the benefits of dance for this population are promising (Earhart, 2009), moving toward standardized practice guidelines is challenging. PD-related associations endorse community-based programs or commercial videos on their websites, but none of these programs

or tools have been rigorously tested for feasibility, safety, or efficacy (Hirsh, 2009). Exercise prescriptions of any kind for persons with PD need to take into account multiple intrinsic and extrinsic variables. Participant satisfaction and enjoyment in exercise (O'Brien, Dodd, & Bilney, 2008) and in dance classes (Hackney & Earhart, 2010) have been well documented. Yet, issues affecting on feasibility such as compliance, teacher-to-participant ratio, group familiarity (with other group members as well as with exercise mode), safety in movement choices to reduce fall risk, and long-term effects on functional and behavioral status, also must be investigated more thoroughly.

This pilot study primarily was designed to assess the feasibility and safety of group delivery of an intensive trial of modern dance on mobility and balance in adults with early-to-middle stage PD. Feasibility is defined as adherence, cost, ease of attendance and participation, level of risk (adverse occurrences such as falls or other medical episodes), and potential for long-term follow-up either individually or as a group. A second aim was to explore the value of quantitative measures of balance heretofore not researched in studies on dance and PD and to examine qualitative data for trends toward physical and behavioral change. Such prospective data would assist in designing future research on dance protocols that would meet the specific needs of this population. Given the brief, intense intervention, the research team speculated that the participants would participate fully without adverse incidents and that trends toward functional gains would be evident in qualitative observation and on select balance measures.

Method

This pilot research (quasi-experimental, single group pretest–posttest) was approved by the Institutional Review Board at Winston-Salem State University (WSSU). The study received funding from a Research Initiation Grant awarded by the WSSU Graduate School.

Participants

Eligibility included adults between 50 and 85 years old, diagnosed primarily with idiopathic PD, who were dwelling independently in the community and who required minimal assistance in transfers and ambulation. Excluded were those diagnosed with additional neurological disorders, history of head trauma, and cognitive or hearing impairments that would interfere with hearing music and/or hearing or following verbal instructions.

Recruitment proved challenging. Although 28 PD support groups exist in the state of North Carolina, this was the first time in the state that research involving a dance protocol was offered to this population. Although there is national recognition of the potential benefits of dance for people with PD (Westheimer, 2008), little knowledge of these purported benefits had filtered down to the medical or lay communities in the region. Due to a variety of reasons, the study had to be rescheduled and relocated several times to recruit a reasonable sample of participants. A convenience sample ultimately was recruited from a wellness center affiliated with a teaching hospital in North Carolina. The wellness center attracted a large number of people with PD, who routinely exercised and/or received outpatient therapy, including participating in the "Big and Loud" program run by the staff speech and physical therapists (LSVTGlobal®, 2010). Located in a shopping mall with free parking, the center provided easy access for a relatively homogeneous sample of active, independent, community-dwelling adults with PD, most of whom already had bonded socially.

Twelve prospective participants met the eligibility criteria and obtained their doctor's clearance to participate. One participant cancelled prior to intake testing due to complaints of hot weather. The study was offered free of charge, with a $50 honorarium promised to those completing at least two thirds of the dance classes and the posttest session. The final group of eligible participants included 11 adults (5 males and 6 females, mean age 72.7 $\pm$ 8.7) with early-to-middle stage Parkinson

Table 1. Demographics of Adults with Parkinson Disease in a Modern Dance Class

ID	Age	G	Dx Yr	MMSE	MFES	PD Meds	Falls	Freeze	Turning	Hx Dance
201	84	M	2010	30	8.5	Sinemet	0	N	N	Y
202	61	F	2008	30	8.1	Sinemet	6–12	N	N	N
203	71	F	2008	30	9.2	Azilect	0	N	Y	N
204	72	M	2009	29	5.8	Sinemet	1	N	Y	N
205	70	M	2009	30	9.6	none	0	N	N	N
206	77	F	2008	29	7.9	Sinemet	1	Y	Y	N
207	61	M	2007	30	7.4	none	1	Rare	Y	N
208	78	M	2008	29	7	Sinemet	2	N	N	N
209	79	F	2004	30	10	Requip	1	N	N	N
210	84	M	2010	29	8.9	Sinemet	1	N	Y	Y
211	61	F	2005	30	8.9	Sinemet	1	N	N	N
AV	72.5			29.6	8.3					
SD	8.7				1.2					

Note. Dx Yr = Year of diagnosis, MMSE = Mini-Mental State Exam score, MFES = Modified Falls Efficacy Scale (balance confidence score), Falls = within the last year, freezing episodes, trouble with turning, previous dance training (yes = ballroom only).

disease (Hoehn & Yahr, 1967 score of 1–2.5). All participants were within 1–6 years of diagnosis of idiopathic PD, except one person with non-idiopathic PD. Seventy-five percent had fallen at least once in the last year. (See Table 1, for demographic information about the study sample.) Prior to study enrollment, most reported overall good health and pursued an active lifestyle of exercise, leisure, and support group activities. Participants were allowed to continue all current activities but were asked not to enroll in any new activities during the study. None of the subjects had previous experience with modern dance but the two oldest male participants practiced ballroom dance.

Data Collection and Measures

At intake, the study coordinator requested that all participants sign informed consent. Additionally, all were requested to complete a medical questionnaire on current and past medical history, fall history, freezing episodes, and basic problems with mobility in activities of daily living. Those expressing difficulty in filling out the forms independently could receive the help of a proxy. Three participants required help from their spouses one due to general movement slowness with hypophonia and hypokinetic speech and two needed help recalling the number and type of prescribed medications they were currently taking.

Screening

At intake, the Mini-Mental State Exam (MMSE; Folstein, Folstein, & McHugh, 1975) served as a basic screen of cognitive status for safety. This brief cognitive screening test helped establish whether potential participants were oriented and able to hear, comprehend, follow, and remember two- and three-step commands. A more rigorous cutoff point on the MMSE has been suggested to detect cognitive deficits (27 of the 30 points, rather than 23–24, established in the original instrument; Jefferson et al., 2002). In the current study, none of the participants scored less than 29 of the 30 points (Table1), indicating no significant cognitive impairment that alone would jeopardize their ability to participate. The Modified Falls Efficacy Scale (MFES) also was administered as a baseline for balance confidence (Tinetti, 1986). The MFES is a self-reported scale of 14 items, in which persons rate their balance confidence on a scale from 1 (lowest perceived confidence) to 10 (highest) in performing simple activities of daily living (e.g., walking around the house, walking outside, and

cooking). Subjects averaged 8.3 ($\pm$1.2), out of a possible 10 points across all 14 items, indicating good ability to conduct themselves independently in daily activities without assistance or fear of falling (Tinetti, 1986). Determinants of balance confidence and the relationship between balance confidence and fall risk are conjectural in people with PD (Mak & Pang, 2009). Nonetheless, administering the MFES helped establish a relative baseline of perceived confidence in daily navigation in this group.

Balance Testing

Selected measures of balance were administered by two community-based, licensed physical therapists with at least 5 years of clinical experience. The physical therapist testers were blind to the ultimate aims and outcomes of the study, as well as the movement choices in the dance protocol. Before intake screening or testing began, both therapists underwent a 4-hr training session at the testing site on the mechanics of test administration to ensure standardization and reliability in the testing procedures, as well as emergency procedures to ensure safety.

Selection of balance measures was based on evidence suggesting that no one clinical test is sufficient to fully assess postural stability in this population (Brusse, Zimdars, Zalewski, & Steffen, 2005). Two measures were selected on the basis of their clinical utility and comprehensiveness, as well as their validity, sensitivity, cost-effectiveness, and prospective use in future research: (a) the Timed ''Up and Go''(TUG; Nordin, Rosendahl, & Lundin-Olssen, 2006) and (b) the Fullerton Advance Balance Scale (FAB; Rose, Lucchese, & Wiersma, 2006). The physical therapists administered the TUG and the FAB across two time periods: first, at intake (along with the MMSE), to objectively assess participants' ability to participate safely in an active dance exercise class, and again within 1 day of the conclusion of the study (posttest). Subsequent pretest–posttest comparisons were analyzed for trends toward change in balance and mobility in prospectively designing future research. Although statistically significant pre–post differences were not anticipated for either test, the study coordinator speculated that pretest–posttest comparisons on these objective tests would show a trend toward improvement in balance and that video analysis would show discrete alterations in coordination not commonly captured by clinical tests (Haggard, 1997).

The TUG is a timed test (in seconds) of movement efficiency and is an indirect measure of functional balance and fall risk (Shumway-Cook, Brauer, & Woollacott, 2000). Participants stand up from a chair (with arms), walk 3 m at a comfortable pace, turn around to walk back to the chair, and sit down. A TUG score of 13.5 s or longer is predictive of a 90% risk for falls (Shumway-Cook et al., 2000; Morris, Morris, & Iansek, 2001). Here, freezing or episodes of postural instability (near falls and actual falls) were tracked.

The FAB is a 10-item ordinal scale of dynamic balance designed to reveal possible functional limitations in visual, somatosensory, and vestibular sensory systems as well as neuro-musculoskeletal limitations (Rose et al., 2006). The FAB combines elements of several standardized balance tests, such as standing together with eyes closed, turning 360, and functional reach (Berg Balance Scale; Berg, Wood-Dauphinee, Williams, & Maki, 1992), standing on foam with eyes closed (Clinical Test of Sensory Interaction on Balance; Shumway-Cook & Horak, 1986), walking with head turns (Dynamic Gait Index; Marchetti & Whitney, 2006), and reactive postural adjustment (Push and Release Test; Jacobs, Horak, Tran, & Nutt, 2006). Elderly persons who score 25 points or lower (out of a possible 40 points) are deemed at high risk for falls (Hernandez & Rose, 2008).

Both testing sessions took place in the same room as the dance classes and conditions were kept consistent across time periods. As per standardized guidelines for each test, a mean of two trials for the TUG was recorded, along with one trial of the 10 items in the FAB. All tests and dance class sessions were video recorded with a camera stationed on a tripod in one corner of the room.

Feasibility

Feasibility was assessed by compliance (attendance), attrition rate, administration requirements and costs, incidence of adverse events, and responses to participation on the feedback questionnaire. Compliance was defined as daily program attendance and was calculated by dividing the number of person-sessions missed by total person-sessions. Administration requirements included space allocation, access to the therapy site, transportation, and personnel costs required to administer the study. Adverse events were defined as falls or abnormal physiological responses to exercise, such as syncope, diaphoresis, or long-term muscle pain as monitored by the study coordinator, the dance teacher, and/or the participant himself or herself, or the caregiver. Caregivers also were invited to participate as desired but their personal responses to the study were not considered as data.

Protocol

A large 30 square feet multipurpose room at the back of the wellness facility was offered free of charge to the study coordinator. The room was well lit, with adjustable temperature controls for comfort. The room had no mirrors and the door could be closed for privacy. Stackable, cushioned chairs with armrests were placed in a large open circle to start the class, with other chairs placed at the perimeter of the room for resting as needed. Participants were instructed to wear comfortable clothing and closed-toed, nonslippery or sticky shoes to facilitate ease of movement on the thin industrial carpet. Caregivers were invited to participate actively in the class but were asked to refrain from merely observing to allow for those persons with PD to participate freely without scrutiny. All persons were asked to participate during the "on" phase of their medication regimen during testing and class sessions.

The dance classes began 3 days after the second baseline test. The 3-week training schedule consisted of nine classes, scheduled each Tuesday, Wednesday, and Thursday of 3 consecutive weeks. Each class was 85 min in length for a total of approximately 11 hr of instruction. Trained health care personnel, water and juice, and bathroom facilities were in close proximity at all times.

A dance teacher with 35 years of teaching experience was hired to teach all classes. Although the teacher had no prior experience teaching movement to this population, she had extensive experience teaching movement classes to the well elderly. She was selected not only on the basis of the length of her teaching experience (mostly at the college level) but also for her knowledge and expertise in teaching older populations fitness classes, modern dance, and folk dance. The teacher was counseled in advance by the study coordinator only on issues of safety in movement choices, such as the need to avoid abrupt transitional movements in standing, and excessive or abrupt movements of the head and neck. Choices for movement content, sequencing, pacing, and musical accompaniment were entirely drawn from previous experience with the elderly and from observing commercial tapes of exercise classes endorsed by Parkinson disease associations.

The teacher's rationale for her method was to use three specific modern dance constructs: (a) awakening and augmenting participants' sensory perception of their whole body moving with a clear sense of direction through space; (b) maximizing balance perturbations within margins of safety; and (c) maximizing a sense of personal efficacy (what the teacher referred to as encouraging "permission to move"). This latter construct implied challenging participants' capacity to move autonomously by improvisational problem solving, rather than merely imitating the teacher. Each class was taught with compact discs and taped music consisting of mixed instrumental tunes selected to complement movement choices. The dance movements mimicked many functional movements common to everyday life (walking with swinging arms, bending, and reaching) but were not task-specific. These functional movements, when taught within a dance context, demand more random balance perturbations and challenge a wider range of motion and variety of dynamics not readily

encountered in daily living. Many of the elements practiced were conducive to motor learning, such as repetition with variation, part- and whole body coordinated activities, memory and recall, and mental practice of motor imagery (Schmidt & Lee, 2005).

The class was divided into three parts. These three parts progressed from more static activities in sitting to more dynamic movements both in static standing and crossing the floor in linear and curvilinear weaving patterns. Part one of the class included a relatively fast, energetic 7- to 10-min warm-up in the chair that emphasized awakening sensory awareness and orienting to the whole moving body. The teacher spoke loudly, clearly, and authoritatively, so that her verbal guidance could serve as an auditory cue (in addition to the music) in helping participants coordinate breathing with rhythmic movement. The teacher's intentional physical demonstrations also helped reinforce movement learning and coordination through ample use of visual and verbal cueing. Using words rich in visual and kinesthetic imagery interspersed with counting, the teacher explored three basic movements in sitting: slow, sequential, and rhythmic flexion, extension, and rotation of the spine, leg movements in alternating rhythmic patterns (e.g., marching, Charleston, etc.), and reaching with the arms near and beyond the base of support. Improvisation was introduced during the chair exercise segment, in which the teacher asked for volunteers to create a movement, until three or four movements were offered. These gestures were woven into a sequential ''dance.''

Part two of the class consisted of approximately 30 min of standing and ambulating activities. The teacher advanced the pace to the level of a low aerobic effort. Participants needed simultaneously to be mindful not only of their own body movement but of others moving quickly in the group in close proximity to one another. Lower limb movements were kept simple and functional (free of syncopated steps). Rather, the teacher emphasized and exploited moving spatial relationships, such as linear, diagonal, and random walking pathways in which participants could practice weaving in and out of the line of progression. The weaving not only was designed to challenge balance but also to facilitate affect through social interaction. The level of complexity of coordination increased when the teacher asked participants to coordinate the arm movements they had learned in the chair with various walking patterns. This portion of the class also exploited large range trunk and upper body movements. Smaller-to-larger body and arm movements were performed in cardinal, diagonal, and random spatial pathways with variations in muscular effort (e.g., ''flicking,'' ''pushing,'' and ''slicing'' with the arms). Hands-on assistance was kept to a minimum throughout the class unless a participant appeared at risk of physical harm to self or others. The teacher was alert to changing the class pace when individuals appeared at risk for fatigue, falling, or other potentially adverse events.

Part three of the class involved an additional 15–20 min of small group improvisation. For example, standing in place, participants would invent ''hand dances'' where one hand ''had a conversation'' with the other hand. Participants were guided first to ''chatter'' (quick and small movements) from one hand to another or to ''yawn'' (big and slow movements). The hand dances gradually evolved into creative improvised ''conversation'' among two to four other group members. The last 8–10 min of the class involved a slower paced cooldown period that transitioned back to sitting and resting. Participants often stayed 10–15 min after the class ended to socialize and share experiences. At the conclusion of the 3-week study, all participants were given a self-reported feedback questionnaire to complete overnight and submit when they returned the next day by appointment for the balance posttesting session.

Data Analysis

SPSS Version 7.0 and Excel 2003 were used to analyze statistics from the FAB, the TUG, and basic descriptive intake data. Significance for parametric and nonparametric statistics was set at $p = .05$ (Portney & Watkins, 2008). A Canon 2R65 digital video camcorder was used to record testing and class sessions. These data were analyzed by the study coordinator and by an objective physical

therapist observer not connected with the study. Results from items on the feedback questionnaire (Appendix 1) were collated and averaged.

Results

Feasibility

All 11 participants completed the study, both pre- and post-study sessions, and the feedback questionnaire. No adverse events occurred within the class time or nor were noted secondarily to lingering effects of the class. The class series was delivered at a low cost of $720, inclusive of dancer teacher's fee and refreshments. Feedback results from the questionnaire indicated overall satisfaction with having attended the class series but select problems were acknowledged with regard to class pacing and select movement choices.

Balance

Pre/posttest comparisons from the Timed "Up and Go" test were not significant (Table 2); Pre/posttest comparisons from the Fullerton Advanced Balance Scale were significant at the .05 level for the group as a whole ($p = .01$) with an average change in score of +3.1 points (Table 3).

Discussion

The primary purpose of this study was to determine the feasibility of modern dance for a small sample of adults with PD. Although general guidelines exist on appropriate modes of exercise for persons with neurodegenerative diseases, little research has been conducted on the impact of specific components of exercise on either short- or long-term mobility in PD (King & Horak, 2009). A second aim, therefore, was to examine both quantitative and qualitative data to help design protocols for prospective studies.

Feasibility

Initial evidence of feasibility in this study is seen in the high level of compliance (attendance), lack of attrition or adverse events, cost-effectiveness, and overall satisfaction and social benefits of

Table 2. Pre- and Posttest Scores on the Timed "Up and Go" Test of Participants With Parkinson Disease in a Modern Dance Class

ID	Pre	Post	Difference
201	8.6	7.7	−.9
202	22.0	18.4	−3.6
203	10.4	10.3	−.1
204	14.3	12.8	−1.5
205	8.9	11.1	+2.2
206	11.6	11.0	−.6
207	21.5	18.8	−.6
208	15.8	12.4	−3.4
209	18.4	22.8	+4.4
210	10.0	9.9	−.1
211	12.2	9.6	−2.6
M	13.9	4.8	
SD	13.1	4.7	

Note. Time in seconds. Minus (−) indicates increased speed (faster performance); Plus (+) indicates slower speed.

Table 3. Pre- and Posttest Total Scores on the Fullerton Advanced Balance Scale of Participants With Parkinson Disease in a Modern Dance Class

ID	PreFABtot	PostFABtot	Change
201	35	35	0
202	24	28	+4
203	23	24	+1
204	23	29	+6
205	31	36	+4
206	25	26	+1
207	26	28	+2
208	27	31	+4
209	19	16	−3
210	27	30	+3
211	25	31	+6
M	25.9	28.5	+3.1
SD	4.2	5.4	

Note. Pre-study and post-study totals. Top score = 40 points < 25 = 90% fall risk.

participation. Each of these elements will be discussed in turn. Attendance was 91% ($n = 11$). One participant joined during the second week of the study but participated fully during the second 2 weeks. Another fell at home during the second week and missed four classes midway through the study, but attended all remaining sessions, including posttesting. Compliance was 100% for the remaining nine subjects. By the conclusion of the study, most of the participants had forgotten about the prospective $50 gift card honorarium, making it unlikely that this gift constituted an inducement to attendance. The group as a whole was able to sustain attention and follow verbal and musical cueing for up to 40 min of progressively complex movements. Rarely did any group members sit out due to apparent fatigue, pain, or inability to follow.

Total cost of the program was $720 (inclusive of a $700 fee paid to the dance teacher and $20 for refreshments). Additional research expenses that would not be budgeted for in a routine community dance class, included $3600 total paid to the 2 licensed physical therapists for administering the tests, a $50 honorarium offered to each of the 11 participants who completed the study, $100 expenses for the study coordinator for gas and incidentals, and $60 for recording materials (camcorder mini-tapes and DVDs). The wellness facility space was offered free as a service to the community.

Impact on Balance

Dynamic balance depends on integration of multi-sensory input, flexible attention (ability to dual- and multi-task), and quick reactive responses to changes in direction and environmental surfaces (Jacobs & Horak, 2007; King & Horak, 2009). All these are challenged in dance through rapid internal and external perturbations with a variety of muscular dynamics and speeds. Participants in this study did not appear to gain in movement efficiency. Pre/posttesting results from the Timed "Up and Go" test were nonsignificant for the group ($n = 11$; Table 2). Nor was there a trend toward significance. Average pre- and post-study scores comparatively were 13.9 s ($\pm$4.8) and 13.1 s ($\pm$ 4.7), respectively. Although movement performance was faster for the group as a whole (9 of the 11 participants), most participants scored within 1–2 s of their pretest value, possibly indicating a learning effect more than an actual functional gain. Two participants (205 and 209) scored higher (i.e., an increase in seconds, indicating a subsequent decrease in gait speed). The increase in speed (slower performance) for participant 205 (8.9 s pre vs. 11.1 post), possibly was due to persistent leg pain

secondary to falling at home several days earlier. For undetermined reasons, participant 209's posttest scores were slower on the TUG (18.4 pre- vs. 22.8 s post) as well as on the FAB (a score of 19 pre vs. 16 post; Tables 2 and 3). Meaningful change in the TUG has been established (a decrease of 4.09 s) for those with Alzheimer disease (Ries, Echternach, Nof, & Blodgett, 2009) but not for Parkinson disease. Two participants approached ta posttest value of over 3.5 s (Table 2), participants 208 and 202. Participant 208 was the youngest and fittest of the male participants. Conversely, participant 202 was the most impaired in terms of bradykinesia and masked facies. Her posttest TUG score decreased by nearly 4 s, implying increased movement efficiency. Qualitatively, she appeared to show significant gains in her affect, physical and facial expressiveness, and her ability to move and coordinate complex movements.

In general, this group of participants appeared to be at a lower functional level than the group with PD researched in a study on tango (Hackney et al., 2007). The group was slower on average on the TUG at baseline than the experimental tango group (10.7 ± 0.4 s pre and 9.8 ± 0.4 s post) reported by Hackney et al. For this group of persons with PD, self-reported number of falls over the last year and pretest FAB scores suggested a higher risk of falling for more than half of the group. Mean time on the TUG among the elderly has been reported as higher for those at risk for falling (11.1 vs. 13.0 s for male non-fallers vs. fallers and 13.0 vs. 13.9 for female; Thrane, Joakimsen, & Thornquist, 2007). Although reaction times of persons with PD generally have been shown to decrease (i.e., movement gets faster) when cues are externally cued (rather than self-initiated; Ballanger et al., 2006; Siegert et al., 2002), low power and inadequate dosage renders the results of this study insufficient to interpret significance.

Results on the Fullerton Advanced Balance Scale were significant at the .05 level for the group as a whole ($p = .01$) with an average change in score of +3.1 points (Table 3). Of note is that at intake, half of the participants scored at or lower than the baseline score of 25 (high risk for falls). Gains primarily were noted in more dynamic or multitasking items, such as changing levels, Item 6 (Step up and over a 6" bench, $p = .002$), and multitasking with vestibular perturbation, Item 9 (Walking with head turns, $p = .01$). Neither of these movements were practiced during the dance series. Scores for the FAB have not been standardized to detect meaningful significant differences—either statistically or practically. At the same time, the results of this study are promising. Post-study score improvement implies a trend toward balance improvement after a brief and relatively intense intervention, although further research involving larger and more stratified samples, increased control, and long-term retention.

Participant Feedback

Important factors affecting on design of future studies and classes surfaced from participant responses on the feedback questionnaire (see Appendix 1 for questionnaire). Participants were candid in commenting on the organizational structure of the class and their perceived gains (physical and social). A number of suggestions were offered in regard to pacing and music choices, movement choices, familiarity and length of the study, and perceived value for continued participation.

Pacing

Participants generally reported that the pace was too fast, especially in more complex steps such as braiding (Carioca). Participants further showed mixed responses to class pace and music choices. Suggestions implied that better choices for rhythmic music and pacing could have been made, for example (a) to better match the movements with the rhythm of the music; (b) to ensure that the music be played at a volume for all to hear; and (c) to select a pace that should allow everyone to follow the teacher's lead.

Table 4. Self-Reported Perceived Difficulty in Performing Movements by Participants With Parkinson Disease in a Modern Dance Class

Movement	Average Score
Flexing/extending spine	3.6
Turning	4.3
Stepping sideways, diagonally, and circle	3.6
Rhythmic stepping	4
Coordinating arm and leg movements	7.3
Improvising	4.6

Likert-type scale—1 = *easiest*, 10 = *hardest*.

Evidence supports the use of verbal, visual, and auditory cueing in exercise for correct body placement and movement timing, both of which enhance movement ease and safety (Nieuwboer et al., 2007). In dance, augmented auditory cues promote movement initiation (downbeat), sequencing (connection and flow of movement), and problem solving in programming body coordination (e.g., walking and clapping). Auditory cueing appears to improve gait initiation, walking speed, and cadence (Howe, Lovgreen, Cody, Ashton, & Oldham,, 2003) and decreases severity of freezing (Siegert et al., 2002). In a study using positron emission tomography, healthy subjects performing a stepping sequence to a tango beat found increased activity in the basal ganglia, especially the putamen (Brown et al., 2006). Initial speculation purports that auditory cues might bypass defective loops from the basal ganglia via other thalamic and cerebellar pathways (Nieuwboer et al., 1997). Yet, it appeared from participant feedback that the kind of music (its rhythm, loudness, and complexity) was important in helping sustain motor learning. In this study, an average of five different rhythmic choices were introduced throughout the study (e.g., waltz, soft rock, Celtic, and other popular music), as opposed to the tango (Hackney et al., 2007) where the timing of step patterns is governed by a unified strong, repetitive rhythmic beat.

Movement Choices

Of interest were responses to Item 4, which asked participants to rate hallmark movements used in the class using a Likert-type scale of 1–10 of perceived difficulty (1 *being easiest* and 10 *hardest*; Appendix 1). Judging by participant responses, appears that many of the movements challenged them to nearly the limits of their abilities. Compared to stepping patterns, turning, improvising, or flexing/extending the spine, the most difficult movement option was coordinating arms and legs (mean score 7.3 out of 10, in terms of rated difficulty). These complex patterns of arm-and-leg coordination constituted a large portion of class time (Table 4). This finding suggests that a slower and more individuated progression of movements would be useful in helping participants learn more complex movements. This movement progression could begin with orienting perceptually in the space and warming up more slowly by breathing and moving isolated body parts, before moving into more coordinated patterns.

Video observation showed a number of improvements in coordination and balance with spontaneity of expression and/or movement choice, even among those participants with the highest degree of hypokinesia, masked facies, or tremor. The participants themselves acknowledged few demonstrable changes in balance, however, suggesting a mismatch between self-perception and actual performance. Several remarked that they had entered the study without anticipating any improvements in balance. Given the diagnosis of PD (a degenerative and ''incurable'' disease), some expressed that one should not expect to see improvement, especially given the brevity of the study. Three of the 11

persons noticed positive improvements while walking (e.g., spontaneous arm swing). A more common response was increased awareness of the degree of deficit (e.g., the need to improve one's "posture" or "coordination") or increased self-efficacy ("The most important thing I learned was to ask for help when I am confused."). Although the study questionnaire captured a number of direct and implied comments relating to overall participation, future surveys might enhance their sensitivity to change by querying other psychometric factors. For example, it would behoove researchers to administer a survey several times during a study to capture subjective perceptions of bodily sensations and feelings related to well-being and movement ease and aspects of self-efficacy (Johnson & Almeida, 2007).

Familiarity

Participants acknowledging the highest degree of satisfaction with the study were those who had backgrounds in ballroom dance. These participants were most likely to report spontaneous improvements in balance and satisfaction with music and movement choices and class pacing, as well as to notice positive changes in their movement profile (such as balance improvements, spontaneous arm swings with walking, and being faster on their feet). Others felt they needed much more time to "master" the steps, with at least three of the participants finding the movements too unfamiliar and complex to begin to master. In the latter case, participants varied in their emotional reactions to this challenge, either by "joining in the fun" regardless or feeling more "isolated" as a consequence.

Perceived Value

Despite visible and verbal expressions of group enjoyment and few complaints of physical discomfort or disease throughout the study, only 1 participant of the 11 stated that she would continue to seek other dance classes offered in the community. Some stated lack of interest in this kind of dance (one participant with 100% attendance remarking that he "just didn't like modern dance."). Others claimed to be too busy to add more activities to their schedule of activities and others expressed a wish to avoid participating in unfamiliar groups and settings.

Suggestions for Future Research

Although feasibility studies can help researchers in gauging the potential clinical utility of an exercise class, more controlled studies are needed to improve validity and sensitivity of a number of factors. At the most fundamental level, increased sample sizes with randomized experimental and control groups to test the efficacy of dance as compared with another form of related exercise would strengthen the findings in this study. Selecting among those persons with "tremor-dominant" Parkinson disease versus those with "postural instability-gait-difficulty" could better help stratify subjects. Furthermore, more quantitative testing of postural control and balance would help with stratification and with class design. A retention phase would help consolidate motor learning findings through tracking motivation to continue exercising, fall rates, freezing episodes, and other events over at least a 3-month period. Other factors needing further scrutiny and control include group delivery, teacher training, and dosage (e.g., length or intensity of classes); these will be discussed below.

Group Delivery

Group classes offer a cost-efficient way to deliver "therapeutic" interventions and have been shown to offer physical and social benefits, including for persons with PD (Earhart, 2009). Compliance, lack of attrition, and the general upbeat tenor and camaraderie of the group throughout

the study suggested that the social benefits in this study concurred with previous evidence (Cruise et al., 2010). Among the elderly, evidence for social benefits of group exercise is robust (Elward & Larson, 1992). Social interaction among people living with the same disease appears to be a stronger predictor for continuing to exercise than any individual motivation to improve physical capabilities (Allen, Dodd, Taylor, McBurney, & Larkin, 2004). This group, already engaged in physical activities and/or therapy, appeared to enjoy the movement challenges, and the opportunity to participate in a noncompetitive or nonjudgmental atmosphere. Members of the group generally looked out for one another, for example, by assisting others who froze or were having difficulty comprehending more complex locomotor movements by holding their hand and guiding them along.

A question looms large regarding the optimal group size. Given only one instructor, how large a group with Parkinson's should be recruited to ensure that individual needs are met and that the group as a whole can participate safely? Guidelines exist for a feasible patient-to-instructor ratio in exercise classes for adults with diverse deficits post-stroke. In one study involving a slow paced exercise protocol within a tightly controlled environment, researchers suggest an 8-to-1 ratio (participants-to-trained instructor; Mount, Bolton, Cesari, Guzzardo, & Tarsi, 2005), while in another more vigorous aerobic protocol, a 3-to-1 ratio is suggested (Eng et al., 2003). Implied is these findings is that the greater the type and degree of deficit, the lower the ratio should be of participants to trained personnel (Mount et al., 2005), especially when more dynamic exercises of balance and agility are involved (Eng et al., 2003). No guidelines are evident for participant-to-instructor ratio for group-delivered classes for persons with PD. In this study, one teacher was responsible for a class of 11 with no additional assistance. Instruction was primarily verbal with music accompaniment and any hands-on guidance was kept to a minimum to encourage participants to move independently. When participants in this study appeared stuck (frozen) or unable to keep up with the pace, they either sat down, or received some verbal or manual guidance from another class member. This did not appear to affect the overall pace of the class. Future class designs, however, might benefit from increased stratification of participants, so that movement choices can better address the needs of each individual within the group context.

Teacher Training

With the growing popularity of dance programs for people with PD, caution must be exercised in that some programs have not been tested scientifically for efficacy (Hirsch, 2009). Participants from this study implied the need to adjust pacing, rhythm, and to increase sensitivity to individual needs within the group. At this point in time, scant information exists on training instructors to teach exercise to people with PD. Short-term seminars are being initiated by dance and rehabilitation centers to teach dancers basic skills (Westheimer, 2008), but no medical credentialing or practice guidelines exist (Hirsch, 2009). It is suggested that community-based teaching programs at a minimum should include training addressing basic exercise physiology, first aid, and emergency procedures (Hirsch, 2009). In this study, the group found the overall pace of the class too fast, preferring a slower pace and progression. More than half the members of the group implied that movement choices were too complex and novel in commensurate with levels of learning and gains made.

Dosage

Because of the multiple psychophysical and intrinsic and extrinsic variables associated with exercise effects, determining the exercise prescription (optimal mode, frequency, duration, and intensity) that will trigger physiological gains is a complex process (Hirsch, 2009). Dosage for this study was

determined largely by availability of research team participants and anticipation of participant and caregiver burden in attending a relatively intensive exercise program. The entire study required 4 hr of research team training prior to the pretest phase, 1 hr of intake and post-study testing per participant, and 11 hr of class time (exclusive of travel time). This dosage approximated half of that of previous studies on tango (1-hr session twice a week for 10 weeks (20 sessions in total; Hackney & Earhart, 2010; Hackney et al, 2007).

Exercise prescription should be evaluated in light of the evidence on brain plasticity. Models of PD and exercise (both animal and human) suggest that intense sensorimotor training changes the brain and positively affects a number of other systems (Hirsch & Farley, 2009). Focused, high-intensity exercise may ameliorate the signs and symptoms and neurometabolic pathophysiology of PD (Hirsch & Farley, 2009). Impact includes slowing the motor deterioration associated with disease progression; prophylactic protection of dopaminergic neurons and metabolites from toxic events, decreasing the psychophysical stresses of inactivity and the disease itself (Dibble, Hale, Marcus, Gerber, & LaStayo, 2009; Ridgel, Vitek, & Alberts, 2009). In this study, small, but significant gains were recorded in the posttest FAB scores, but without follow-up, it is impossible to determine the long-term effects or potential functional gains.

Concluding Summary

For this sample of adults with early-to-middle stage PD, modern dance appeared to offer a pleasurable and feasible alternative to other modes of exercise—one that is cost-effective, relatively simple to administer, and with social as well as potentially functional benefits. Future studies clearly would benefit from larger and more tightly stratified and randomized experimental and control groups. Dosage needs to be specifically determined with long-term retention and functional transfer in mind. Future studies also might include a retention phase that would track fall history, freezing episodes, and quality of life factors (Ravenek & Schneider, 2009). Comparing modern dance with tango or modern dance with aerobic dance is necessary to determine efficacious variables and contexts. Further studies await analysis on the specifics of the movement protocol that would better support the use of modern dance in promoting functional gains in this population.

Appendix 1

Feedback Questionnaire

Please respond to these questions as candidly as possible. All responses are entirely voluntary and confidential.

1 **Was this class helpful in finding improved mobility in everyday life?**
Please explain why (or why not) and give examples (e.g., increased stamina, easier to do specific activities, etc.)

2 **Do you think your balance improved?**
How? Where you able to keep up with the pace? Follow the steps? Did your coordination improve over time?

3 **Did the class challenge you?**
Please explain how.

4 **RATE** how easy or hard it was for you to perform the movements
1 = easiest, 10 = hardest
Bending & straightening the spine_____
Turning _____
Stepping sideways, diagonally, or in a circle _____
Moving your arms in coordination with your legs _____
Rhythmic stepping _____
Improvising _____

5 **Which items were ESPECIALLY HELPFUL in keeping pace with the class?**
Taped Music _____
Teacher's verbal cues_____
Watching the teacher_____
Watching others_____

6 **Did the class help you with creative expression?** Give an example.

7 **Did you experience any lingering (prolonged, sustained) unpleasant effects (e.g., dizziness, muscle soreness, etc.)?**

8 **What was the most important thing you learned?**

9 **Did the class inspire you to join another dance class in the community?** If not, why not?

10 **Do you have any recommendations for the research team for designing future studies?**

Author's Note

The Parkinson's Knowledge and Needs Exchange™ Survey was commissioned and funded by Boehringer Ingelheim Pharmaceuticals, Inc. GfK Roper Public Affairs & Media designed and conducted the survey on behalf of Boehringer Ingelheim Pharmaceuticals, Inc. (National Parkinson's Disease Foundation Parkinson's Knowledge and Needs Exchange Survey, 2008).

Declaration of Conflicting Interests

The author(s) declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research and/or authorship of this article: The Graduate School of Winston-Salem State University.

References

Allen, J., Dodd, K. J., Taylor, N. F., McBurney, H., & Larkin, H. (2004). Strength training can be enjoyable and beneficial for adults with cerebral palsy. *Disability and Rehabilitation*, *19*, 1121-1127.

Baker, K., Rochester, L., & Nieuwboer, A. (2007). The immediate effect of attentional, auditory, and a combined cue strategy on gait during single and dual tasks in Parkinson's disease. *Archives of Physical Medicine and Rehabilitation*, *88*, 1593-1600.

Ballanger, B., Thobois, S., Baraduc, P., Turner, R. S., Broussolle, E., & Desmurget, M. (2006). Paradoxical kinesis is not a hallmark of Parkinson's disease but a general property of the motor system. *Movement Disorders*, *21*, 1490-1495.

Berg, K., Wood-Dauphinee, S., Williams, J. I., & Maki, B. (1992). Measuring balance in the elderly: validation of an instrument. *Canadian Journal of Public Health*, *S2*, S7-S11.

Bloem, B. R., Hausdorff, J. M., Visser, J. E., & Giladi, N. (2004). Falls and freezing of gait in Parkinson's disease: a review of two interconnected, episodic phenomena. *Movement Disorders*, *19*, 871-884.

Bower, J. H., Maraganore, D. M., McDonnell, S. K., & Rocca, W. A. (1999). Incidence and distribution of parkinsonism in Olmsted County, Minnesota, 1976–1990. *Neurology*, *52*, 1214-1220.

Brown, S., Martinez, M. J., & Parsons, L. M. (2006). The neural basis of human dance. *Cerebral Cortex*, *16*, 1157-1167.

Brusse, K. J., Zimdars, S., Zalewski, K. R., & Steffen, T. M. (2005). Testing functional performance in people with Parkinson disease. *Physical Therapy*, *85*, 134-141.

Cruise, K. E., Bucks, R. S., Loftus, A. M, Newton, R. U., Pegoraro, R., & Thomas, M. G. (2010). Exercise and Parkinson's: Benefits for cognition and quality of life. *Acta Neurologica Scandinavica*. Published ahead of Print, March 1.

Dibble, L. E., Hale, T. F., Marcus, R. I., Gerber, J. P., & LaStayo, P. C. (2009). High intensity eccentric resistance training decreases bradykinesia and improves quality of life in persons with Parkinson's disease: A preliminary study. *Parkinsonism and Relative Disorders*, *15*, 752-757.

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

Elward, K., & Larson, E. G. (1992). Benefits of exercise for older adults. A review of existing evidence and current recommendations for the general population. *Clinics in Geriatric Medicine*, *8*, 35-50.

Eng, J. J., Chu, K. S., Maria Kim, C., Dawson, A. S., Carswell, A., & Hepburn, K. E. (2003). A community-based group exercise program for persons with chronic stroke. *Medicine and Science in Sports and Exercise*, *35*, 1271-1278.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state": A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, *12*, 189-198.

Gallese, V. (2007). Before and below 'theory of mind': Embodied simulation and the neural correlates of social cognition. *Philosophical Transactions of the Royal Society of London, B Biological Sciences*, *362*, 659-669.

Goodwin, V. A., Richards, S. H., Taylor, R. S., & Campbell, J. L. (2008). The effectiveness of exercise interventions for people with Parkinson's disease: A systematic review and meta-analysis. *Movement Disorders*, *23*, 631-640.

Hackney, M. E., & Earhart, G. M. (2010). Effects of dance on gait and balance in Parkinson's disease: A comparison of partnered and nonpartnered dance movement. *Neurorehabilitation and neural repair*, *24*, 284-392.

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

Haggard, P. (1997). Coordinating actions. *Qualitative Journal of Experimental Psychology A*, *50*, 707-725.

Haggard, P., & Wolpert, D. M. (2005). Disorders of body scheme. In J.-J. Freund, M. Jeannerod, M. Hallet, & R. C. Leiguarda (Eds.), *Higher order motor disorders* (pp. 261-272). Oxford, UK: Oxford University Press.

Hanna, J. L. (2008). A nonverbal language for imagining and learning: Dance education in K-12 curriculum. *Educational Researcher*, *37*, 491-506.

Hernandez, D., & Rose, D. J. (2008). Predicting which older adults will or will not fall using the Fullerton Advanced Balance scale. *Archives of Physical Medicine and Rehabilitation*, *89*, 2309-2315.

Hirsch, M. A. (2009). Community-based rehabilitation for Parkinson's disease: From neurons to neighborhoods. *Parkinsonism and Related Disorders*, *1553*, S114–S117.

Hirsch, M. A., & Farley, B. C. (2009). Exercise, neuroplasticity and Parkinson's disease. *European Journal of Physical Rehabilitation Medicine*, *45*, 215-229.

Hirsch, M. A., Toole, T., Maitland, C. G., & Rider, R. A. (2003). The effects of balance training and high-intensity resistance training on persons with idiopathic Parkinson's disease. *Archives of Physical Medicine and Rehabilitation*, *84*, 1109-1117.

Hoehn, M. M., & Yahr, M. D. (1967). Parkinsonism: Onset, progression and mortality. *Neurology*, *17*, 427-442.

Howe, T. E., Lovgreen, B., Cody, F. W., Ashton, V. J., & Oldham, J. A. (2003). Auditory cues can modify the gait of persons with early-stage Parkinson's disease: A method for enhancing parkinsonian walking performance? *Clinical Rehabilitation*, *17*, 363-367.

Hui, E., Chui, B. T., & Woo, J. (2009). Effects of dance on physical and psychological well-being in older persons. *Archives of Gerontology and Geriatrics*, *49*, e45-e60.

Jacobs, J. V., & Horak, F. B. (2007). Cortical control of postural responses. *Journal of Neural Transmission*, *114*, 1339-1348.

Jacobs, J. V., Horak, F. B., Tran, V. K., & Nutt, J. G. (2006). An alternative clinical postural stability test for patients with Parkinson's disease. *Journal of Neurology*, *253*, 1404-1413.

Jefferson, A. L., Cosentino, S. A., Ball, S. K., Bogdanoff, B., Leopold, N., Kaplan, E., & Libon, D. J. (2002). Errors produced on the mini-mental state examination and neuropsychological test performance in Alzheimer's disease, ischemic vascular dementia, and Parkinson's disease. *Journal of Neuropsychiatry and Clinical Neurosciences*, *14*, 311-320.

Johnson, A. M., & Almeida, Q. J. (2007). Exercise and Parkinson's disease: Musculoskeletal rehabilation strategies. *Geriatrics and Aging*, *10*, 318-321.

Kim, S., Horak, F. B., Carson-Kuhta, P., & Park, S. (2009). Postural feedback scaling deficits in Parkinson's disease. *Journal of Neurophysiology*, *102*, 2910-2920.

King, L. A., & Horak, J. B. (2009). Delaying mobility disability in people with Parkinson disease using a sensorimotor agility exercise program. *Physical Therapy*, *89*, 384-393.

Li, F., Harmer, P., Fisher, K. J., Xu, J., Fitzgerald, K., & Vongiaturapat, N. (2007). Tai Chi-based exercise for older adults with Parkinson's disease: A pilot-program evaluation. *Journal of Aging and Physical Activity*, *15*, 139-151.

Longstaff, J. S. (2000). Re-evaluating Rudolf Laban's choreutics. *Perceptual and Motor Skills*, *91*, 191-210.

LSVTGlobal®. (2010). Rehabilitative therapy for people with Parkinson's. Retrieved on July from http://www.lsvtglobal.com/index.php?action=schedule

Mak, M. K. Y., & Pang, M. Y. C. (2009). Balance confidence and functional mobility are independently associated with falls in people with Parkinson's disease. *Journal of Neurology*, *256*, 742-749.

Marchetti, G. F., & Whitney, S. L. (2006). Construction and validation of the 4-item Dynamic Gait Index. *Physical Therapy*, *86*, 1561-1660.

McKinley, P., Jacobson, A., Leroux, A., Badnarczyk, V., Rossignot, M., & Fung, J. (2008). Effect of a community-based Argentine tango dance program on functional balance and confidence in older adults. *Journal of Aging and Physical Activity*, *16*, 435-453.

Morris, M. E., Iansek, R., Summers, J. J., & Matyas, T. A. (1995). Motor control considerations for the rehabilitation of gait in Parkinson's disease. In D. J. Glencross & J. P. Piek (Eds.), *Motor control and sensory integration: Issues and directions* (pp. 61-93). Amsterdam, NL: Elsevier.

Morris, S., Morris, M. E., & Iansek, R. (2001). Reliability of measurements obtained with the Timed "Up and Go" test in people with Parkinson disease. *Physical Therapy*, *81*, 810-118.

Mount, J., Bolton, M., Cesari, M., Guzzardo, K., & Tarsi, J., Jr. (2005). Group balance skills class for people with chronic stroke: A case series. *Journal of Neurological Physical Therapy*, *29*, 24-33.

National Parkinson's Disease Foundation Parkinson's Knowledge and Needs Exchange Survey. (2008). Retrieved on 16 July from http://us.boehringer-ingelheim.com/news_events/press_releases/press_release_archive/2008/oct_7_2008.html

Nieuwboer, A., De Weerdt, W., Dom, R., & Lesaffre, E. (1998). A frequency and correlation analysis of motor deficits in Parkinson patients. *Disability and Rehabilitation*, *20*, 142-150.

Nieuwboer, A., Kwakkel, G., Rochester, L., Jones, D., van Wegen, E., Willems, A. M., & Lim, I. (2007). Cueing training in the home improves gait-related mobility in Parkinson's disease: The RESCUE trial. *Journal of Neurology, Neurosurgery, and Psychiatry*, *78*, 134-140.

Nordin, E., Rosendahl, R., & Lundin-Olssen, L. (2006). Timed "Up & Go" test: Reliability in older people dependent in activities of daily living—focus on cognitive style. *Physical Therapy*, *86*, 646-655.

O'Brien, M., Dodd, K. J., & Bilney, B. (2008). A qualitative analysis of a progressive resistance exercise programme for people with Parkinson's disease. *Disability and Rehabiliation*, *30*, 1350-1357.

Olanow, C. W., & Tatton, W. G. (1999). Etiology and pathogenesis of Parkinson's disease. *Annual Review of Neuroscience*, *22*, 123-144.

Portney, L., & Watkins, M. (2008). *Foundation of clinical research: Applications to practice* (3rd ed.). Upper Saddle River, NJ: Prentice Hall.

Ravenek, J. J., & Schneider, M. A. (2009). Social support for physical activity and perceptions of control in early Parkinson's disease. *Disability and Rehabilitation*, *21*, 1-12.

Ridgel, A. L., Vitek, J. L., & Alberts, J. L. (2009). Forced, not voluntary, exercise improves motor function in Parkinson's disease patients. *Neurorehabilitation and Neural Repair*, *23*, 600-608.

Ries, J. D., Echternach, J. L., Nof, L., & Blodgett, M. G. (2009). Test-retest reliability and minimal detectable change on the Timed "Up and Go" test, the Six-Minute Walk test and gait speed in people with Alzheimer disease. *Physical Therapy*, *89*, 569-579.

Rose, D. J., Lucchese, N., & Wiersma, L. D. (2006). Development of a multidimensional balance scale of use with functionally independent older adults. *Archives of Physical Medicine and Rehabilitation*, *87*, 1478-1495.

Song, R., June, K. J., Kim, C. G., & Jeon, M. Y. (2004). Comparisons of motivation, health behaviors, and functional status among elders in residential homes in Korea. *Public Health Nursing*, *21*, 361-371.

Smith, N. A., & Batson, G. (2010). Postural control in adults with idiopathic Parkinson disease: Treating complex balance deficits with multi-system approaches. *Geri Notes: Journal of the Geriatric Section of the American Physical Therapy Association*, *17*, 16-19.

Schmidt, R. A., & Lee, T. D. (2005). *Motor control and learning: A behavioral emphasis.* (5th ed.). Champaign, IL: Human Kinetics Press.

Siegert, R. J., Harper, D. N., Cameron, F. B., Abernethy, D. (2002). Self-initiated versus externally cued reaction times in Parkinson's disease. *Journal of Clinical and Experimental Neuropsychology*, *24*, 146-153.

Skidmore, F. M., Patterson, S. I., Shulman, L. M., Sorkin, J. D., & Macko, R. F. (2008). Pilot safety and feasibility of treadmill aerobic exercise in Parkinson disease with gait impairment. *Journal of Rehabilitation Research and Development*, *45*, 117-124.

Stevens, C., & McKechnie, S. (2005). Thinking in action: Thought made visible in contemporary dance. *Cognitive Process*, *6*, 243-252.

Shumway-Cook, A., Brauer, S., & Woollacott, M. (2000). Predicting the probability for falls in community-dwelling older adults using the timed up & go test. *Physical Therapy*, *80*, 896-903.

Shumway-Cook, A., & Horak, F. B. (1986). Assessing the influence of sensory interaction on balance. *Physical Therapy*, *66*, 1548-1550.

Thrane, G., Joakimsen, R. M., & Thornquist, E. (2007). The association between timed up and go test and history of falls: The tromso study. *British Medical Journal Geriatrics*, *7*, 1.

Tinetti, M. E. (1986). Performance-oriented assessment of mobility problems in elderly patients. *Journal of Aging and Geriatric Studies*, *34*, 119-126.

Westheimer, O. (2008). Why dance in Parkinson's disease. *Topics in Geriatric Rehabilitation*, *24*, 127-140.

Bio

Glenna Batson, PT, ScD, MA, is an associate professor of physical therapy at Winston-Salem State University with more than three decades of involvement in complementary and integrative approaches to self-care. Recent research includes validating clinical tools for detecting balance deficits in elite dancers, and the effects of perceptuo-motor learning on balance, using the Alexander Technique and mental practice of motor imagery in the elderly and Feldenkrais Method® on adults post-stroke.